Chapter-1

INTRODUCTION

1.1 Profession

Profession is an occupation that requires advanced training in the liberal arts or sciences and mental rather than manual work (Davis and Cornwell, 2010).

The professionalism is defined by following **seven** characteristics:

- Professional decisions are made by means of general principles, theories or propositions that are independent of the particular case under consideration.
- Professional decisions imply knowledge in a specific area in which the person is expert. The professional is an expert only in his or her profession and not as expert at everything.
- The professional's relations with his or her clients are objective and independent of particular sentiments about them.
- A professional achieves status and financial reward by accomplishment, not by inherent qualities such as birth order, race, religion, sex or age or by membership in a union.
- A professional's decisions are assumed to be on behalf of the client and to be independent of self-interest.
- The professional relates to a voluntary association of professionals.
- A professional is someone who knows better what is good for clients than do the clients. The professional's expertise puts the client into a very vulnerable position. This vulnerability has necessitated the development of strong professional codes and ethics, which serve to protect the client. Such codes are enforced through colleague peer group.

1.2 Engineering

Engineering is a profession that applies mathematics and science to utilize the properties of matter and sources of energy to create useful structures, machines, products, systems and processes (Davis and Cornwell, 2010).

Engineering may be defined as the application, under constraints of scientific principles to the planning, design, construction, and operation of structures, equipment, and systems for the benefit of society (Sincero and Sincero, 1996).

Engineering is the profession in which a knowledge of the mathematical and natural sciences gained by study, experience, and practice is applied with judgment to develop ways to utilize economically the materials and forces of nature for the benefit of human society.

In other words, Engineering may be defined as the application, under constraints of scientific principles to the planning, design, construction and operation of structures, equipment and systems for the benefit of the society. If the tasks performed by environmental engineers were examined, it would be found that the engineers deal with the structures, equipment and systems that are designed to protect and enhance the quality of the environment and to protect and enhance public health and welfare.

"Scientist discover things, Engineers make them work."

Any engineering project, large or small, a product being designed, or a services to be provided encompasses within its implementation a series of decisions made by engineers. Sometimes these decisions turn out to be poor and or not appropriate. A far greater number of decisions, however, made hundred of times a day by hundreds of thousands of engineers, are correct and improve a lot of the human civilization, protect the global environment, and enhance the integrity of the profession. Because so few engineering decisions turn out poorly, engineering decision making is a little-known and rarely discussed process. Yet, when a decision turns out to be wrong, the results are often catastrophic. Often Engineers and Doctors are put on the same footing by the career choosers, however, a doctor can harm only one person at a time while engineer have potential to harm thousands at a time thorough incorrectly designed systems (Vesilind and Morgan, 2004).

1.3 Engineering decisions

Engineering decisions could be based on: (1) technical analysis, (2) cost effectiveness analysis, (3) cost benefit analysis, (3) risk analysis, (4) environmental impact analysis, and (5) ethical analysis.

Technical decisions are quantifiable and can be evaluated and checked by other competent professional engineers. In engineering, there seldom is "one best way" to design a project or a product. If there ever was a best way, then engineering would become stagnant, innovation would cease, and technical paralysis would set in. Just as we recognize there is no single perfect work of art, such as painting or a fashion design, there is no perfect road or a water treatment plant. If there were a perfect plant, painting or a road, all future water treatment plants or roads (not the alignment but the structure!) look alike (Vesilind and Morgan, 2004).

The undergraduate engineering student is often taught during early years of an engineering education that each homework assignment and test question has a single "right" answer and that all other answers are "wrong". But in engineering practice many technical decision may be right, in that a problem may have several equally correct technical solutions. For example, teaching aid in the a class could be: chalk and a duster, white board marker or a LCD projector. Each of these options may have some merits or demerits. Similarly, a sewer can be constructed with a concrete, cast iron, steel, aluminum, plastic or clay materials. With correct engineering design procedures, such a sewer would carry the design flow and , thus, would be technically correct (Vesilind and Morgan, 2004).

When carrying out technical analysis, we often do not have all the information we need to make decisions. Therefore, we must make assumptions. These assumptions, of course, must be made using the best available data with a (sometimes liberal) sprinkling of good judgment.

While technical calculations can answer technical questions, questions of cost require a different form of engineering decision making i.e. cost-effectiveness analysis. Engineering typically find themselves working for an employer or client who requires that various alternatives for solving an engineering problem be analysed on the basis of the cost. For example, if a municipal engineer is considering purchasing refuse collection vehicles and finds that he or she can buy either expensive trucks that achieve great compaction of the refuse, thereby making efficient trips to the landfill, or inexpensive trucks that require more trips to the landfill, how does the engineer know which is less expensive for the community? Obviously, the lowest total cost alternative would be the most rational decision (Vesilind and Morgan, 2004).

If a project is planned, an estimate of the benefits derived is compared in ratio form to the cost incurred. Should this ratio be more that 1.0, the project is clearly worthwhile, and the projects with the highest benefit/cost rations should be constructed first because these will provide the greatest returns on the investment.

Internal Rate of Return (IRR) is an indicator to reflect the profit of the projects. The IRR is the "annualized effective compounded return rate" or "rate of return" that makes the net present value of all cash flows (both positive and negative) from a particular investment equal to zero.

In more specific terms, the IRR of an investment is the discount rate at which the net present value of costs (negative cash flows) of the investment equals the net present value of the benefits (positive cash flows) of the investment.

Internal rates of return are commonly used to evaluate the desirability of investments or projects. The higher a project's internal rate of return, the more desirable it is to undertake the project. Assuming all projects require the same amount of up-front investment, the project with the highest IRR would be considered the best and undertaken first. IRR values of some of the projects in Nepal is shown in Table 1.1.

Table 1.1 Internal rates of return values

Project	Capacity	Project Cost (Arab)	IRR (%)
Lower Arun Hydroelectric Project	310 MW	61.50	10*
Kaligandaki "A" Hydroelectric Project	144 MW	31.70	15.00
Chameliya (Chhetti Gad) Hydroelectric Project	85 MW	13.49	14.00
Upper Trishuli-3 "B" Hydroelectric Project	37 MW	4.31	23.60
Tadi Khola Small Hydro Power Project	5 MW	0.27	16.00
Rural Electrification, Distribution and Transmission (1999)		6.62	14.40
Expansion of Matatirtha Substation	132 kV	0.41	12.42
Butwal to Mahendranagar Transmission-II	132 kV	2.72	14.71
Chapali SS and Lainchaur-Chabel	132 kV/66 kV	0.89	14.17
MMHP-Dumre-Damauli-LMHP Transmission	132 kV	1.07	12.46
Melamchi Water Supply Project	170 MLD	32.48	13.50

*estimated

Often the benefits of a proposed project are not such simple items as recreational value but the more serious concern for human health or other social aspects. When life and health enter benefit/cost calculations, the analyses are generally referred as risk/benefit/cost analysis to indicate that people or resources are at risk. They have in the past few years become more widely known as simply risk analyses. Risk analysis is comprise do risk assessment and risk management. The former involves a study and analysis of the potential effect of certain hazards on human health. Using statistical information, risk assessment is intended to be a tool for making informed decisions. Risk management, on the other hand, is the process of reducing risks that are deemed unacceptable.

In our private lives we are continually doing both. Smoking cigarettes is a risk to our health, and it is possible to calculate the potential effect of smoking. Quitting smoking is a method of risk management because the effect is to reduce the risk of dying of certain diseases. Some risks we choose to accept while other risks are imposed upon us from outside. We choose, for example, to drink alcohol, drive cars, or fly in airplanes. Each of these activities has a calculated risk because people die every year as a result of alcohol abuse, traffic accidents, and airplane crashes. Some risks are imposed from outside and we can do little about them. For example, it has been shown that the life expectancy of people living in a dirty urban atmosphere is considerably shorter than that of people living identical lives but breathing clean air. We can do little about this risk, and it is this type of risk that people resent the most. In fact, studies have shown that the acceptability of an involuntary risk is on the order of 1000 times less than our acceptability of a voluntary risk. Such human behavior can explain why people who smoke cigarettes still get upset about air quality or why people driving recklessly complain about the bad road conditions. Thus for externally imposed risks, it is essential to decide what levels of risks are acceptable. Based on the these values, calculation of acceptable levels of pollution is also possible. This exercise ultimately leads to make a decision about the development of a project or an activity.

Engineering decisions are also based on the environmental impacts caused by the project activities which could be in planning, implementation or operation phase. In addition to the potential effect to human health and well being, environmental impacts also include effects on the natural resources or infrastructures providing socio-economic services. While carrying out an environmental impact assessment (EIA) of a potential project, a no-project scenario is referred against the various alternatives which helps to identify the environmental impacts and engineering or social mitigation measures. Similarly, life cycle assessment (LCA) of products is increasingly used in identifying the environmental impacts caused by the manufacturing process and use of the products.

Traditionally, engineers were able to practice their profession without having to address environmental ethics to the same depth that is now required. Ethics provide a systematized framework for making decisions where values conflict. Both the cost-effectiveness analysis and the benefit/cost analysis are methods for making decisions based (mostly) on money. Risk analysis calculates the potential damage to the health, and environmental impact analysis provides a means for decision making based on long-term effects on resources. Ethical analysis involves values rather than cost or environmental data. There are two theories leading to the ethical analysis: utilitarianism and deontological. A detail on these two theories can be found elsewhere. An ethical perspective focuses on the attitude of people towards other living things and towards the natural environment.

The methods of decisions making available to engineers stretch from the most objective (technical) to the most subjective (ethical). The inherent method of decision making is the same in all cases. The problem is first analysed – taken apart and viewed from many perspectives. When all the numbers are in and the variables are evaluated, the information is synthesized into a solution (Vesilind and Morgan, 2004).

1.4 Environmental Engineering

Environmental Engineering is defined as the application of engineering principles, under constraint, to the protection and enhancement of the quality of the environment and to the enhancement and protection of public health and welfare (Sincero and Sincero, 1996).

Environmental Engineering is manifest by sound engineering thought and practice in the solution of problems of environmental sanitation, notably in the provision of safe, palatable (tastes pleasant), and ample public water supplies; the proper disposal of or recycle of wastewater and solid wastes; the adequate drainage of urban and rural areas for proper sanitation; and the control of water, soil, and atmospheric pollution, and the social and environmental impact of these solutions. Furthermore it is concerned with engineering problems in the field of public health, the elimination of industrial health hazards, and the provision of adequate sanitation in urban, rural and recreational areas, and the effect of technological advances on the environment (ASCE, 1977).

Traditionally, the environmental engineering has been the province of the civil engineering profession. Around 1968, the name sanitary engineering or public health engineering was changed to environmental engineering.

In Nepal, Society of Public Health Engineers (SOPHEN) is an association working the sector. Refer Box 1 for details.

Box 1 : Introduction to SOPHEN

Society of Public Health Engineers, Nepal (SOPHEN) was registered in Nepal in 1990 AD (2047 BS) as an independent professional organization by a group of Nepalese Engineers. At present, it has 374 members.

SOPHEN is governed by an executive committee of eleven members elected by the general members of the society.

Some of the major responsibilities of SOPHEN include the enhancement of technical and professional competencies of its members, work for the protection of the basic professional rights and support the government and other agencies in the formulation of policies and strategies in related fields.

SOPHEN is committed to carry out various professional activities that are intended to bring qualitative results to improve the sanitary and environmental conditions of the country. It aims to work in association with other professional bodies in Nepal and aboard. SOPHEN has been recognized by all the sectors of the society as a leading professional body of Nepal.

Objectives

- Dissemination of state-of-art technologies to practitioners, policy makers and beneficiaries.
- Establish professional relationship with similar institutions to national and international level sharing ideas and technologies for mutual benefits and interests.
- Coordinate with other national and international professional bodies enhancing professional competencies to the implementation of emerging technologies.
- Building capacities of its members through various research, training and workshop in national and international level.
- Support the government to develop, adopt and implement policies and strategies for overall development of sanitary and environmental conditions of the country.
- Provide technical counseling and awareness to public for any critical environmental issues emerged due to natural or human activities.

Source : SOPHEN (2012)

In general Environmental engineering is focused on:

- Provisions of safe, palatable, and ample public water supplies
- Proper disposal of or recycling of wastewater and solid wastes
- Control of water, soil and atmospheric pollution including noise pollution

Environmental engineers have the responsibility

- To plan, design, construct and operate sewage treatment plants to prevent the pollution of receiving streams.
- To build and operate water treatment plants.
- To build and operate solid waste collection, transportation and disposal systems
- To plan, design, construct and operate air pollution control equipment.
- To design reservoirs and to control groundwater contamination.
- To carry out environmental assessment of projects and products
- To provide inputs in decision making regarding the environmental issues of development sector and welfare of public
- To predict the level of pollution and design control mechanisms and products

One aspect of the profession of environmental engineering is that environmental engineer is engaged in a truly worthwhile mission. The environmental engineer is the epitome of the solution as opposed to the problem. Our client, in the broadest sense, is the environment itself, and out objective is to preserve and protect our global home, for the sake of our progeny as well as Mother Earth herself.

Additional Reading

(1) Vesilind and Morgan : Chapter 16 page 433-467
(2) Davis and Cornwell : Chapter 1 page 1.1-1.31
(3) Rubin and Davidson : Chapter 1 section a to e
(4) Reible : Chapter 1 : pp 1-19

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ASCE (1977) Official Record, Environmental Engineering Division, Statement of Purpose, American Society of Civil Engineers, New York

Davis, M. L. and Cornwell, D. A. (2011) Introduction to Environmental Engineering, Fourth ed., Tata McGraw Hill Education Private Limited, New Delhi, India

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Society of Public Health Engineers, Nepal (SOPHEN) (2012) : Official introduction, Website of SOPHEN, http://sophen.org.np/who_we_are/sophen.php (Downloaded on March 22, 2012)

Vesilind, P. A. and Morgan S. M. (2004) Introduction to Environmental Engineering, Thomson Brooks / Cole