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A CAREER GUIDE FOR PROFESSIONAL ENGINEERS

Paving the way to an exciting future



Published by the Association of
Consulting Engineers of Namibia

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solutions do not always emerge at the first attempt and because the project may take a very long time before it is completed.

He should have good communication skills and interpersonal relations. An aptitude and interest in experimenting, mathematical calculations and planning are also of great importance.

The mechanical engineer should be someone with integrity and good management skills to enable him to progress easily into senior positions within his company.

To study mechanical engineering at a university, matric exemption is required and most universities require at least a C symbol in Mathematics and Physical Science to be accepted to study Mechanical Engineering.

After a student has obtained a B.Sc degree in Engineering, a three-year practical training period is required before the

may register as a professional engineer. Technicians now also offer degrees in engineering (Bachelor of Technology - B.Tech). The duration of studies is a minimum of four years. If a student does not wish to follow a degree course at a technician he may enroll for a three-year National Diploma course in any of the engineering disciplines.

Work possibilities

Mechanical engineers can work in various positions in government departments. There are also a host of mining houses and private industries and consultants where a mechanical engineer can go and work for.

A registered mechanical engineer with the appropriate experience and initiative can work as a consultant for the government or a private company or he can start his own construction or manufacturing engineering company.



The industrial engineer plays a major role in the industrial and manufacturing process. This includes production technology and quality control.

railways, drilling machines and ventilation fans to name only a few of the devices.

4.5.2 Power Generation

Engineers in this field attempt to provide in the energy requirements of consumers. In this field the mechanical engineer mainly works with big steam turbines and they also study the effective use of solar energy and the generation of electricity through heat.

4.5.3 Transport

These engineers work in close relation with other engineering specialists to design and develop aircraft, ships, motor cars as well as steam and gas turbines and petrol and diesel engines. New kinds of engines are continuously being developed and designed.

4.5.4 Biomedical Engineering

Excellent examples of the mechanical engineer's activities in the biomedical engineering field are the development of the hart-lung machine, artificial kidney machine, pacemaker, heart valves, artificial limbs and operation monitors.

4.5.5 Agriculture

Mechanical engineering brought a change in farming methods by providing equipment such as tractors, harvesters and milking machines. Engineers in this field assist in the economic production of food.

4.5.6 Environmental Engineering

Specialist mechanical engineers create a controlled environment that humans require in order to work comfortably. This field of study is being called ergonomics and is important for the engineer that does development stud-



Biomedical engineering includes the development of medical equipment such as pacemakers, operation monitors, heart valves and artificial limbs.

ies. Mechanical engineers in this field of study work in close relation to engineers from other disciplines.

4.5.7 Industrial Engineering

The mechanical engineer plays a major role in the industrial and manufacturing process. This includes production technology and quality control.

Requirements

The prospective mechanical engineer must have the ability to see and interpret a three-dimensional drawing and have the ability to carry out complex calculations. He must also have perseverance, as

FOREWORD

By the Honourable Minister of Works,
Transport and Communication,
Mr O V Plichta

It is with pleasure that I, as the Minister of Works, Transport and Communication, undertake to write the foreword for the Career Guidance Book, an initiative of the Association of Consulting Engineers of Namibia.

This publication has been developed to provide a primary source of information for scholars aspiring to enter the field of Engineering.

The field of Engineering, including engineers, technicians and technologists, plays a vital role in any country, but especially in a developing country where infrastructure such as roads, bridges, electrification of rural areas, pipelines, dams, buildings, factories and transport studies has become a major necessity.

Namibia is now in a position to train its own technicians at the Polytechnic of Namibia, keeping pace with expansion.

The Association of Consulting Engineers of Namibia that acts as the voice of the consulting engineer in Namibia, has identified the need in secondary schools to acquire information regarding the engineering profession. The direct result is the Career Guidance Book that explains, in simple terms, the various options an aspiring engineer or technician will have when choosing a career in the engineering field.

Furthermore, congratulations to the



**Honourable Minister O V Plichta,
Minister of Works, Transport and
Communication**

Association for translating their vision of establishing a strong engineers corps in Namibia through this study guide and in doing so contributing to creating a solid force of Namibian engineers from all the regions of the country. I trust that the result will be positive and that Namibia will benefit from this action in the years to come.

1. Paving the way to an exciting career

1.1 What it takes to become an engineer

The engineering profession is one of the most exciting and challenging careers available in the world. Namibia as a developing country offers many opportunities to professional engineers, professional technologists and technicians.

The Association of Consulting Engineers of Namibia (ACEN) endeavours to introduce all Namibian scholars to the profession and to canvass for prospective engineering students. Namibia needs its own engineers.

The ACEN has therefore decided to publish this career guide to assist you in making the best career choice and paving the way for you to establish yourself in the engineering industry.

Engineering provides a wide range of alternatives enabling you to use your abilities to the full. The variety of this career can reap immense personal rewards. You can choose to become part of a government department, a multinational organisation, or join a specialist company to work in a laboratory, or work from home.

You may wish to undertake fundamental research to broaden the horizons of industry. The engineering team in any discipline is made up of a number of people with different skills and expertise, each playing a vital role in ensuring that the tasks in hand are executed competently.

An *engineer* is a person who has



Engineering provides a wide range of alternatives enabling you to use your abilities to the full.

undergone professional training in pure and applied science. Engineering is a profession in which a knowledge of the mathematical and physical sciences, gained by study, experience and practice, is applied to the efficient use of the materials and forces of nature.

Engineering has various disciplines: mechanical, electrical, structural, industrial, chemical and civil engineering and within each discipline are many fields in which one can specialise.

maintenance control of these systems. General applications for Electronic Engineers can be found with government and semi-government institutions, as well as private consultancy and telecom and data industry.

4.5 Mechanical Engineering

The mechanical engineer's task includes the design, construction, installation, maintenance and marketing of mechanical equipment in various fields of application. He/she applies his/her knowledge practically in the development of techniques and establishing of industries. The mechanical engineer also manages his department and is in control of the budget.

Mechanical engineering can be considered the corner-stone of modern

technology and this engineer works with all forms of mechanically powered equipment that leads the way to greater convenience, progress and safety of mankind.

Mechanical engineers usually work in offices and sometimes make use of laboratories. They also have to travel and have to inspect the sites where equipment has to be installed and or was installed.

There are different fields of activities and for a mechanical engineer to be productive in all of these fields is impossible, therefore they specialise in one of the following fields:

4.5.1 Mining

The mining industry sector demands great innovativeness of the mechanical engineer. The mechanical engineer normally has to give input on pumping plants, conveyor belts, underground



The tasks of a mechanical engineer that specialised in the field of mining include the design, construction and installation of mechanical equipment in a mining plant

The electrical energy reaches the consumers through an extensive distribution network. They may use the energy for transport, heating or lighting purposes, to power electrochemical processes, electronic equipment or household apparatus.

The mining industry uses some 30% of the electricity generated in South Africa. The manufacturing industry and households consume 60% of the generated energy and the transport industry uses about 5% of the energy supply. Electrical engineers are responsible for the efficient and safe use of this energy. The electrical engineer's first responsibility is to plan and design these electrical systems starting from energy sourcing, generation and distribution to the use of electricity.

The next responsibility is to monitor and supervise any building and manufacturing processes in this regard. Further, the electrical engineer controls the safe maintenance and operation of all these systems.

General applications to exercise the duties can be found in government service, private consultancy and industry.

Electronic engineers are responsible for the processing and control of information in all forms. The electronic engineer's main task is concerned with the computer-aided control of systems and telecommunications systems. Typical products of these engineers include radio and television systems, computers, video tape recorders and compact disc players, electronic games, radar systems, medical electronic systems and control systems for aircraft and factories. The international telephone network is also a product of the electronic engineer.



Electrical energy reaches consumers through an extensive distribution network designed by engineers

The availability of electrical energy is a key factor for development and information which is becoming an increasingly valuable commodity in modern society. It follows that there is a large demand for electrical and electronic engineers.

Also, with Electronic Engineering applications the engineer is responsible for the planning and design of communication and information systems such as telephone installations or data systems. Subsequent responsibilities are the supervision of manufacturing and installation processes of such equipment as well as the reliable operation and

1.2 Educational Requirements

1.2.1 Secondary Education

A senior certificate with Mathematics, Science and your first language on Higher Grade or HIGCSE level or the first language on IGCSE level when A-level Science subjects are taken. The Polytechnic of Namibia requires a B symbol for Mathematics and Science or Biology on IGCSE level. Students with lower symbols will complete the course over four years and not in the required three years.

1.2.2 Tertiary Education

Professional Engineer

A bachelor's degree in engineering at honours level or equivalent level recognised for this purpose by the Engineering Council, or a qualification which in the opinion of the Council is equivalent thereto, followed by a minimum of 3 years' practical experience to achieve professional status. Responsibilities include conceptual planning, design and the development of innovative technology.

Incorporated Engineer

A four-year B.Tech degree in engineering, recognised for this purpose by the Council or a qualification which in the opinion of the Council is equivalent thereto. Professional status is achieved after three years of experience in a specific discipline of engineering.

Registered Engineering Technician

A diploma in engineering with adequate content, recognised for this purpose by the Council or a qualification

which in the opinion of the Council is equivalent thereto, followed by two years of experience to achieve professional status.

The field of engineering and what your expectations are, would determine where you could study. Once you have decided which direction of engineering you wish to pursue, you can find out which educational institution offers the course you want to follow.

1.3 Job Opportunities

Engineering in all its aspects is a job of demand. Jobs are offered by Municipalities, Government Departments, Private Consulting practices, Contracting firms, Educational Institutions, Research, to name just a few.

1.4 Remuneration

Remuneration will vary according to your qualifications, the sector of employment and the economy of the country.

1.5 Personal Requirements

If you want to become an Engineer, you should:

- Be a diligent worker with the ability to persevere, as the engineering course is taxing.
- Have a creative mind.
- Have a good aptitude for mathematics, science and technology.
- Be able to visualise things.

An engineer's task is mainly of an intellectual nature. Engineering offers a good profession for both men and women.

2. Engineering Disciplines

2.1 Industrial Engineering

Industrial Engineers concern themselves with production in the widest sense to increase production factors to their optimum values.

Industrial engineers are involved in the full life cycle of a product. In the design stage, they see to the functionality and the aesthetic aspects of the product and ensure the manufacturability of the product; they even design the product line on which the product is manufactured. At each step of production they identify and choose the most economical alternative. That may include an automated process, like a manufacturing robot.

The study and the use of labour and machines in the most productive manner play a significant part of the industrial engineer's daily task. Industrial engineers also design and manage large informative systems and help to develop a scientific basis for making management decisions.

2.2 Chemical Engineering

Chemical engineers must convert the laboratory chemist's test tube reaction into a process that will produce hundreds or thousands of tons of a particular product daily.

Chemical engineers develop industrial processes that change the composition or characteristics of material on a large scale, for example food, petroleum, mining and minerals, fertiliser, paper, glass and pharmaceutical industries.

An interest in chemistry, managing and

operating installations are important for success as a chemical engineer. Chemical engineers deliver products that play an important role in every aspect of modern society.

2.3 Electrical and Electronic Engineering

Electrical and electronic engineers work with electrical energy systems and information systems.

2.3.1 Electrical Engineers

Electrical engineers are responsible for the generation of electricity in power stations where the primary energy source (coal, hydro-energy, nuclear energy) is converted into electrical energy.

The electrical energy reaches the consumers through a distribution network. They may use the energy for heating, lighting or transport purposes, to power electrochemical processes, electronic equipment and household appliances. Electrical engineers are responsible for the efficient and safe use of this energy.

2.3.2 Electronic Engineers

Electronic engineers are responsible for the processing and control of information in all forms.

The electronic engineer's main task is the computer-aided control of systems and telecommunications systems. Some products of these engineers include radio and television, computers, video and hi-fi equipment, electronic games, medical electronic systems, telephone

normally the project leader when a new office block or shopping complex is being developed.

During the design of a building the architect is responsible for the attractiveness of the building and the structural engineer is responsible for the stability of the building - by designing the structural frame which will be clad by brickwork or panelling.

To ensure that a safe structure is provided as basis for the building an accurate detail analysis is made of:

- The soil conditions, i.e. how the settlement of soil will affect the completed structure.
 - The materials proposed for construction, i.e. determine how the proposed materials will react to movement, wind-forces and load forces that will be applied to the structure.
 - The wind effects, i.e. what precaution must be taken to ensure that the structure will not fall over when the wind blows at high speeds.
 - The thickness of columns, footing sizes, concrete slabs and amount of reinforcing in concrete.
- The ratio/relation between concrete thickness and reinforcing used will determine the bending movement the structure can resist. The reinforcement will also prevent the concrete from cracking.
- The sizes of structural steel sections in roof trusses and steel beams.

Structural engineers also design large timber trusses for roofs. The engineer must ensure that the roof will withstand major wind, hail or snow storms.

Structural engineers have to be above reproach at their jobs; too much is at stake for everyone involved.

An unusual aspect of being a structural engineer is that an engineer has to understand the timing of construction projects better than the construction manager himself. This is because random inspections and unsupervised tours through the construction site are critical to keeping builders honest and the public safe. If a structural engineer conducts these inspections at a time when construction is stalled, insignificant or complete, he cannot tell whether the work was carried out properly without tearing down the building. A structural engineer must be familiar with all the aspects of construction and the methods of construction. Structural engineers have to have a keen eye for detail and a comprehensive understanding of building standards and materials - their job is a difficult, important but rewarding one.

4.4 Electrical and Electronic Engineering

Electrical and electronic engineers work with electrical energy systems and information systems

Electrical engineers are responsible for the generation of electricity in power stations where the primary source of energy (e.g. coal, nuclear energy, hydro-energy) is converted to electrical energy.

4.2.2 Water Engineering

Water engineering deals with the sustainable utilisation, control, treatment, protection and management of water for the benefit of mankind and the environment. It includes the following activities: water supply, sewerage, drainage, irrigation, flood control, erosion control, water and wastewater treatment, water pollution control, hydro-electric generation, coastal and marine engineering and water resources management.

4.3 Civil Engineer: Structural

Structural engineers do not mind that some see them as the police of the construction industry; most enjoy making sure that structures are safe and sound. "If we don't do our job properly, everyone pays." People just assume that places they live, play and work in are safe. Without proper designs by structural engineers structures may suffer damage and become unsafe, high-rise buildings and bridges might collapse, high towers and pavilions will be unsafe and factory buildings will collapse during wind storms.

Much of the structural engineer's job takes place on-site, often outdoors, at various stages of construction of public and private projects. The structural integrity of a building is based on sound engineering principles.

The structural engineer often works as a team with the architect, quantity surveyor, electrical engineer and the mechanical engineer. The architect is



Electronic engineers are responsible for the processing and control of information in all forms

networks, aircraft control systems, etc. The availability of electrical energy is a main factor for development and information and is becoming of increasing value in our modern society.

2.4 Mechanical Engineering

Nearly all branches of mechanical engineering are linked with the development of engines, pumps, turbines, generators, compressors, vehicles, ships, aircrafts, etc.

Mechanical engineers are responsible for the design, development, production and marketing of these machines. They also organise and run industrial installations and process plants.

At graduate level, mechanical engineers can specialise in fields such as machine design, marine engineering, naval architecture, aeronautical engineering, air conditioning and refrigeration and vehicle engineering.

Computer-aided design is a tool for modern mechanical engineers.

2.4.1 Mechanical engineering as applied to the water industry

Engineers in this field design, test, build, and operate various types of machinery. The field is divided into pumps and other machinery, mechanisms, materials, hydraulics, pneumatics, energy, heating, ventilating and airconditioning. The mechanical engineer, therefore, must be trained in mechanics, hydraulics, and thermodynamics and must have a detailed knowledge of subjects such as metallurgy and machine design. A mechanical engineer designs the machines that make products and must see to it that the design is both economically viable and efficient.

2.4.2 Naval, Marine and Coastal Engineers

Naval engineers design and supervise the construction of ships, while marine engineering, a specialised branch of mechanical engineering, is concerned with the design and operation of systems needed to propel a ship and keep it afloat.

Coastal engineers, on the other hand, are concerned with designing and construction of marine structures.

2.5 Civil Engineering

The field of civil engineering has been known as such since the mid-18th century when that designation was adopted to distinguish it from military engineering. The latter was then particularly active in building fortifications in Europe. However, the profession goes back to ancient times when engineers used their



Pumping installations, pipelines and purification plants are all engineering installations.

4.2.1 Water Supply and Waterworks

Waterworks such as purification plants, pumping installations, pipelines, canals, reservoirs, wells, and water towers are man-made devices for diverting and collecting water from the water sources. These are all engineering installations necessary to treat and deliver the water to the consumers and to cope with the occurrence and movement of water in our habitats. The treatment of water is necessary because of contamination of water in reservoirs, wells, and rivers and the requirement to render the water safe for human consumption and non-aggressive to water supply infrastructure.



information. It offers a varied career and as long as there is motorised transport there will be a requirement for roads engineers, technicians and artisans.

2.5.3 Geotechnical Engineers

Geotechnical engineers study rock and soil mechanics and take responsibility for the design of effective and economic earth and rock structures, dam walls and road fillings.

2.5.4 Transportation Engineers

Transportation engineers are involved in the design and construction of roads, railways, airport runways and traffic systems.

2.5.5 Process Engineers

This branch of engineering is a specialisation that flows out from Civil or Chemical Engineering. It is concerned with the process design of water and wastewater treatment facilities. The practice is to analyse process engineering problems in terms of fundamental unit operations or unit processes. It is the task of the process engineer to select and specify the design that will best meet the particular requirements of process and the most appropriate equipment for the applications.

2.5.6 Sanitary Engineers

This is a branch of civil engineering, but because of its great importance for a healthy environment, especially in dense urban population areas, it has acquired the importance of a specialised field. It is concerned with the control of environmental factors affecting health, including water treatment, supply and distribution; disposal of community wastes and reclamation of useful components of such wastes; control of pollution of surface waterways; control of atmospheric pollution. Over the course of history they have made a particularly significant contribution by creating sanitary systems to reduce disease and improve the environment.

4.1.4.3 Traffic Analysis

The study of traffic and predicting traffic growth are important aspects of roads planning. All designs take into account current and future traffic. Extensive use is made of computer models.

4.1.4.4 Masterplans

A roads masterplan for a region or country is a long-term assessment of road requirements. This is then used to plan the construction of new roads or the upgrading of existing ones.

Road networks are gradually being captured on Geographic Information Systems using the latest in computer technology.

4.1.4.5 Research

Research is continually carried out into improved road-building materials.

4.1.4.6 Construction

Roads Contractors can offer a varied career path leading towards the management of large scale projects. Various technical inputs are required in Construction, including surveying, concrete technology, surfacing technology, programming, formwork design, quantity surveying, etc.

Road Construction also offers careers for artisans such as carpenters, mechanics, drain layers and machine operators.

4.1.5 Summary

The roads industry utilises the latest computer technology in design, planning, asset management, data analysis, project management and the transfer of

intuition, ingenuity and judgement to

create such structures as pyramids and aqueducts. Civil engineering is perhaps the broadest of the engineering fields, for it deals with structural design, soil mechanics, foundation engineering, transportation, water systems, environmental systems, engineering economics, construction management and other disciplines. When specialising in water systems, the civil engineer focuses on hydrology, water dynamics and water infrastructure engineering, such as dams, pumping stations, canals, pipelines, irrigation systems, harbours, docks, aqueducts, tunnels, and other engineered constructions. The civil engineer must have a thorough knowledge of the properties and mechanics of construction materials, the mechanics of structures and soils and of hydraulics and fluid mechanics.

They therefore play a leading role in the development of the infrastructure which improves the quality of life and promotes the basis for a sound economy on which we depend.

Civil engineers usually specialise in one of the following fields:

2.5.1 Structural Engineers

Structural engineers use materials such as concrete, metal, timber and reinforced plastics. These materials are indispensable in the design of large buildings and bridges.

2.5.2 Water Engineers

Water engineers design and build dams, irrigation systems, storm water systems, sewerage and water purification systems and harbours and coastal structures.

Road networks are gradually being captured on Geographic Information systems using the latest in computer technology

4.2 Civil Engineer: Water

Water Engineering is practiced by civil engineers in association with electrical, mechanical and chemical engineers.

A water engineer is required to be specialised in the field of water engineering in which the water and environmental sciences are applied to solve engineering problems in the fields of environmental protection, water management, treatment, supply and utilisation.

