Sustainability Definition and Goals of Assessment

MEASURE

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About this module

Content and learning objectives:

This introductory module presents several philosophical concepts that underpin the development of our current understanding of *sustainability*. Sustainability is a topic that concerns everyone and we introduce one possible classification of the *stakeholders* of sustainability *assessment*. Finally, a number of key concepts in sustainability assessment are introduced, such as the concept of life cycle, damage, mid- and end-point indicators.

The objective of this module is to present current generally accepted definitions of key concepts.

What is sustainability?

1713: Sustainable Forestry

Early industrial use of resources by human society is largely associated with the use of timber for ship building, construction and as fuel. In many regions uncontrolled use of forests had led to nearly complete loss as early as 900 BC.

In early 18th century Chief executive of the Royal Saxon Mining Department of the Kingdom of Saxony Hanns Carl von Carlowitz noted that logging and reforestation must be in balance for the success of the local economy: if the rate of logging would be significantly larger than the rate of new forest growth, there will quickly be nothing to sell. Forestry at the time being the backbone of the local economy.

This is, probably, the first recorded mentioning of sustainable approach to the use of resources, linking natural resources and economy.

What is sustainability?

1700-1900: Enlightenment, Economic Development and Classes

Ideas relating to sustainability can be found in the writings of the scientists and philosophers of *enlightenment*, the era of rapid development of science and technology.

With new understanding of natural laws, early industrialization and the growth of wealth, the idea of humanity becoming independent on the forces of nature became real. The concept of 'development' has emerged as a technocratic, anthropocentric view on the world, ultimately dominated by humanity.

At the same time Jean-Jacques Rousseau wrote about a *utopic social order, humanity living in harmony with nature, operating cooperatively through largely agricultural small-scale, steady-state economies*. Compare this with the ideas of 'more with less', small-scale distributed manufacturing and use of local resources, that are currently dominating the discussions on the path towards sustainable technologies and society. Key difference, of course, is growth: we largely retain the idea of *growth* as key to our economic system.

What is sustainability?

1700-1900: Enlightenment, Economic Development and Classes

Development is the cornerstone of modern economy. Foundations of developmental economy were laid down in the works of Adam Smith (1723-1790). But Adam Smith also warned against uncontrolled development: economic development must be accompanied by creating ‘rules of justice’, in modern terms – regulation – to avoid the potential consequences of unregulated capitalism.

What is sustainability?

1700-1900: Enlightenment, Economic Development and Classes

What could be the consequences of a lack of regulation in development?

In the writings of Sir Francis Bacon we find ideas about Christian oligarchy controlling knowledge and technology, and in the writings of Rene Descartes about the vision of technocracy – total domination of man over nature. Those are the foundations of anthropocentric view of the world that dominated mankind for several centuries.

Lack of regulation in development leads to unsustainable business practices and significant, sometimes irreversible, environmental and human health damage. This is well documented in the cases of gaseous emissions (CFCs, green-house gases, sulphur and nitrogen oxides, etc), deforestation, overfishing, overuse of pesticides, overuse of antibiotics, *etc*.

What is sustainability?

1700-1900: Enlightenment, Economic Development and Classes

Another consequence of unregulated business is the growth in social injustice, exploitation and economic inequality.

This problem was studied by Karl Marx. He theorised that his contemporary structure of the society and capitalist economy must lead to social tension; that poverty and crisis are inherent in such a society. Marx developed a utopian concept of a class-less society based on a distributional ethical principle. Although this concept does contain fundamental flaws, the idea of having an overarching ethical principle guiding the society is a key principle in our current definition of *sustainable development*.

What is sustainability?

1860-1950: Emergence of Global Knowledge, the idea of Noosphere

By the start of the 20th century many thinkers have recognised that humanity has become a force commensurable to geological-scale phenomena. Humanity populated all parts of the planet, adapted to various climates, developed capability to resist floods, build new islands, *etc*. Human knowledge becomes more universally accessible and the emergence of global knowledge was the next logical step.

Edouard Le Roy, Pierre Teilhard de Chardin and Vladimir Vernadsky developed the idea of *Noosphere*, to be part of other 'spheres' of Earth we recognise (litho, strato-, etc). As humanity is able to alter landscapes, condition of atmosphere and oceans, it is now an integral part of a shared space. Within this space *knowledge* plays a central part – in the utopian Noosphere humanity is able to share knowledge globally and mobilise global knowledge and human activity for solving problems on the planetary scale.

This is one of the closest ideas to our concept of sustainability in the pre-modern western philosophies.

Sustainable Development

1987: ‘Our Common Future’

In 1983 UN established World Commission on Environment and Development (WCED), under chair of Mrs Gro Harlem Brundtland. The commission published its famous report in 1987. The report, most significantly, linked development, environment and equality:

- degradation of environment is caused by few technologically developed countries, but affects all,
- it is unthinkable to limit the development of poorer countries in order to limit the impact on environment from development; development and environmental degradation must be de-coupled,
- poverty leads to environmental degradation,
- our inability to meet the needs of many people are not due to lack of resources, but due to state of technology and ineffective social organisation.

Sustainable Development

1987: ‘Our Common Future’: operational definition of SD

Quoting from the report: ‘…sustainable development *is a process of change* in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are all in harmony and enhace both current and future potential to meet human needs and aspirations’.

This is insufficient as a ‘how to be sustainable’ guide, but it gives the suggestion - 4 things have to be addressed simultaneously: how we use resources, what do we spend money on, what technologies to focus on and how to change our decision making processes.

Sustainable Development

1987: 'Our Common Future': sustainability principles (or smallprint is usually quite important)

Our understanding of SD depends on our value system, our societal and normative choices. Hence, there is no *objective* view of what is sustainable.

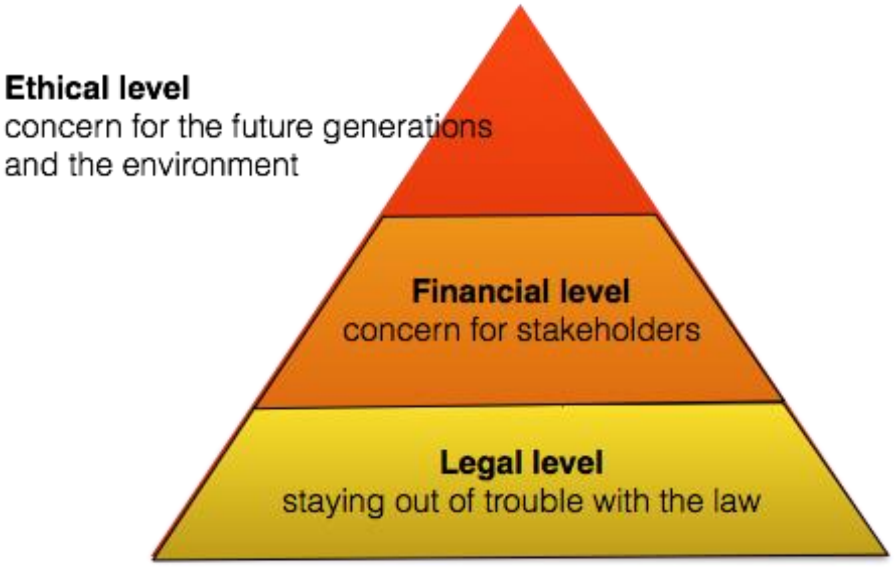
Equality is everything: inter- and intra-generational, geographical, procedural, interspecies.

Sustainability is a holistic problem. It cannot be addressed without a whole-system approach.

Sustainability is not an end-state – it is a process of evolution towards the more sustainable manner of living.

High Moral Ground

We can provide an alternative to the above operational definition of sustainability, based on the theory of moral development. This provides a framework that should be familiar to most businesses and that parallels the currently used framework of corporate social responsibility.



Ethical behaviour of industry must be associated with concern for the future generation and the environment. Pure financial drivers and response to financial pressures from regulators are insufficient.

Link this idea with the earlier philosophers who urged constraints on capitalism and development of ethical guiding principles.

Stakeholders of Sustainability

In addition to an operational definition of sustainability, it is useful to understand who are the primary 'consumers' of information about sustainability performance of a product, process or a company – the stakeholders of sustainability assessment.

Sustainability assessment comprises a set of decision-support tools, which ultimately provide information on the practical implementation of any activities towards improving sustainability of technologies and society, and their effectiveness.

Identification of all the stakeholders of sustainability assessment and their most critical issues forms the first part of the assessment process:

I. Identification of stakeholders.
II. Definition of appropriate assessment tools and evaluation of metrics.
III. Communication of assessment outcomes.

Stakeholders of Sustainability

We can define the hierarchy of stakeholders, identify their critical issues and then correlate these with the tools.

The simple hierarchy of stakeholders is related with the life-cycle of a product/process:

- Product (process) development is the lowest hierarchy level. The relevant stakeholders are scientists, engineers, designers (‘techies’).
- Companies manufacture the products. Their interests are mainly commercial, as well as societal. Main stakeholders are business and sustainability managers, marketeers.
- Companies rely on infrastructure of cities, countries, regions. Regional governments are interested in how their industries perform and contribute to the region. Only at the level of regions the issues of shared resources could be addressed.
- Ultimately we all live in the same space: we want to have access to clean water, to good environment for recreation, we want to have plentiful supply of energy, good healthcare, plenty of opportunities for ourselves and our children.

Stakeholders of Sustainability

Product/Process Level Stakeholders

Products and processes have their *main useful function* – how they satisfy the user-defined product 'brief' (drug must cure without side effects, paint should not smell, etc). At this level the main objectives are to achieve the desired technical performance.

However, from sustainability perspective *features of sustainable products*, must also be included in performance targets.

The question should be: how to satisfy the main useful function in a way that no, or minimal, *adverse secondary functions* arise; where adverse functions include any negative effects that will incur future *costs* (see definitions of costs further in this module).

Stakeholders of Sustainability

Product/Process Level Stakeholders (cntd)

Features of the stakeholders at this level: highly technical, competent with advanced concepts in many areas of science and technology, competent with statistics.

These features of stakeholders reflect the nature of information that would be useful for decision support to them: highly technical and relevant, robust, efficient to obtain, reliable, numeric and specific to different aspects of the problem. It is useful to stress that *life-cycle* based technical indicators (*mid-point indicators*, see definition later in this module) are required to obtain meaningful information on some performance aspects.

At this level one would expect the stakeholders to be competent with multivariate analysis, multi-criteria decision making, in-depth statistical interpretation of the data, generating numerical performance metrics against different pre-defined criteria, etc.

Stakeholders of Sustainability

Company Level

Efficient delivery of products, precise understanding of customer requirements, access to materials (good supply chain), reputation, visibility, … there are multiple aspects that are specific to the company level.

The stakeholders would not be interested in highly technical measures, that are used at the product/process level, but rather in measures that characterise the business performance: for example values normalised to ‘value-added’, measures that characterise efficiency in resource use, etc.

Stakeholders of Sustainability

Infrastructure Level

Main questions:

- Are there sufficient resources to support industry in the region?
- Energy import/export, energy security.
- Resilience to catastrophic events.
- Developmental opportunities.
- Environment and biodiversity in the region as key element of sustainability.

Hence most decision-support measures would relate to resource use, land use, emissions, critical materials use, social impacts of technology.

Stakeholders of Sustainability

Society Level

At the level of society main interests are around availability of clean air and water, availability of energy, environmental diversity, impact of technology on health and contribution to healthcare and well-being – key factors required to sustain life and well-being. Stakeholders are end-users of products, general public, national and international regulatory agencies, governments.

At this level most decision-support measures would be averaged over a region, preferably based on *end-point* indicators (see definition later in this module). All measures should be easily interpretable, related to international targets and frameworks of assessment.

Stakeholders of Sustainability

Practical issues

What is the best practical way to identify all relevant stakeholders in specific cases of company-based projects?

1) Consider the life cycle of a product/process and list all stakeholders who are involved at all stages within the lifecycle.
2) Conduct interviews with representatives of each stakeholder group to evaluate their requirements for data, their approach to sustainability.

Goals of Assessment

Product/process design support methodology

A good product would be close to its *ideal final result* (see definition further in this module). This implies minimal 'costs' in delivery of main useful function. Since we know that there are many costs (see different types of costs further in this module), we need to evaluate performance of a product / process against multiple categories:

- Resource efficiency
- Emissions to different environments (air, water, soil) and their impact
- Energy efficiency (use of renewable energy)
- Land efficiency (footprint)
- Contribution to wellbeing and resolution of key societal challenges
- Other social factors (jobs creation, noise pollution, etc).

Multi-criteria decision making can then be used to understand how well a particular technical solution responds to the need, delivery of a specific useful function.

Goals of Assessment

Product/process design support methodology (cntd)

Assessment of sustainability is an innovation driver. Deeper understanding of where adverse secondary functions, or costs, originate during delivery of the main useful function should give targets for future development and innovation.

The best product does not have negative consequences, or it combines multiple useful functions (multifunctional products), or some of its negative secondary functions could be changed into new useful functions for other products (circular economy).

Goals of Assessment

Corporate Sustainability Targets

How new products/processes contribute to public statements about sustainability targets of companies? Metrics evaluated at a company level primarily concern with this question.

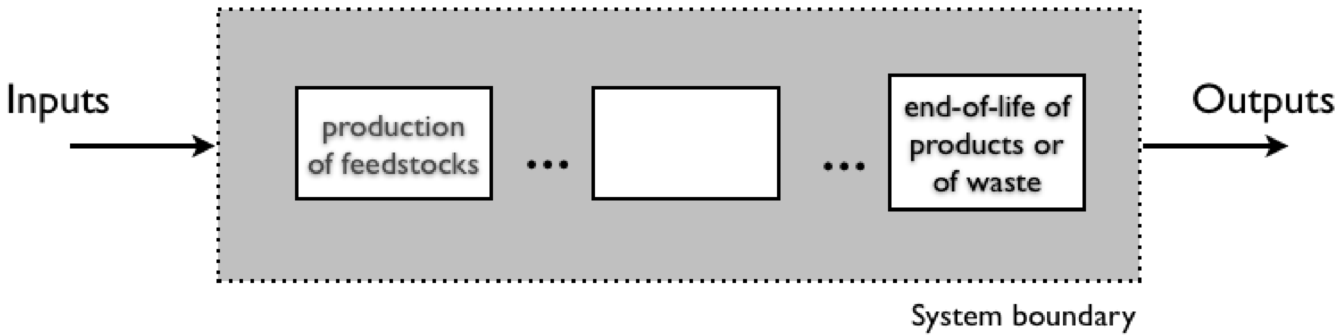
Let's examine such corporate targets. Unilever' target is to "halve its environmental footprint by 2020 while growing its business." This means that every product of Unilever brands must contribute to this target. *Footprint* is a composite measure and its evaluation requires *life cycle* approach. Hence, internal life cycle assessment of all products and impact of innovation on the product's footprint is an important internal target.

Concluding Remarks

- Our current understanding of sustainability and sustainable development are based on the foundations of Western philosophy and Western ideas of development.
- Sustainability is not an end game. It is a continuously changing target. It changes along with the evolution of our needs, technology, climate and our knowledge.
- To support the transition towards more sustainable society we need quantitative targets and measures that could be used as decision support tools.
- To define targets we need to understand end-point damages. To develop useful decision support tools we need to understand stakeholders.
- Life cycle concept is essential for good decision support tools related to sustainability and sustainable development.

Life Cycle Approach

LCA definition: a ‘compilation and evaluation of the inputs, outputs and potential environmental impacts of a product system throughout its life cycle’.



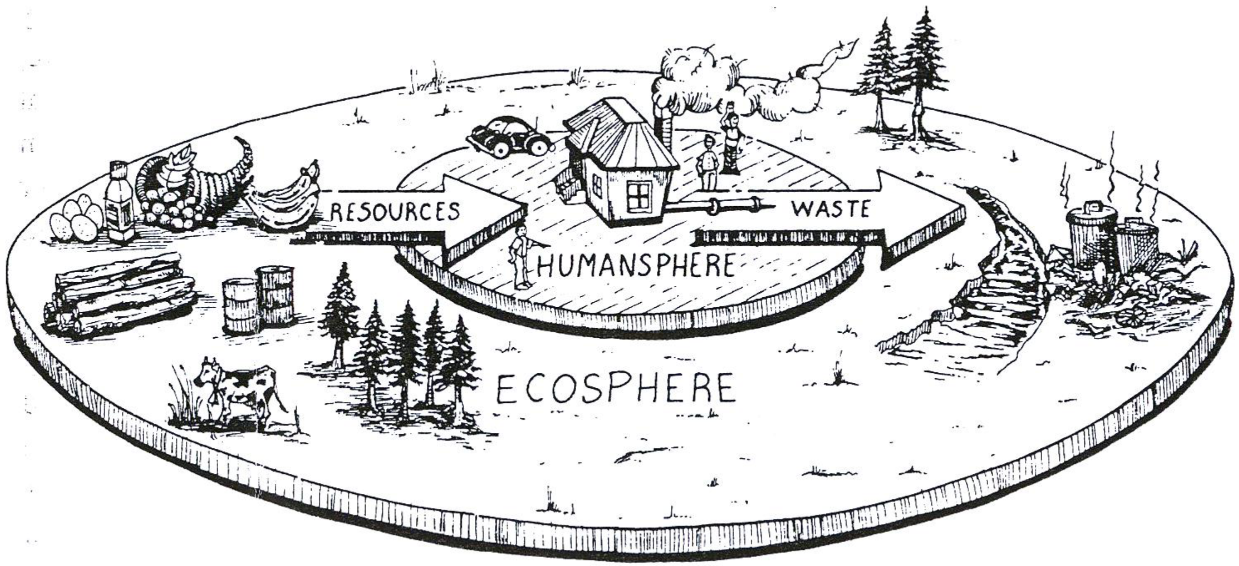
Main application of LCA:
analysis of the origin of problems related to a particular product,
comparison of parameter improvement of a given product,
design of new products, and
possibility to choose between a number of products.

ISO 14040:2006 (2006) Environmental Management – Life Cycle Assessment – Principles and Framework. European Committee for Standardisation, Brussels, Belgium.
ISO 14044:2006 (2006) Environmental Management – Life Cycle Assessment – Requirements and Guidelines. European Committee for Standardisation, Brussels, Belgium.

Footprint

The concept of footprint is to visualise impacts of a product/process hidden in its supply chain and after-life.

On the left of the figure the natural resources are complex molecules synthesised by Nature, as well as raw materials such as minerals and ores. On the right are degraded bio-resources, CO_2 and mixed material waste.

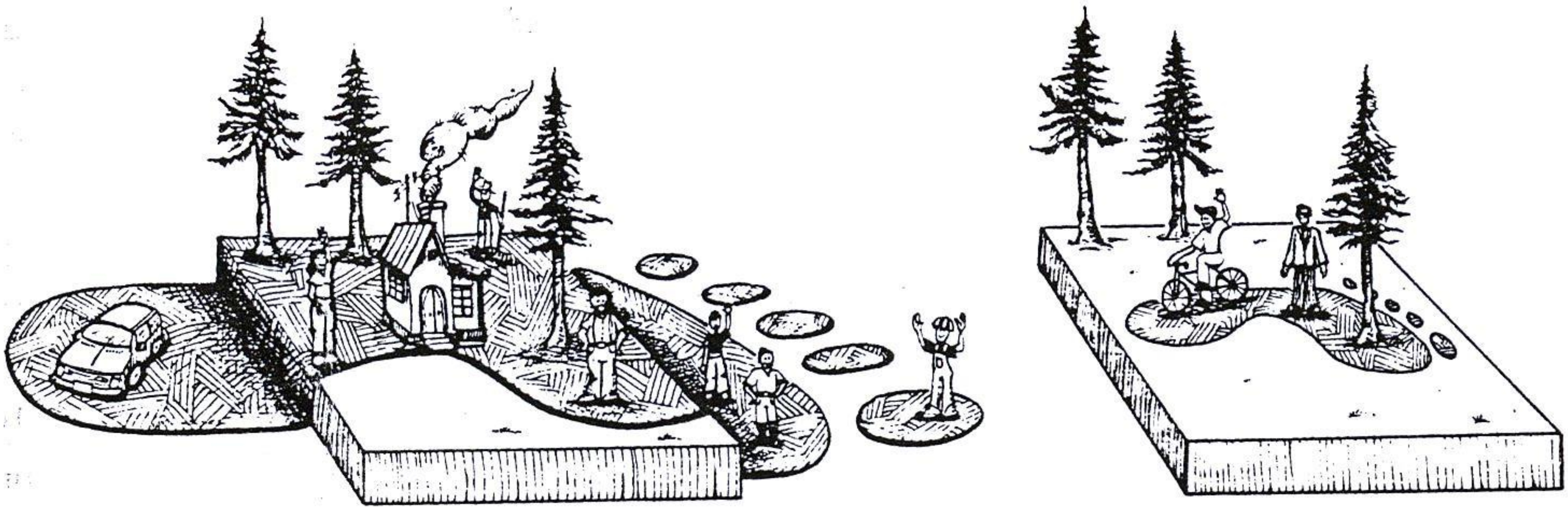


This represents the current linear process of using resources to satisfy humanity's needs. Footprint is the area of land required for all phases of a life cycle of a product.

Illustrations: Phil Testemale
M. Wackernagel, D. Yount, *Env. Monitoring and Assessment*, **51** (1998) 511-529.

Footprint

Society is sustainable if its footprint is smaller than the actually available biotically productive land.



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Types of Costs

It is easy to forget about costs beyond type II in the table to the right.

Type I costs are always considered, but how would one quantify worker moral or consumer loyalty? Yet, these costs are not insignificant: consider legal cases in pharmaceutical sector or recent explosion in the Gulf deep water oil drilling (Type III costs). Then consider the costs due to damage to brand image (a recent automotive industry example comes to mind).

Type I Costs	Direct Costs. Traditional capital investment and operational costs, including: • Equipment • Labor • Raw materials • Waste Treatment
Type II Costs	Indirect and Hidden Costs: • Reporting • Monitoring • Regulatory (e.g. operating permits and fees)
Type III Costs	Contingent Costs • Liabilities (e.g. clean up) • Lawsuits • Damage to resources • Accidents
Type IV Costs	Internal Intangible Costs. • Company or Brand Image • Consumer loyalty • Worker morale • Worker relations • Community relations
Type V Costs	External Intangible Costs • Increase of housing costs • Degradation of resources

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Useful Function

The concept of useful function is introduced in methodology of creative problem solving. One variant is known as “Theory of Inventive Problem Solving”. Here we stipulate that a product has a defined ‘*useful function*’: paint has colour, glue has certain adhesive properties, drugs cure diseases. The delivery of a useful function necessarily accompanied by harmful functions. The better is the product the fewer are the number and extent of the harmful functions. Thus, one can define an Ideal Final Result, or Ideality:

$$Ideality = \frac{\sum_i (Useful\ function)_i}{\sum_j (Harmful\ function)_j}$$

G. Altshuller, *Creativity as an exact science*, Gordon & Breach Scientific Pub, 1984.

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Useful Function

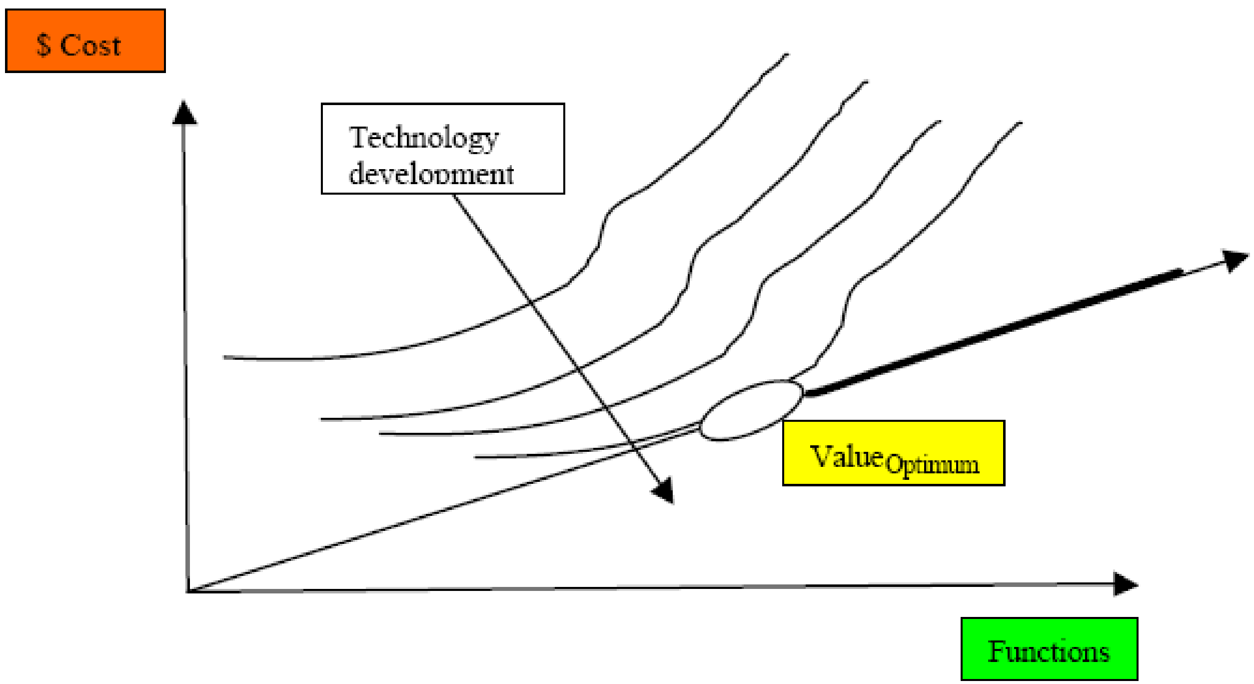
The concept of useful function is very close to Value in value analysis. Compare:

$$Value = \frac{Function}{Cost} = \left[£^{-1} \right] \qquad Ideality = \frac{\sum_i \left(Useful\ function \right)_i}{\sum_j \left(Harmful\ function \right)_j}$$

The sum of harmful functions could be represented as cost. E.g., cost of environmental remediation of by-products from manufacture of the product, cost of transport of the product, cost of disposal at the end of life of a product, *etc*.

Useful Function

Both, value and ideality are increased as technology (means of delivery of useful function) evolves:



Literature and further reading

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