

Wageningen, Nov. 10th 2011

Sustainable engineering

Hans Lyklema

Wageningen University

KLV 125 years: congratulations!

What about another 125 years?

- Over the past 125 years society has changed drastically.
- It will continue to change drastically over the coming 125 years.
- →Beyond predictions made on the basis of extrapolations of present trends
- →Beyond present opinions.
 - Such as : economic growth is a must, money must be invested to protect the environment, the BNP reflects the quality of a society, values of goods can be expressed in euros, democracy is the best political system.

Engineering Sustainable?

- **Sustainable**: maintaining the earth in a condition allowing decent human life for a long period.
 - Brundtland report.
 - Long time → 125 years or longer.
- **Engineering**: completing things optimally within external constraints.
 - Quantification, even if not all information is available. Common sense.

The p.p.p. mantra.

- In alphabetic order: people, planet, profit.
- The three p's are not equally important.
- Tell us your sequence and we shall tell you what you are

The p.p.p. mantra -2

- The three p's are not equal.
- For sustainability the only valid response is:
- Planet >> people >> profit.
 - No profit without people and no people without planet.

Anchoring of sustainability.

- How to proceed if we cannot trust extrapolation from recent trends?
- The **basic laws of nature** did not change over the past 125 years and will not change over the coming 125 years.
- → a hold for achieving sustainability of our planet.
 - And, hence, of mankind.

Basic laws of nature.

- All people are mortal.
- The First Law of Thermodynamics.
- Matter is indestructible.
- The Second Law of Thermodynamics.
- You cannot eat your cake and have it.

Basic laws of nature. Relevance for sustainability.

- All people are mortal. Basic law of biology. **Uncontested**
- The First Law of Thermodynamics. No perpetual motion. **Uncontested**
- Matter is indestructible, **except for nuclear reactions**
- The Second Law of Thermodynamics. No perpetual motion of the second kind. **Understood??**
- You cannot eat your cake and have it. **Unless you can recycle it. Is that always possible?**

Essence of the Second Law.

- In physical parlance, it is the law for the increase of entropy.
- In mundane language, it states that it is impossible to upgrade matter and/or energy without external energy source.
 - Upgrading: waste water purification, changing heat into work, recovering waste phosphate from surface water, reclaiming lithium from batteries, etc.
- → An ecological price has to be paid for recycling.

Ecological pressure.

- Some ecological supplies are abundant, in particular those requiring only solar energy and bioproducts (“**cradle to cradle**”).
- Others are not (area, potable water, minerals,.....).
- → if we heed Brundtland we must measure the ecological stock and adjust our (behavioral) metabolism to it
- → Need for indicator(s).

Two kinds of indicators.

- **Integrated ones.** One number to quantify the quality of the environment.
- Indicators for each contribution
 - Clean air, clean water, energy, dust, greenhouse gases, CO₂, etc.
- **Individual indicators** appear more specific, and hence transparent, but the problem is that all these contributions are interconnected.

The ecological footprint (EFP).

- It is the best integrated indicator we have:
- -(1). It is relatively simple to compute
- -(2). It is easily understood by a broad audience.
- -(3). Its unit (hectare) is readily conceivable.
- -(4). It shows the same trends as other integrated indicators, like LCA analyses, entropy computations,.....
- -(5). It is insensitive to financial arguments.

The basic formula

- For a country:
- $EFP = B \times \langle EFP_{pp} \rangle$
 - B = population
 - $\langle EFP_{pp} \rangle$ = average footprint per person
- For each country (or city or groups of countries,.....) the EFP can be computed and compared with the EFP for mondial sustainability.
 - Technology does not occur in the equation!
- For The Netherlands the present EFP is too high by **AT LEAST A FACTOR OF TWO.**
 - Living Planet report 2010, based on data of 2007.....

Basic task.

- For sustainability, the product
- $EFP = B \times \langle EFP_{pp} \rangle$
- must be reduced by **at least a factor of two**. Which one of the two or something of both?
- The choice is the **product of two taboos** and beyond engineering.

Action proposals for engineers.

- Action proposals can be divided according to their time scales.
- **-(1). Very short term (today).** Celebrate the better achievements of KLV over the past 125 years.

Action proposals-2

- **-(2).Short term (~ several years).** Continue present activities but try to become more conscious about the ecological price tags.

Few things are really sustainable, notwithstanding slogans, like: sustainable development, economy, residential areas, engineering ???.

Often projects are called “sustainable” although only one indicator is considered.

Be aware of the Al Gore farce.

Do this for yourself and for your competitor.

Action proposals-3

- -(3). Longer term (generation). Are the new projects really needed?
 - Government buildings in The Hague. Over the past decennia their volume has tripled, Are the Netherlands now three times as well governed?
 - Fast railway from The Hague to Groningen saves ~20 minutes over present rail and 35 minutes with 1938. How will this time be spent?

Action proposal-4

- -(4). Long term (125 years and over).
Consider a situation with fewer people but continuing demand for facilities: right up the street of engineers.

Final wish.

- Hope that over another 125 years there is enough reason for my successor to congratulate you again.