Selection criteria, Sustainability and Decision making

In choosing the **best** alternative for an engineering project, you need to have some clear **criteria**.

Sustainability

One obvious criterion is **technical adequacy**. An engineering system needs to be "strong" enough to satisfy the loads placed upon it. For a structure, this will include material strength and serviceability, as well as resistance to fire, fatigue, corrosion, and so on. For a pipeline, it means adequate flow capacity, pressure resistance, corrosion resistance, etc. These criteria we will call the **engineering** requirements.

The next most obvious criterion is **economic adequacy**. The system needs to be affordable by the client. It is reasonable to expect that the engineer has made some effort to design a system at minimum cost (subject to other constraints).

The third criterion is **environmental impact**. The engineer should work to minimise environmental impact. This often places *constraints* on a design that rules out certain design options.

The fourth criterion is **social or ethical impact**. Obvious social impacts include noise, dust, visual impact, etc. Less obvious are issues of ergonomics and social inclusivity.

These last three criteria are often referred to as the **Triple Bottom Line**. The traditional bottom line is economic – costs versus benefits. To this, we add measures of environmental and social impact.

Together, these criteria are the **4 E's**: engineering, economic, environmental and ethical. Engineering's primary purpose is to serve society. Yet, oddly enough, engineers often don't think of the impact of their work on society.

Decision making

When it comes to choosing a **preferred alternative** for an engineering project, you need to satisfy all four of the criteria above.

This can be done by using some criteria as **constraints**. We do this all the time with the technical requirements. We do not choose a beam that is of inadequate strength, for instance. Likewise, if a set of solutions cause undesirable social or environmental impact, we rule them out.

This then leaves us with a set of acceptable or **feasible solutions**, from which we need to choose the "best". At this point we need to make **trade-offs** between different solutions. This is complicated by the fact that the different criteria are measured in different ways and some criteria have no quantifiable measures. (There are no units for beauty, for instance).

At this point, it can be helpful to have input from a range of **stakeholders**. Their views can be gathered through community meetings or consultation.

One methodology for working with multiple criteria using different measures is to assign **scores** (say 1..10) to each of the criteria for each solution and then to **weight** each criterion (again, 1..10). Calculate the total score for each option by multiplying all the weights by the rating scores and adding them up. (This is actually the *dot product* of the rating vector and the weight vector).

Different stakeholders will provide different ratings and weights, and hence they will rank the alternatives in different orders. From all of the consultation, **consensus** on the preferred option or options will hopefully arise.

You can simulate this in your group by using different group members to **play different stakeholder roles**.