11

Assessing

Chapter Overview

In the past, the choosing of alternative designs and solutions in engineering was based on a combination of unstated values, intuition, and the analysis of predicted outcome of the decision. In recent years, however, the engineering assessment has become increasing formal in response to the increasing complexity of the projects. At its core, the assessment process is about deciding which option or options to pursue based on three categories of impacts: economic, societal, and environmental. This process is typically applied to the overall project, but it can be applied to the minutest of decisions. In the past, economic impacts have often taken precedence over the other two. However, as more people start to recognize the societal and environmental impacts of engineering and commerce, "triple bottom line" assessments have grown in popularity.

The assessment process consists of seven steps: [1] initiation, [2] decision statement, [3] information gathering, [4] assessment construction, [5] indicators determination, [6] decision making, and [7] validation. For a thorough assessment, most time and effort will be spent on information gathering, assessment construction, and indicator determination. It is a good practice to include a conventional option or null option in the assessment, making it easier to communicate the difference between the selected solution and the ones the public is familiar with.

The decision statement is an explicit communication of the engineering problem. This is a crucial step in the assessment process – a subpar decision statement can lead to much wasted effort. During the information gathering step, information is acquired from a number of sources, including the people and organizations involved in the assessment, users of the results of the project, governing bodies, special interest groups, and the general public. Examples of relevant information include legislation and codes relevant to the project, strategic plans of the organizations involved in the project, the needs and wants of the users, experience from people who have worked on similar projects,

and the concerns of the general public.

Typically, engineering assessments evaluate a range of economic, social, and environmental indicators. Net Present Value (NPV) and Return on Investment (ROI) are typical economic indicators used in assessments; they reflect the fact that the timing of income and expenditure is as important as its amount. Societal indicators used can vary greatly depending on the project assessed, ranging from the project's impact on regional health and well-being, local employment, and taxation. Similarly, the environmental indicators used can vary greatly. Examples of environmental indicators are biological oxygen demand, species loss rate, and life-cycle carbon emission. It may be necessary to consult experts in social, environmental, and biological sciences to determine which societal and environmental indicators to use. Finally, stories that are pertinent to the project may represent impacts that are not captured by the indicators.

When performing assessments, we often run into the difficulty of needing to compare dissimilar quantities. For example, it is impossible to directly compare the economic impacts of the net present value of a project with the number of jobs created over a long time. One solution is to convert these dissimilar indicators to a common quantity that can be summed into a single "satisfaction" indicator. The weighting of the indicators reflects how much we value each type of impact. This is an area where conflict may arise because the stakeholders may hold different values, and comprises are often required. An alternative approach is to create a multi-criteria decision matrix that highlights and contrasts the different indicators.

Broadly speaking, there are three types of assessments. A constraint assessment tells us if the options meet all of the constraints. A qualitative assessment tells us if some options are inferior. A quantities assessment tells us which option is optimal. Because the indicators may be influenced by different factors, scenario analysis should be performed to illustrate the accuracy and reliability of the assessment. It should be noted that ethics can play an important role during the assessment process. It is up to you to ensure the legitimacy of the assessment, which may be opposed by certain stakeholders, even those in positions of authority. In these events, the engineer should remember his or her professional responsibilities.

Learning Objectives

In this chapter, you will learn about assessing engineering designs and solutions. Specifically, you will:

- learn about the assessment process;
- learn about three types of assessment criteria: economic, societal, and environmental; and
- learn how to develop a single indicator reflecting the three criteria.