Analysing the environmental costs of electronics

Contact: University of Southern Queensland | **Posted:** 3 August 2006

By: David Parsons, Associate Head, Faculty of Engineering & Surveying, USQ

A relatively recent development in the assessment of the environmental impact of electronic systems is life cycle analysis. Life Cycle Analysis (LCA) is a methodology which attempts to achieve two things in detail: account for all material inputs into and outputs from a product or system and relate those inputs to the environmental impacts.

Material inputs are accounted for by firstly creating an inventory of all known inputs. This process begins by recording all the components parts of a product and determining their composition.

For example, a mobile phone handset comprises a plastic case, a printed circuit board with numerous electronic components, a battery, a liquid crystal display (glass and other materials) etc.

The product must be constructed and assembled and again the quantities of various inputs such as energy and moulding processes are evaluated as closely as possible. There are difficulties with this due to questions, for example, about how much of the lighting energy in a factory should be attributed to the assembly of a phone when other products are also made in the same location.

Usually transport and distribution are also involved, so estimates of inputs are required here too. Even the energy used to light warehouses and shops is significant for some products, particularly those destined for the consumer market.

Most electronic products require energy to operate them during their life and some also require things like air-conditioned rooms, connecting cable, etc. The extent of their life of usefulness and of the hours of use per day must also be evaluated.

Eventually electronic equipment reaches the end of its useful life, often due to technological obsolescence rather than physical failure, and is disposed of.

In Australia, disposal of electronic equipment appears to be largely by landfill with a small percentage of exceptions where there is some reuse of equipment or some recycling to recover precious metals.

Collecting all this data constitutes a model of the product's life which can be thought of as a flow diagram.

Then it is necessary to consider the inputs which go into each of the materials and processes identified as well as outputs such as wastes.

For example, we need to know how much oil and energy was used to produce each kilogram of the particular plastic used in the phone case, or what was involved in transporting the phone from port to local shop.

Filling in this background data is a tedious and difficult process and was the reason such analyses were not practical until fairly recently. But LCA techniques are beginning to help at last.

Several software packages have been developed around the world with databases incorporated. The databases contain large quantities of this background data - material production data, transport data, data about manufacturing processes such as welding, extruding and packaging, among many others.

One weakness in such data is that it clearly will depend on various factors such as where in the world it applies.

For example, the way energy is produced and the environmental impact is different in Europe to Australia - because the coal is different and because there are different mixes of electricity source - coal, hydro, gas, nuclear, wind.

Another current weakness for the electronics industry appears to be that little data is available for electronics equipment specifically. Many LCA studies done recently have relied on in-house data or on detailed collection of relevant data.

Impact assessment is usually in terms of the final impact on some meaningful criteria. It is based on current understandings of the relevant science in the various areas along with some measures of its reliability and statistical variation.

This scientific knowledge has been incorporated into models of impact by various researchers and built into the software.

Some versions of the software allow the user to choose one of several different models which allow comparisons to be made between models, thus providing some additional verification of outcomes.

Global warming is measured in terms of carbon dioxide equivalent. There is developing scientific acceptance of the global warming impact and most gases emitted by industry can be quantified in terms of their impact.

Human health impact is often measured in terms of DALYs per kg of substance emitted - disability adjusted life years, which is based on statistical measures of the health impacts of known substances.

Ecotoxicity is a measure of damage to ecosystem quality which results from emissions of toxic substances to air, water or soil. It is measured in terms of potentially affected fraction of species times area times years, per kilogram of emission.

Analysis thus involves entering inventory data into the software, activating an impact model and performing the relevant calculations using the software.

There are two major uses to which life cycle analysis is put - to identify the 'hot spots' of a particular system or to compare two different ways of achieving the same purpose.

A single product can be analysed to produce knowledge about the environmental impact of each major aspect of that product. This can help to work out where effort can most usefully be applied to improve its environmental performance.

For example, analysis of production, transport, use and disposal stages can be compared.

Such an analysis of a mobile phone system in Europe in 2003 showed that about 90% of the environmental impact of the system was due to the phone handset.

Energy consumption is a major factor and the material content of the phones is also significant, partly because of the integrated circuits used. The relatively short life of mobile phones of about two years is also a major factor.

The second way analysis is used is to compare which of two functionally-equivalent products is environmentally preferable.

For example, a study in Switzerland compared looking up a telephone number in a book, over the web or with a book in CD-ROM form. The results were that the telephone book and the CD-ROM processes were about the same whereas use of a PC and the internet was better overall by a factor of about six times.

David Parsons is a lecturer and associate head of electrical, electronic and computing engineering, Faculty of Engineering & Surveying, University of Southern Queensland.