Sustainability & Engineering Practices Overview

One of a number of discussion papers produced by the IPENZ Presidential Task Committee on Sustainability during 2003 and 2004.

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1. Introduction

This paper translates *sustainability principles* [1] into overarching practical tasks and requirements for the engineering profession. These apply to a greater or lesser extent to all sectors, and have not necessarily been repeated in each sector paper.

Because sustainability has a long-term focus, beyond the life of most engineering projects, products, processes or systems – generically called projects – the methodology and resource use by projects needs to focus on both short and long term factors. This is often far beyond the duties imposed by professional codes of ethics.

Key sustainability factors for engineers are:

- The need to **manage changes in the environment** (both local and global) as the consequence of any engineering activities to ensure the continued viability of the planet (Principle 1).
- Ensuring the **equity and safety of engineering activities** for both current and future generations is also of high importance (Principle 2). Wherever possible this also means **improving the quality of life**, particularly for the poor and those in developing countries.
- **Problem solving**, one of the key aspects of a professional engineers skills, needs to be done in a holistic way (Principle 3), so that solving one problem does not create another, and the solution arrived at is the optimum one from many viewpoints.
- Where practicable engineers need to consider **making good problems already caused** by failures to follow sustainability principles (Principle 3).

These factors are explored further below, from an engineering perspective.

2. Key Sustainability Factors

Managing changes in the environment.

1. Maintain the **integrity of global and local biophysical systems** engineers must thoroughly consider any project or plan that will have a significant impact the life support functions upon which human well-being depends, many of which are irreplaceable. For example the use and placement of dams on waterways, or the deployment of a technique, material or process with unknown side effects – such as nanotechnology assembly processes.

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[1] Task Committee Document 1: Sustainability Principles

2. Ensure that the **true cost of resource depletion is included** in all feasibility studies and estimates. Usually the market cost is assumed to include all costs, but this is often not so, and where alternatives exist, the more sustainable product or material should be used. For example a recyclable or reusable container is inherently more sustainable than a single-use container, whatever the apparent cost.
3. Minimise the absolute use of resources, and to convert the energy source from fossil based to renewable energy requires a **constant awareness of optimisation processes on a life cycle basis.** For example engineered products, processes and services should be designed to minimise the initial use of resources and to provide for maximum recycling and reuse of resources. This applies both to scarce resources, and apparently abundant resources such as concrete and timber, all of which have an embedded energy content.
4. **Maximise the use of renewable resources** but always within sustainable extraction or harvest rates and taking account of environmental damage. For example biomass from sustainable forests used as a boiler fuel instead of oil or gas.
5. **Minimising waste products**, particularly hazardous ones, from the total life cycle of engineered products, processes or systems, preferably as near to the source as practicable. Ensure that any waste discharges are within the short term assimilative capacity of the environment, without long term accumulation.

Equity and safety of engineering activities.

6. Engineering projects, products or processes should be aimed primarily at **improving the overall quality of life** for humans and other life forms, but not at the expense of the environment.
7. **Any increased consumption** of resources and energy, must be **weighed against the improvement in quality of life** to be achieved.
8. Resource use must be **considered over a sufficiently long time scale** so that present and future generations are not disadvantaged economically, socially or environmentally, by excessive and unnecessary consumption. This may be considerably longer than an anticipated project lifetime.
9. **Positively weight projects, products and processes that decrease significant gaps** in health, security, social recognition, political influence between groups of people. Those that do the opposite should be carefully considered before embarking on them in whole or in part.
10. All **those affected by engineering projects shall be consulted where practicable** and given equal opportunity without repercussions to voice their concerns. Their relevant opinions shall be considered and where practical incorporated into the planning, decision making and implementation process.
11. Where outcomes cannot be accurately foreseen choices shall be **based on risk reduction and the precautionary principle** – where in the absence of data, new risk is avoided – as much as practicable or foreseeable.

Holistic problem solving

12. An integrated systems, or an **overall holistic approach shall be taken** including all stakeholders and the environment when attempting to solve problems. Rather than

focussing solely on the technology aspects, and solving one problem at the expense of another, a coordinated solution shall be aimed for.

13. Problem **solutions shall be based primarily on existing or new human needs** rather than finding a use for a newly available technological means.
14. Approaches that are **multi-faceted, and synergistic are preferable** to single issue approaches. For example using transportation in such a way that viable loads are available for both journeys, is more sustainable than single load journeys.

Making good problems already caused

15. Where desirable and technically and economically practicable, **past environmental degradation should be remedied**. For example land degradation and groundwater contamination, and hazardous waste sites should be considered at a minimum for stabilisation, and wherever possible total clean-up to current or foreseeable standard.
16. **Past hazardous practices shall cease and be cleaned** up in a cost effective way and time frame. These include for example hazardous materials such as asbestos, lead, mercury, and PCBs.
17. **Reduce the use of non-sustainable practices** (such as burning or using petroleum and fossil fuel products for feedstocks) to zero over a relatively short time frame.
18. **Support social and economic accounting methods** which disclose, identify and quantify previous or developing environmental problems.

3. Implications for IPENZ Members and Engineers in General

A policy framework is emerging in New Zealand for sustainable development to be implemented in certain specific areas. Engineers have many opportunities to be involved in this process. They also have professional responsibilities to do so, as noted, for example, in the IPENZ Code of Ethics:

> *"Members shall be committed to the need for sustainable management of the planet's resources and seek to minimise adverse environmental impacts of their engineering works or applications of technology for both present and future generations."*

Members of IPENZ and of its various technical groups and societies are encouraged to learn more about sustainability and apply it in their day-to-day actions at work and in other aspects of their lives. Further information is readily available both from New Zealand and internationally. The engineering profession should lead the way and be seen to lead the way towards a more sustainable future.

There a number of specific ways in which engineers and the engineering community can move New Zealand towards sustainability. The following checklist will give some guidance on this.

1. General Sustainable Engineering and Technology Checklist

1. Have you thoroughly considered any project or plan that will have a significant impact on the life support functions upon which human well-being depends? ☐

2. Have you ensured that the true cost of resource depletion is included in all your feasibility studies and estimates? ☐

3. Have you minimised the absolute use of resources on a life cycle basis, and used renewable energy as much as possible? ☐

4. Have you maximised the use of renewable resources within sustainable extraction or harvest rates and taken account of environmental damage? ☐

5. Can you minimise waste products, particularly hazardous ones, from the total life cycle of engineered products, processes or systems, as near to the source as practicable? ☐

6. Does the project, product or process improve the overall quality of life for humans and other life forms, without large increases in the consumption of resources and energy, or at the expense of the environment? ☐
7. Has resource use been considered over a sufficiently long time scale so that present and future generations are not disadvantaged by excessive and unnecessary consumption? ☐
8. Does the project, product or process decrease comparative gaps in health, security, social recognition, political influence between groups of people as much as it could? ☐
9. Have those likely to be affected by the project been consulted if practicable, and will any relevant opinions be considered and where practical incorporated into final planning? ☐
10. If outcomes cannot be accurately foreseen, is your planning based on risk reduction and the precautionary principle? ☐
11. Have you taken an integrated systems, overall holistic approach including all stakeholders and the environment in your proposed solution? ☐

12. Is your project, product or process based on human needs rather than just finding a use for some newly available technology? ☐

13. Does the project, product or process involve past hazardous practices, and if so can these be eliminated and cleaned up in a cost effective way and time frame? ☐
14. Does the project, product or process contribute towards reducing non-sustainable practices to zero over a relatively short time frame? ☐
15. Can social and economic accounting methods be used at the planning stages to disclose, identify and quantify previous or developing environmental problems? ☐