An Innovation Week on R.E.S.

T.E.I. ΠΑΤΡΑΣ

Environmental management and sustainability: A new field related to RES with an outline of Case Studies

Prof. Ing. Michele Dassisti

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Patra , Greece

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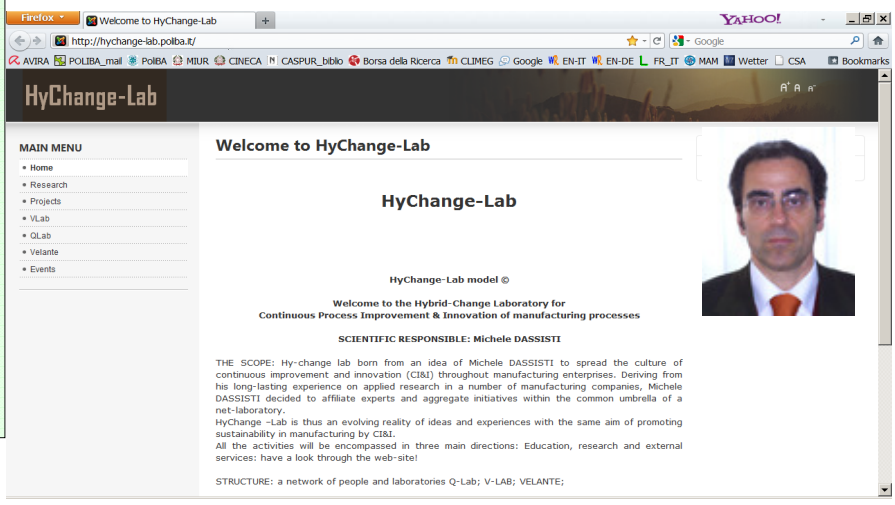

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Rationale

I. **WHAT**
II. **WHY**
III. **WHO**
IV. **WHERE**
V. **HOW (1- 11)**
VI. **WHEN**
VII. **CONCLUSION**

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WHAT's

Sustainability struggle:tangible signs

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- Climate changes

- Crysis of complex systems

SUSTAINABILITY: too general level

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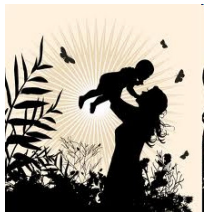
- <<Development that meets the needs of the present without compromising the ability of future generations to meet their own needs>>
  [the Brundtland Commission, 1987]

It is just a matter or RESOURCES??



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Sustainability

SUSTAINABILITY WAS ADOPTED BY UNEP IN RIO DE JANEIRO (1992) AS THE MAIN POLITICAL GOAL FOR THE FUTURE DEVELOPMENT OF HUMANKIND.

IT SHOULD ALSO BE THE ULTIMATE AIM OF PRODUCT DEVELOPMENT.

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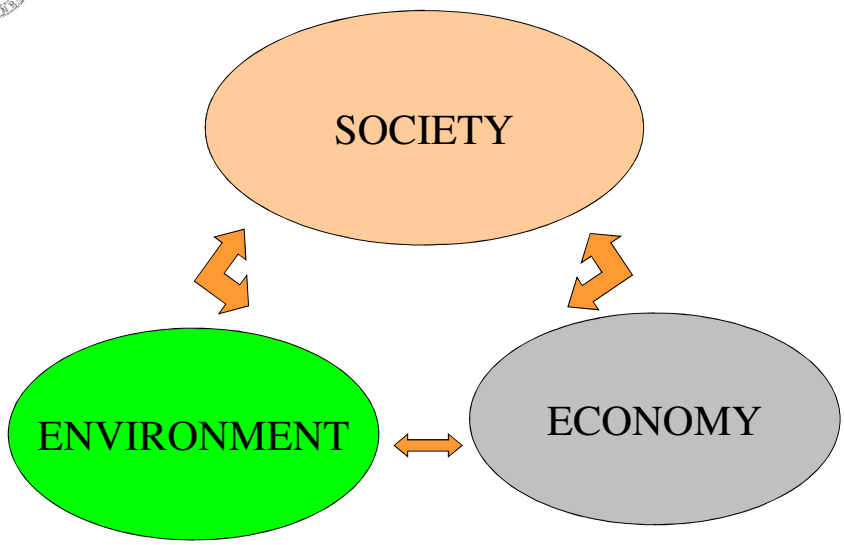
The three pillars of sustainability



"The triple bottom line"

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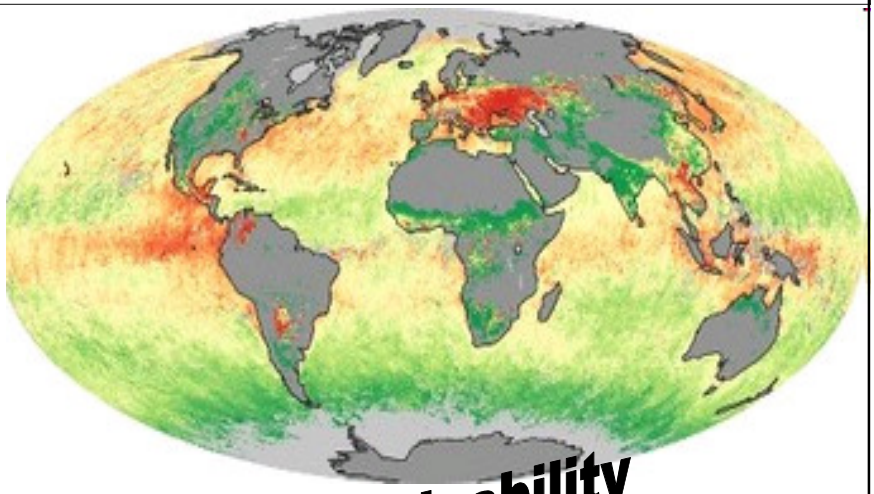
"The beauty in our inability to define it means that we cannot prescribe it." [Fricker,1998]



Sustainability

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WHY's

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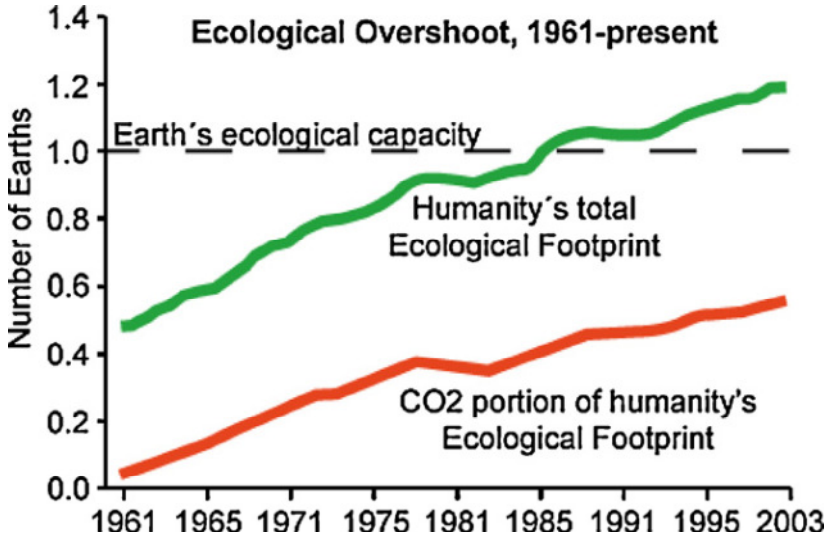
Finitedness of resources



Jovane,2008

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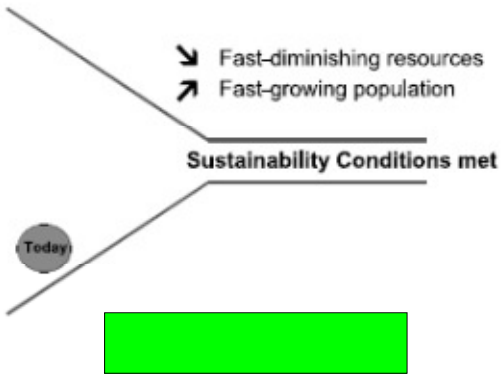
Finitedness of resources



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A philosophical matter: equilibrium……

- The concept of "sustain-ability" implies the concept of "ability to sustain" a status of a system: let's call it a (status of) equilibrium thus means to have a reference point of observation, an interested observer with respect to whom all concepts will hold

- *<<United Nations Brundtland Commission called for sustainable development, 'that which meets all the needs of the present ...>> Appleton, 2006*

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Problem 1 : finitedness of resources

First Law of Thermodynamics:

$$P(t) = P(0)\exp(kt)$$

Where P are resource consumed (k = growth rate)

Can our growth be sustained
in a world of finite resources?

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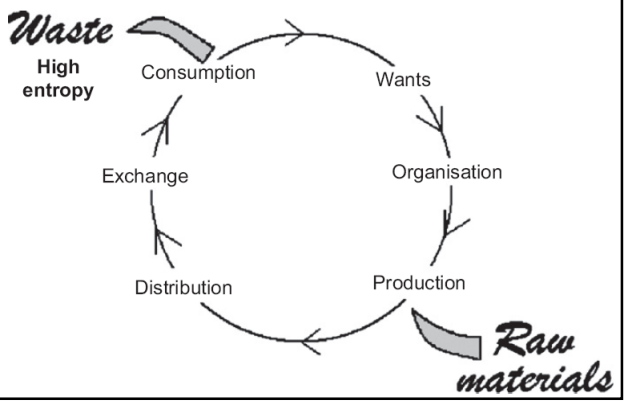
Sustainability vs Growth?!

- *<<The concept of environmental sustainability presents a major challenge to the ''growth paradigm'' of contemporary industrial culture. It is a concept fundamentally rooted in ethics and philosophy, but one which has strong technological ramifications* >>[Pacham,2009]



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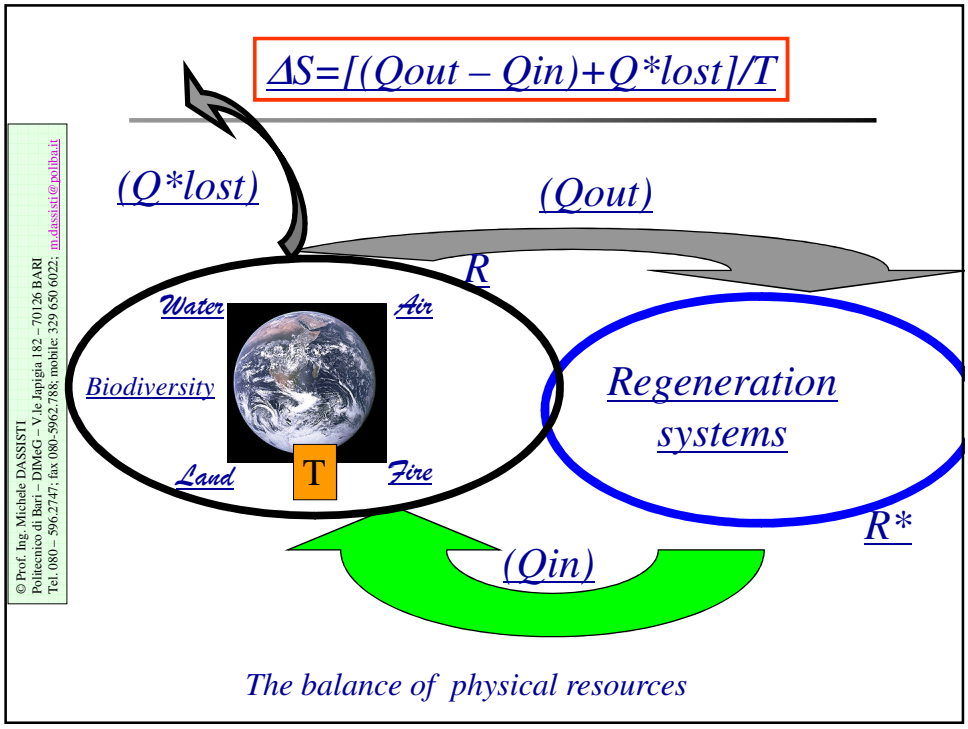
Problem 1 : finitedness of resources

Second Law of Thermodynamics

$$dS = \frac{dQ}{T}$$

The inputs to the system are typically of low entropy S (highly ordered) and the wastes typically of high entropy S (disordered), as the Second Law predicts.



The balance of physical resources

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WHO's

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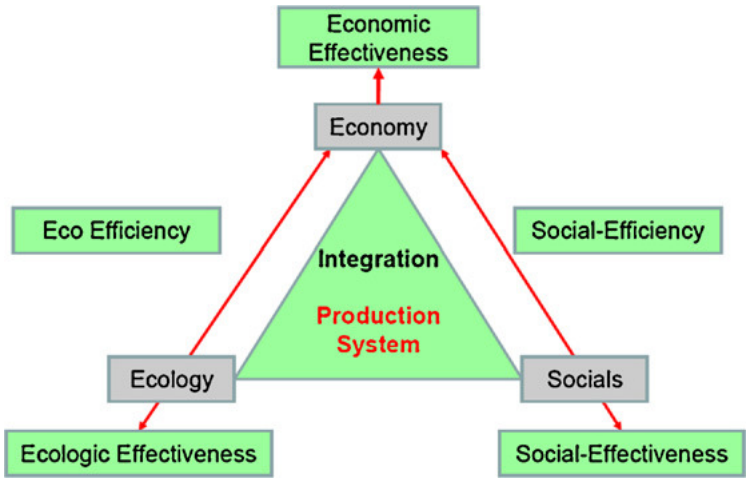
The three challenges for enteprises



Jovane,2008

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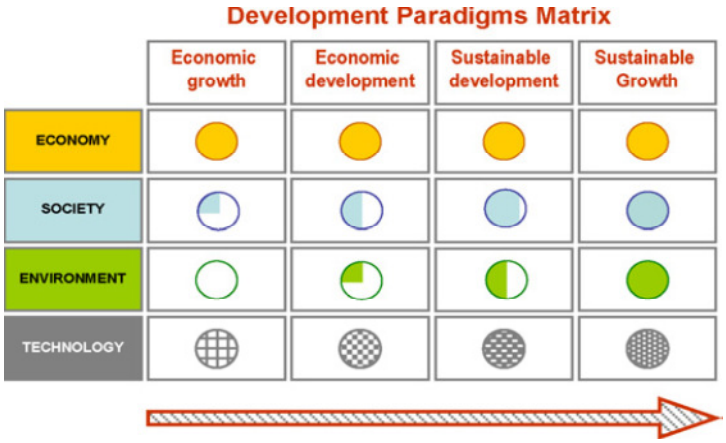
Sustainability and growth….



"sustainable development is a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional chang are made consistent with the future as well as present needs".

Different views =multiple meanings

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- A few brave companies such as IKEA, Electrolux and Interface have fully embraced eco-concepts and integrated them within their businesses, although most companies are currently only at the fringe of embracing such concepts.
- *Yet what such terms mean is often open to differing interpretation and how companies grapple with their meanings, let alone put them into business practice, can be a pretty daunting challenge!*

"Products Earth-and-Profit Friendly "

By SINDYA N. BHANOO Published: June 11, 2010 The New York Times

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- *As the world's greatest soccer players take to the fields at the FIFA World Cup in South Africa, many are wearing jerseys made almost entirely from plastic bottles rescued from landfills in Japan and Taiwan.*

NIKE MBDC cradle to cradle

Walmart Corporate

ECONOMIC SOCIAL ENVIRONMENTAL CARLSBAD

2010 MEMBER ClimateCounts.org INDUSTRY INNOVATORS

patagonia

Cradle to cradle certification

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Paradox #2: sutainable equilibrium

- We (mankind) are Interested Observer of the analysis of the equilibrium (FIND DIRECTION)
- of a system influenced by us where we the same play a role of main actors

(SELF-REFERRING POINT OF VIEW: LOST DIRECTION?)

- *<<All ecologies are reflections of relationships. Attempts to construct industrial ecologies from static descriptions of what is or ought to be connected are shredded by entropy's force..>>Cohen-Rosenthal, 2004*

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TOWARD WHAT?

- Paradox: how can we (mankind) define the right direction if we are the same actor in the system we are trying to measure?
- What means "the right direction" for influencing the future equilibrium state?
  - PRESERVATION SEEMS TO BE

THE ONLY REASONABLE ANSWER UP TO NOW

- *<< Now the phrase 'the environment' evokes in the mind of any reasonably informed person a panoply of images and adjective references such as the environmental movement, environmental issues, the environmental crisis, etc. And in hearing it, that same person will recognize that these terms are evoking something that intrinsically affects the shape of his or her life...>>* *Appleton, 2006*

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STAKEHOLDER's RENSPONSIBILITY

- Sustainability is in our own responsibility either as perception (as IO) or as actors (inducing transformations): it is strictly related to <u>our needs</u>. Our existence itself (as mankind) do contribute to the change of global system equilibrium.

- Before manufacturing there is a <u>need for a function (sustainable needs),</u> then a design of this function: the best eco-design strategy cannot afford a crazy need!

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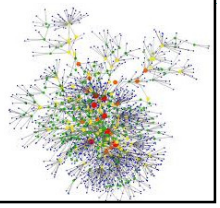
ONTOLOGY: setting our common model



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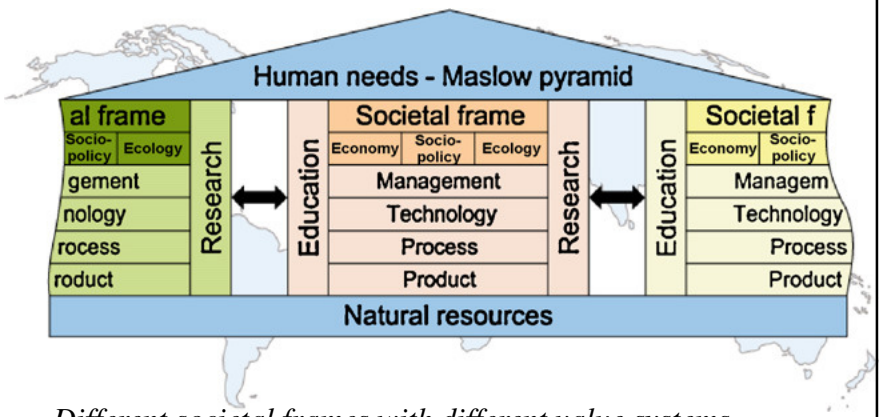
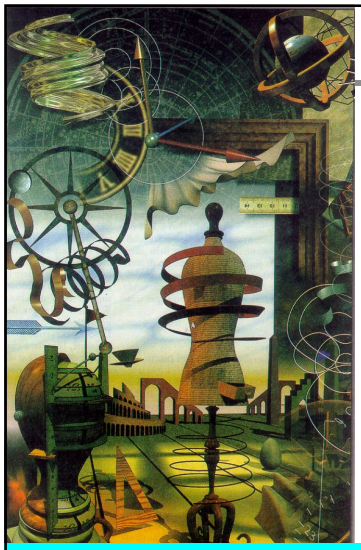
Open mind to a different view…



Different societal frames with different value systems – considering economic, ecological and sociopolitical issues in different regions of the globe – have to be taken into account



STAKEHOLDER's RENSPONSIBILITY

There is a time when we must firmly chose the course we will follow

or relentless drift of events will make decision for us

- *<< If environmental accounting works with the grain of business and business continues to encourage desecration of the planet (albeit at a reduced rate) then, ceteris paribus, we need to conclude that our environmental accounting may, perhaps, be doing more harm than good. . . . >>* *Young, 2006*

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WHERE's

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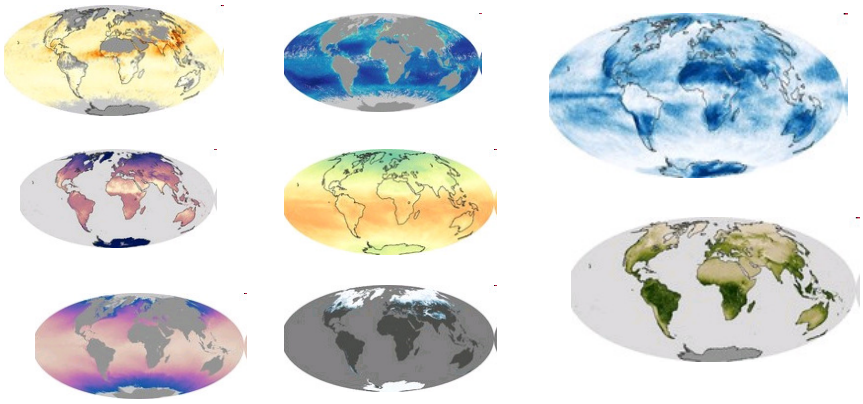
Systemic thinking ....



http://earthobservatory.nasa.gov/GlobalMaps/

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Industrial ecology

Robert White, the former president of the US National Academy of Engineering (1994):

'the study of the flows of materials and energy in industrial and consumer activities, of the effects of these flows on the environment, and of the influences of economic, political, regulatory, and social factors on the flow, use, and transformation of resources'

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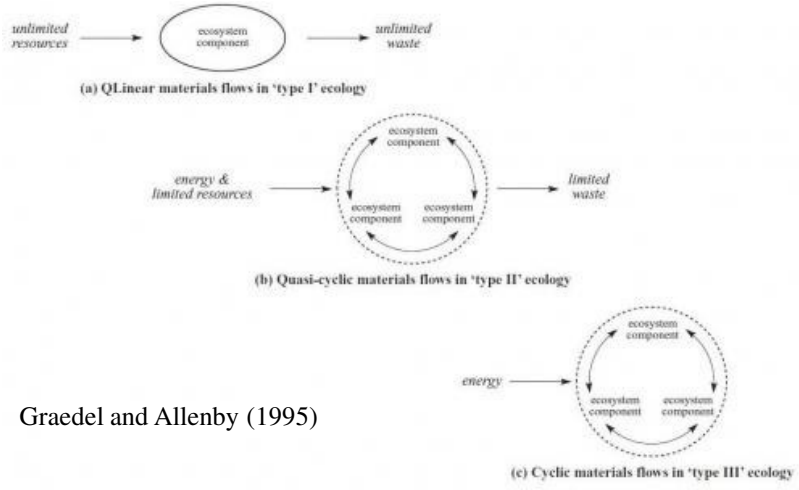
Industrial ecology

- Type I is the most linear and reliant on external resources and sinks,
- Type III stands at the other extreme, having the greatest degree of cycling and less reliance on external resources and sinks.



Graedel and Allenby (1995)

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Industrial ecology

It is ecological in at least two senses :

- Industrial ecology looks to **non-human 'natural' ecosystems as models** for industrial activity.(ex. *The Industrial Symbiosis at Kalundborg:* http://indigodev.com/Kal.html)
- Industrial ecology places human technological activity in the context of the larger ecosystems that support it. This sense of 'ecological' links to questions of **carrying capacity** and **ecological resilience**, asking whether, how and to what degree technological society is perturbing or undermining the ecosystems that provide critical services to humanity.

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The network of companies in the symbiosis, currently about 3 million tons per year.

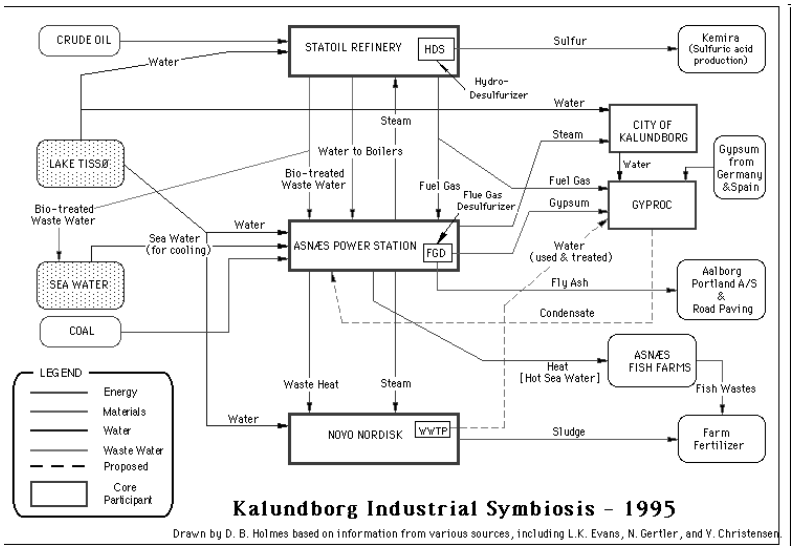

Image © Douglas B. Holmes

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Resilience.

Resilience is the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks—in other words, stay in the same basin of attraction.

Aspects critical :

- **Latitude**: the maximum amount the system can be changed before losing its ability to recover; basically the width of the basin of attraction. Wide basins mean a greater number of system states can be experienced without crossing a threshold Resistance: the ease or difficulty of changing the system; related to the topology of the basin—deep basins of attraction indicate that greater forces or perturbations are required to change the current state of the system away from the attractor.
- **Precariousness**: the current trajectory of the system, and how close it currently is to a limit or "threshold" which, if breached, makes recovery difficult or impossible
- **Panarchy:** how the above three attributes are influenced by the states and dynamics of the (sub)systems at scales above and below the scale of interest

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Equilibrium…… much more than sustainability

The equilibrium between the gradients of opposite sign (in the same dimension)

determine the <u>resiliency</u> of systems

to manufacturing actions

<<Sustainability is the capacity to continue a desired condition or process, social or ecological. Resiliency is the ability of a system to adjust its configuration and function under disturbance. In…>> Tainter, 2006

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HOW's

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Number of different approaches…..

- Analyse (ORGANISATIONAL; ENVIRONMENTAL PERFORMANCE)
- Reduce (WATER; LUBRICATION; POLLUTION; WASTE; ENERGY CONSUMPTION; WASTE)
- Reuse (WASTE)
- Recycle (SYSTEMIC APPROACH)
- ReDesign (DECISION SUPPORT; GREENING PROCESS)
- Remanufacturing
- Eco-efficiency (OPTIMISE)
- Improve (MATERIALS)

=56/250 contribution

NO UNIQUE SOLUTION ⇔ NO SOLUTION?

- Can be so many solution a sign of no solutions?
- Is this a paradox?

The difficulty in finding a common roots in the frame of eco-approaches developed so far reflects the huge number of unknown potential influencing factors

- *<<In the last decade significant progress has been made in recognising and understanding the issues in sustainability. Much remains to be done because the science that underlies sustainability is still far from exact...>> Butterham, 2005*

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SUSTAINABILITY: principle-oriented

'If it is impossible to know how far it is safe to perturb the system we live in without triggering a catastrophic collapse,

then the only reasonable policy is not to perturb it more than it has been perturbed by natural phenomena in the past'

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Green chemistry: 12 principles

- mass and energy in and outputs should be as inherently non-hazardous as possible
- prevention of waste is better than clean up
- minimize energy in separation/purification processes
- maximize mass, energy, volume and time efficiency in product/process
- output-pulled is preferred to input-pushed
- energy is main criterion for choice between recycle, reuse or disposal

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Green chemistry: 12 principles/2

- durability must be targeted (no eternal life)
- avoid one-size-fits-all, minimize excess
- minimize material diversity in multicomponent products
- integration & interconnectivity are a way to industrial ecology
- design for performance in a commercial ‘‘after-life’’
- favour mass and energy inputs from renewable sources

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Green chemistry : warnings

Technical innovation alone will not suffice to ensure that sustainable technology is adopted.

Correct framework conditions are required to enable successful investment in green chemistry and engineering.

These include:

- Correct market conditions—including incentives to increase research and access to finance for new (and potentially risky) innovation
- Cost-effective regulation—that does not inhibit change through over regulation
- Appreciation by society—a demand for new products and systems that is real

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Regulations on M.S.

Sustainability is inherently normative!

- There should be an overall goal and vision toward which policy and management programs and designs are directed.

Those environmental public goods that are defined through science and participatory decision-making processes as valuable enough to limit individual freedom of choice for sake of the common good can be influenced

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Regulations on S.M.

Many countries have enacted environmental legislation that restricts resource consumption, pollution levels, and waste disposal; and encourages uses of recyclable materials

E.g.

- Waste Electrical and Electronic Standard of the European Union (European Commission on Environment 2009)
- United Nations Environmental Protection (UNEP) agency

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Sustainability awareness

Today, with increasing **awareness for environmental protection**, many consumers prefer "green" products.

The associated goodwill of companies that practice sustainable manufacturing could improve market prospects for their products.

Hence, in response to environmental regulations, awareness, and in some cases consumer and community pressures, companies have started to assert **sustainability as one of their strategic priorities.**

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Regulationg bodies

"The US. Environmental Protection Agency is charged by Congress with protecting the Nation's land, air, and water resources. Under mandate of national environmental laws, the Agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life."

Public committment

New initiatives

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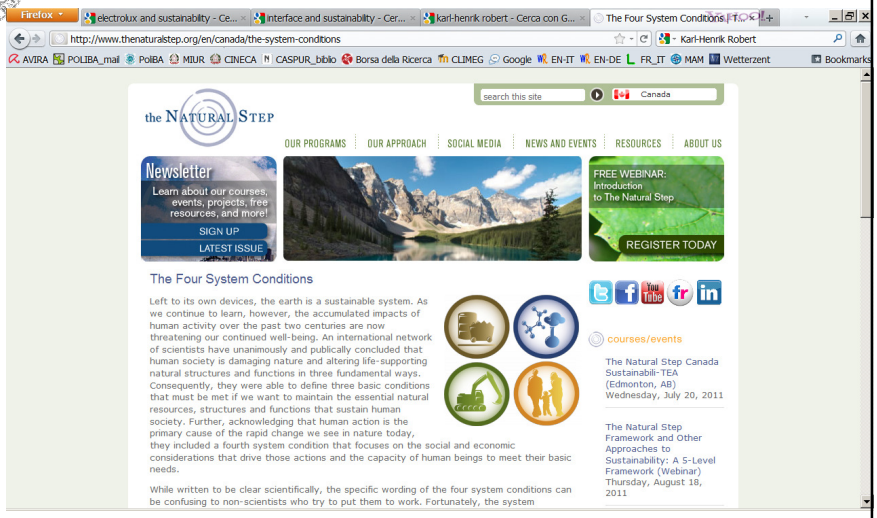
The Natural step: a framework



Karl-Henrik Robèrt, M.D., Ph.D. (born 1947), is one of Sweden's leading cancer scientists and an important figure in the worldwide sustainability movement.

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The Natural step framework

The Four System Conditions...	. . . Reworded as The Four Principles of Sustainability
In a sustainable society, nature is not subject to systematically increasing:	To become a sustainable society we must...
1. concentrations of substances extracted from the earth's crust	1. eliminate our contribution to the progressive buildup of substances extracted from the Earth's crust (for example, heavy metals and fossil fuels)
2. concentrations of substances produced by society	2. eliminate our contribution to the progressive buildup of chemicals and compounds produced by society (for example, dioxins, PCBs, and DDT)
3. degradation by physical means	3. eliminate our contribution to the progressive physical degradation and destruction of nature and natural processes (for example, over harvesting forests and paving over critical wildlife habitat); and
4. and, in that society, people are not subject to conditions that systemically undermine their capacity to meet their needs	4. eliminate our contribution to conditions that undermine people's capacity to meet their basic human needs (for example, unsafe working conditions and not enough pay to live on).

At first reading, the system conditions and basic principles might

QC)
Monday, August 22, 2011

Open House at The Natural Step Canada
Monday, September 12, 2011

IMPACT! Youth Conference for Sustainability Leadership (Guelph, ON)
Thursday, September 15, 2011

Introduction to The Natural Step (Webinar)
Thursday, September 22, 2011

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Finitedness of resources

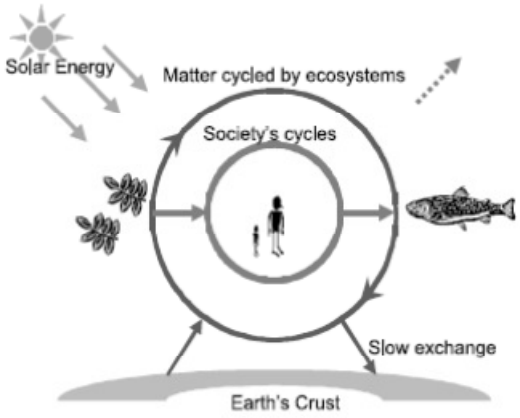

Fig. 2. The TNS systems model of resource cycles.

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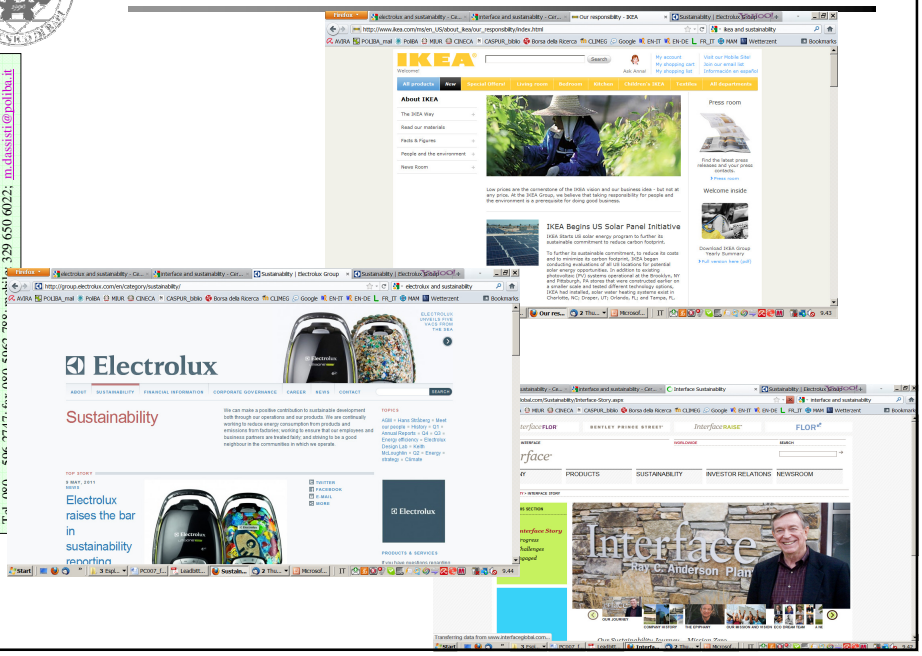
TNS framework

Fundamental human needs that are consistent across time and cultures:

1.subsistence, 2.protection, 3.affection, 4.understanding, 5. participation, 6. leisure, 7.creation, 8.identity, 9.freedom.

Fig. 3. The four TNS system conditions.

The Natural step: the brave companies



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TNS: The case of PVC production

No.1: The industry should commit itself long-term to becoming carbon-neutral

- Achieve major improvements in energy efficiency in manufacturing plants
- Improve generation efficiency, for example by increased use of Combine Heat and Power systems
- Develop programmes for a progressive increase in the use of renewable energy sources for generation of electricity
- Set targets for substantial reductions in transport energy use by improved efficiency, backloading, rationalisation and selection of optimum mode
- Analyse the feasibility and carry out a life-cycle analysis (LCA) of changing feedstocks from hydrocarbons to biomass or other sources

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TNS: The case of PVC production

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- Set targets for substantial reductions in transport energy use by improved efficiency, backloading, rationalisation and selection of optimum mode
- Analyse the feasibility and carry out a life-cycle analysis (LCA) of changing feedstocks from hydrocarbons to biomass or other sources
- Develop co-operative programmes to substantially increase the recycling of waste products including a major effort to work with other agencies and users
- Agree specific targets for adopting carbon sequestration schemes

TNS: The case of PVC production

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No.2: The industry should commit itself long term to a closed-loop system of PVC waste management

Design for recycling

- Enhance joint efforts with stakeholders to increase the amount of recycling and reuse of PVC
- Set specific targets for the above increasing progressively over time
- Continue investigations into the potential toxicity problems arising from PVC in landfill and, where required, ban substances from landfill
- Analyse the sustainability implications of the extent of continued use of landfill and alternative waste disposal routes, including incineration
- Develop the pilot plant for PVC feedstock recycling to full-scale production

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TNS: The case of PVC production

No.3: The industry should commit itself long-term to ensuring that releases of persistent organic compounds from the whole life-cycle do not result in systematic increases in concentration in nature.

- Identify sources and emission/leakage levels of persistent organic pollutants across the whole life-cycle
- Define mechanisms for achieving emissions to a level that results in no systematic accumulation in nature
- Refrigerants and fire fighting chemicals
- Mercury emissions

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TNS: The case of PVC production

No.4: The industry should review the use of all additives consistent with attaining full sustainability, and especially commit to phasing out all persistent compounds foreign to nature, as well as chemicals for which there is reasonable doubt regarding toxic effects.

- determine in which applications it would be prudent to review the use of plasticised PVC, and other potentially problematic additives
- where there is reasonable doubt about the safety of phthalates, research alternative plasticisers and other additives that do not result in systematic accumulation in nature or toxic effects. It is important to note that alternatives should not be assumed to be more sustainable than known problematic substances in the absence of a sustainability analysis.

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TNS: The case of PVC production

No.5: The industry should commit to the raising of awareness about sustainable development across the industry, and the inclusion of all participants in its achievement.

- Engaging stakeholders *(setting priorities with main interest groups)*
- Socially beneficial products *(Future attention to products in the market will also be measured by their social contribution to society)*

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TNS: Europe

Vinyl 2010, European PVC Industry voluntary commitment

- Compliance to ECVM charters regarding PVC production emission standards;
- A plan for a full replacement of lead stabilisers by 2015, in addition to the replacement of cadmium stabilisers effective as of March 2001;
- The recycling in 2010 of 200 000 tonnes of post-consumer PVC waste. This objective will come in addition to 1999 post-consumer recycling volumes and to any recycling of post-consumer waste as required by the implementation after 1999 of European Directives on packaging waste, end-of-life vehicles and waste electronic and electrical equipment, e.g. by recycling 50% of collectable available PVC waste of windows profiles, pipes and fittings, and roofing membranes in 2005 and of flooring in 2008;

TNS: Europe

Vinyl 2010, European PVC Industry voluntary commitment

- A research and development programme on new recycling and recovery technologies including feedstock recycling and solvent-based technology;
- The implementation of a social charter signed with the European Mine, Chemical and Energy Worker's Federation to develop social dialogue, training, health, safety and environmental standards, including transfer to European accession countries;
- A partnership with local authorities within the Association of Communes and Regions for Recycling for the promotion of best-practices and recycling pilot schemes at local level.

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ACT: what will be done?

- As a consequence, long before devoting efforts in eco-design, the first questions should be if we need those functions we are asking from products; then to search the best way to design it and manufacture under the sustainable capabilities constraints.

- *<< Eco-redesigns (E-) consist of short-term, low-functional-change...*
- *Eco-innovations (E+) are a longer-term, high-functional change group of approaches that focus on reinventing...*
- *Sustainable technology innovations (E++) utilize emerging/ unproven technology to provide customer benefits ...>>* *Appleton, 2006*

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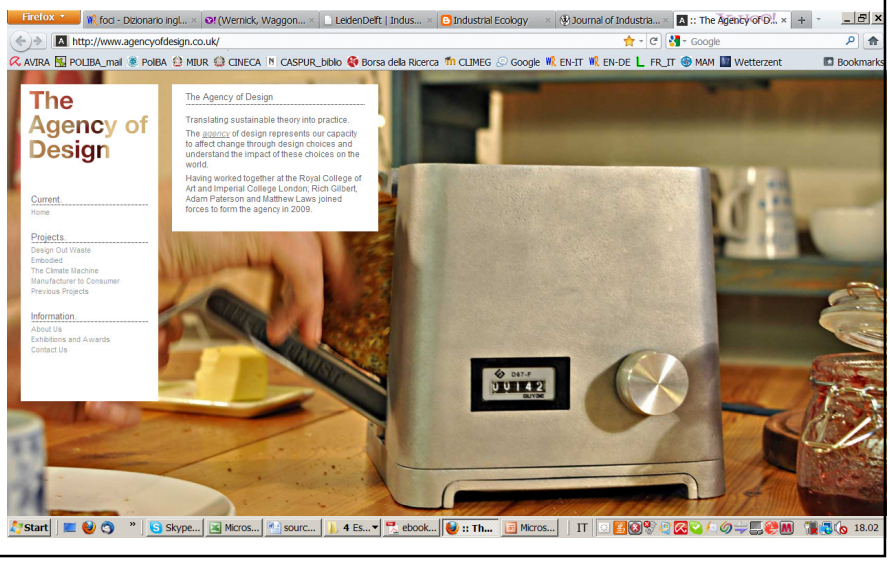
Alternatives to our current wasteful product paradigm



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PRODUCT-SERVICE SYSTEMS:

"A marketable set of products and services capable of jointly fulfilling a user's need.

The product/service ratio in this set can vary, either in terms of function fulfillment or economic value"

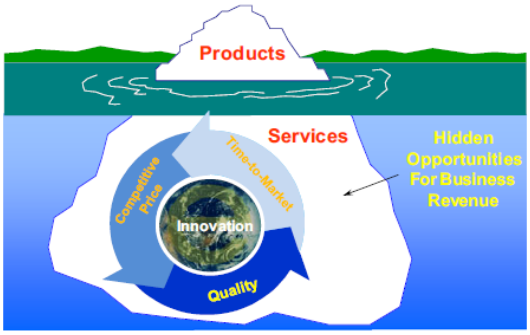

Fig. 3 Iceberg model of service business

Lee,2011

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PSS:to understand!

Designed and marketed to provide customers with a particular result or function—clean clothes, mobility, warmth, etc.—without them necessarily having to own or buy physical products

Behavioural change!

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FUNCTION:
i.e. the capability to satisfy needs

- Manufacture a good: Are all its functions necessary?

- Volume
- Insulate
- Glossy aspect
- Hygenic
- Non-toxic
- Easy to handle
- "Sip oriented"
- ……

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PSS: good rules!

- the sale of the use of the product instead of the product itself;
- the change to a 'leasing society'
- the substitution of goods by means of service machines
- a repair-society instead of a throw-away society
- the change in consumer attitudes from sales to service orientation.

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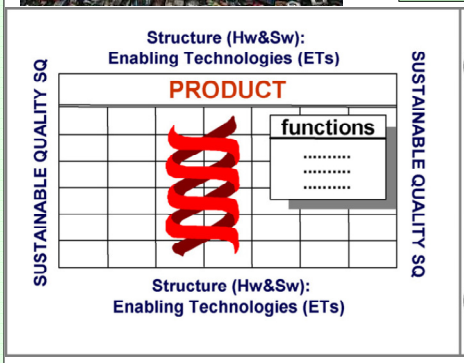
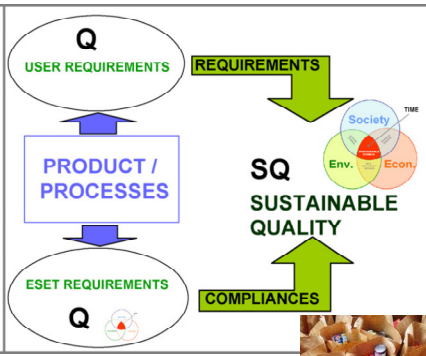
Sustainable quality

Are all the needs necessary?





FUNCTION:
the capability to satisfy needs

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Axiomatic Quality

From "Customer's attribute" to "Functional Requirements" to "Design Parameters" to "Process Variables"

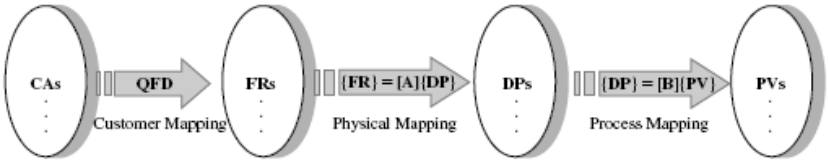

Figure 1.1 Design mapping process.

Acclaro DFSS Light®, a limited version of Acclaro Designer® software provided by Axiomatic Design Solutions, Inc., via free download from the Wiley ftp site
ftp://ftp.wiley.com/public/sci tech med/axiomatic quality/

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Axiomatic Quality

Today's product solutions of current engineering and design activities in many manufacturing companies and design houses are generally suffering from much vulnerability, such as complexity, coupled functional performance, and **modest use of the modularity principle**, among others.

Functional requirements coupling is a common conceptual design vulnerability that generates hidden and unnecessary developmental effort and, later, operational costs in the hands of the customer.

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Axiomatic Quality

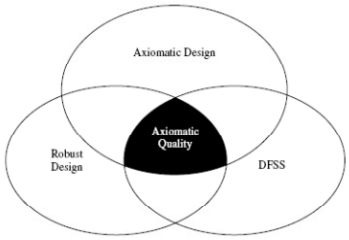

Figure P.1 Axiomatic quality ingredients.

*Starting with the voice of the customer, axiomatic quality focuses on establishing a **comprehensive design process** that utilizes ingredients of Axiomatic Design, Robust Design and Design for Six Sigma from comparative tools: quality engineering, axiomatic design, theory of inventive problem solving, deterministic optimization, and in the absence of quantitative data, fuzzy set theory.*

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Axiomatic Quality

Coupling /incoupling desing: how to arrange sustianable constraints

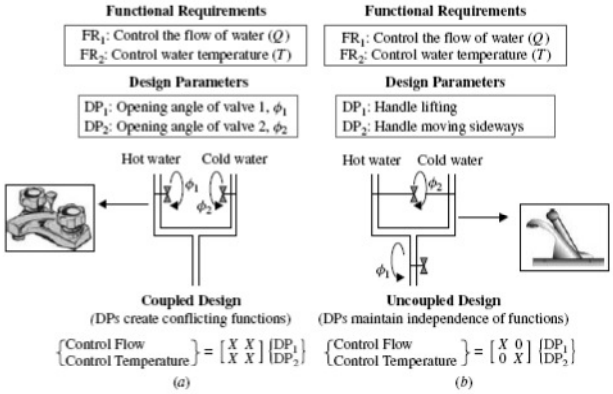

Figure 1.3 Faucet coupling example.

El-Haik, Basem. Axiomatic quality: integrating axiomatic design with six-sigma, reliability, and quality engineering / by Basem Said El-Haik. p. cm. "Wiley-Interscience publication." Includes bibliographical references and index. ISBN 0-471-68273-X (cloth : alk. paper)

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Closed loop manufacturing!

As for the products, Yoshikawa states that

- what people value is not a product itself, but its functionality;
- functionality of a product is service embedded in the product. (People receive the service someone embedded in the product when they use the product);
- latent functionality appears as service when the product is used;
- functionality of a product decreases when it is used. Functionality = SUM services (life of a product terminates when services embedded are exhausted).

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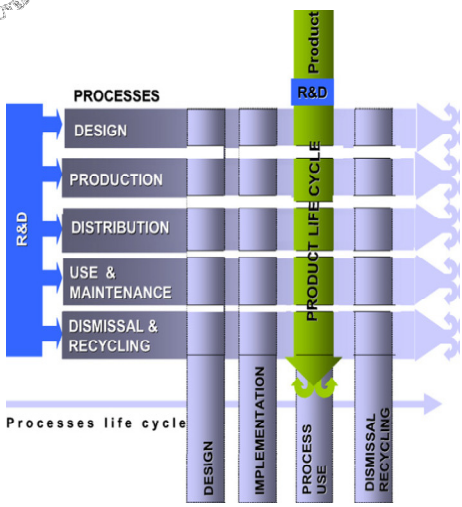
Life cycle approach



•Processes must be designed and operated so that wastes and ecologically incompatible by-products are continuously reduced, eliminated or recycled on-site;

• chemical substances or physical agents and conditions that present hazards to human health or the environment are continuously eliminated;

• energy and materials are conserved, and the forms of energy and materials used are most appropriate for the desired ends;

• work spaces are designed to continuously minimize or eliminate chemical,ergonomic and physical hazards.

Jovane,2008

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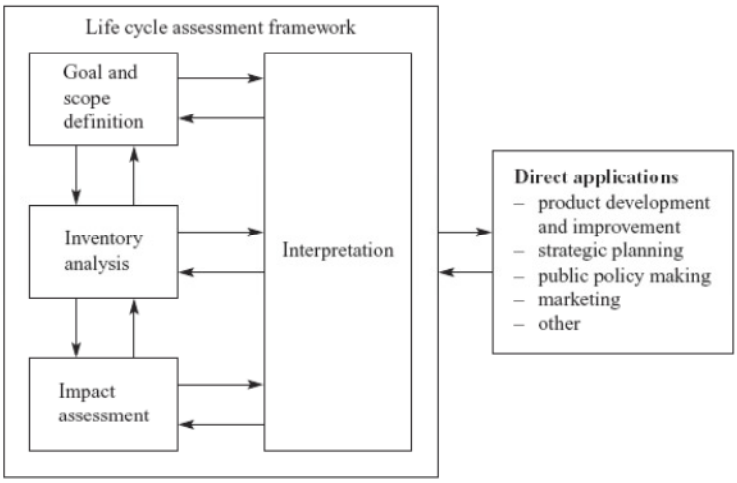
LCA: the third tool



Source: ISO (1996).

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System boundaries

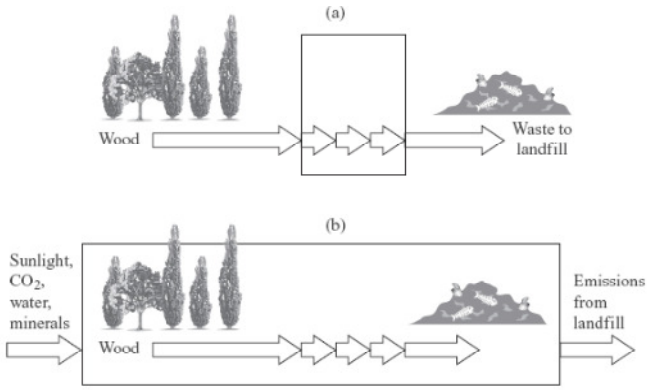

Figure 12.2 *Two ways of defining system boundaries between physical economy and environment in LCA: (a) with narrow system boundaries, (b) with extended boundaries*

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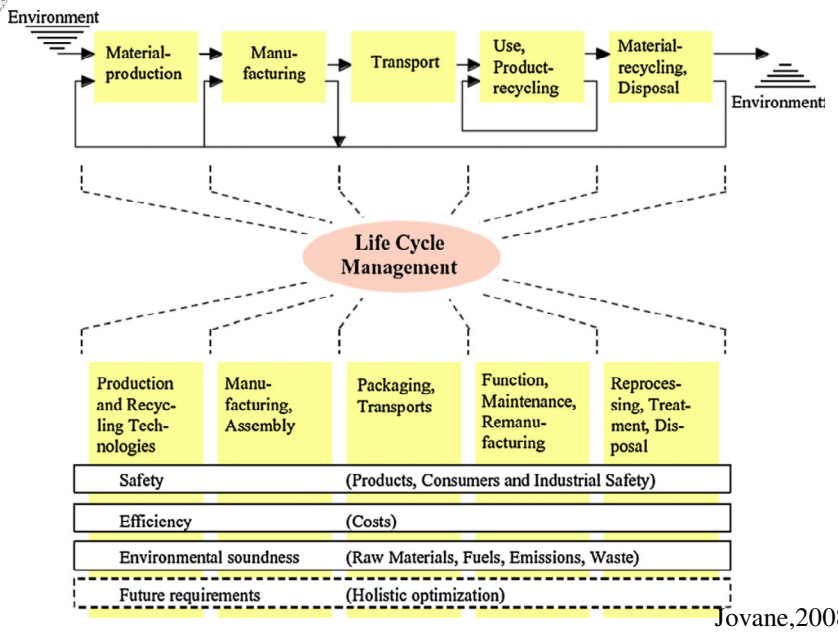
Product life cycle



Jovane,2008

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LCA: Eco_efficiency

- Eco-efficiency (EE) is among the most commonly used concepts in sustainability policies and management discussions.

By definition, eco-efficiency does not include a vision, a goal or a direction.

Life-Cycle Sustainability Assessment

Planet

L-C Assessment: addresses analytically the environmental impacts relating to the whole production chain of a good>>

Profit

-C Costing: summarizes all costs associated with the life cycle of a good that are directly covered in that life cycle

People

<< L-C Societal Assessment: societal impacts but from different aspects: S-responsible investments; product improvement potentials >>

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LCA PRO's

DIFFUSION:

- ❑ LCA methodology was born in the 70 - 80ies from the need and the desire to identify and quantify the environmental effects of a given production system and it is now used around the world.
- ❑solid knowledge base that will allow continuous developments and improvements.
- ❑It has gained the consent of public organizations, private companies and administrations.

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LCA PRO's

CONGRUENCE:

- ❑ allows to outline a comprehensive program of investigation
- ❑ avoids digressions from the intended purpose and wastes of time on irrelevant issues or data
- ❑ the type of knowledge allows to identify the critical points of the cycle and potential response to possible modifications

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LCA CON's

QUALITATIVE:

- ❑ LCA is not a certification, even though sometimes you hear people talk about products certified LCA
- ❑ There is definitely a component of subjectivity in the nature of choices of, for example, data sources, in the identification of system boundaries and in the interpretation of the final results

LCA CON's

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COMPREHENSIVENESS

- ❑ It is an assessment tool that measures the impact of a product, do not automatically enhances it.
- ❑ Information developed through a LCA should be used as a component of a more comprehensive decision-making process
- ❑It is a simplification of a physical system and that is why some experts blame a weak predictive power, while making it clear that it is not possible an absolute and complete representation of any effect of human activities on the environment

LCA CON's

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DATA REFERENCING

- ❑ The absence of normalisation of space and temporal dimensions in the inventory of the data used.
- ❑ Not always the impacts that occur at different times and different places are normalised➔uncertainty in the results of the impacts.
- ❑The accuracy of an LCA study can be limited by the availability and accessibility of relevant information

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Benchmarking

Comparing solutions according to a given context

and for a given scope

based on the best practices and/or performances

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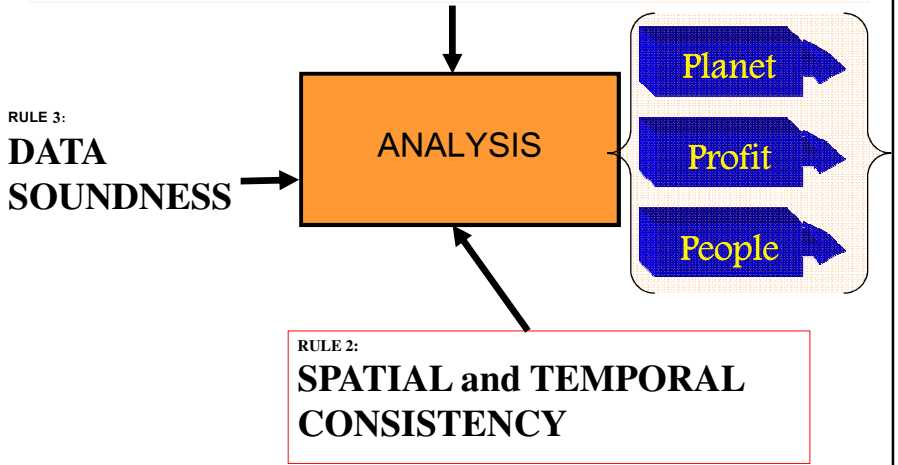
The benchmarking frame

RULE 1:
SPECIFICATION on PHYSICAL TRANSFORMATIONS

RULE 3:
DATA SOUNDNESS



RULE 2:
SPATIAL and TEMPORAL CONSISTENCY

Renewable is sustainable?

III. Renewable energy sources are often presented as "clean". A more correct definition hopefully is that they are "cleaner" than ones based on fossil fuel conversion.

IV. If it is agreed that humankind has no chance to survive on this planet (and, thus, nowhere else), unless a sustainable development is achieved, sustainability has to be established at all levels.

V. ……

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LCA: PV panels

- First generation: *cristalline (mono- / poli-) silicon and ribbon silicon*
- Second generation : *amorphous silicon (a-Si), Cadmium Tellurure (CdTe), CIS, CIGS*
- Third generation : *organic cells (DSSC), solar concentrators, ecc.*

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ASSOCIATION PV CYCLE

Operator	Procedure	Size/Stage of development	PV technology
Deutsche Solar AG	Thermal separation, processing	Pilot production ecological consideration	Crystalline, Thin film in laboratory
First Solar	Thermal decomposition in Inert Gas	Laboratory	Crystalline
Isofoton	Cell recycling Swelling Shredding Reparable module	Laboratory	Crystalline
AIST, Sharp, Asahi	Wafer recycling with mineral acids Solvent swelling Reparaible module	Laboratory	Crystalline
Photovoltech	Reparaible module	Laboratory	Crystalline
BP Solar, Solitech, Seghers	Wafer recycling with mineral acids Wafer recycling in fluidized bed	Laboratory/technical college	Crystalline
Pilkington Solar International	Thermal separation	Laboratory	Crystalline
Siemens SolaR, Shell Solar, Showa Shell	Ferro silicon production High pressure water jet	Laboratory	Crystalline, Thin film
Other	Module shredder Mechanical separation Acid treatment Smelter MWI Concrete aggregates Road construction	Laboratory	Crystalline, Thin film
Disposer	Removal of frame and cable	Production	all

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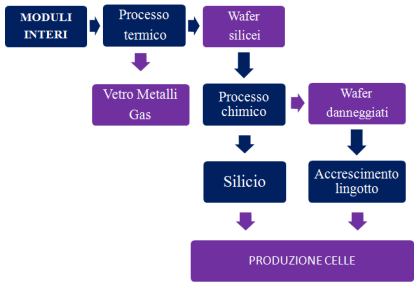
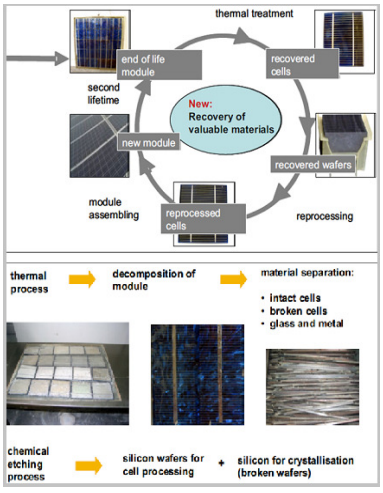
Schematic process of recycling of PV modules in Si-C



Schematic process of recycling Deutsche Solar AG



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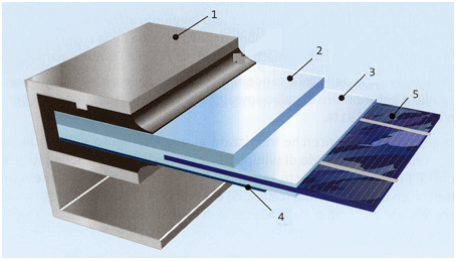
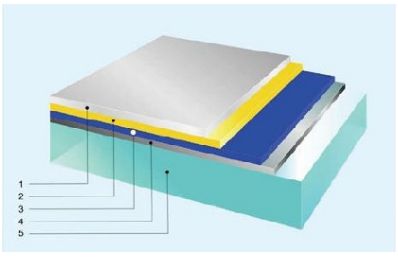
Structure of PV panels

- *1^ generation:*
  1) Al;
  2) Glass;
  3) EVA;
  4) Tedlar;
  5) Solar cells;



- 2^ generation:
  1) ZnO;
  2) CdS;
  3) CIS;
  4) Rear metallic contact;
  5) Glass;



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PV's_:End of Life

- Operative end-of-life after 25-30 years:
  - *Physical degradation of Balance of System*
  - *Delamination, degradation of interconnections, semiconductors…*

BENCHMARKING RECYCLING SOLUTIONS

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Benchmarking EOL

FIRST SOLAR

- Mechanical-chimical process
- CdTe Modules
- Recycle crunched materials
- Yield: 90-95%

DEUTSCHE SOLAR

- Thermo-chimical process
- SiC modules
- Wafer as good as news
- High Temperatures ⟶

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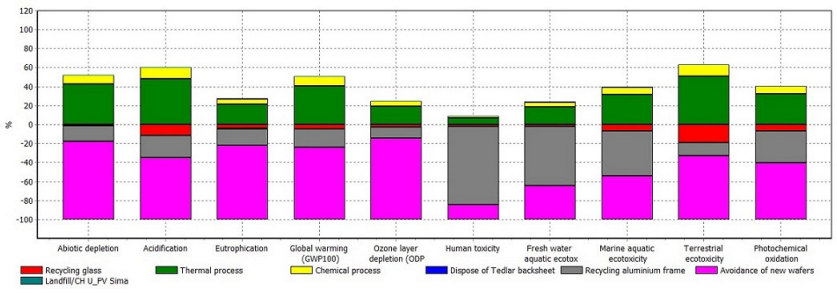
Benchmarking EOL

LCA = Life Cycle Assessment ⇨ *Impact Assessment*



Recycling phase and disassembly Deutsche Solar

[CML 2 baseline 2000 / West Europe 1995]

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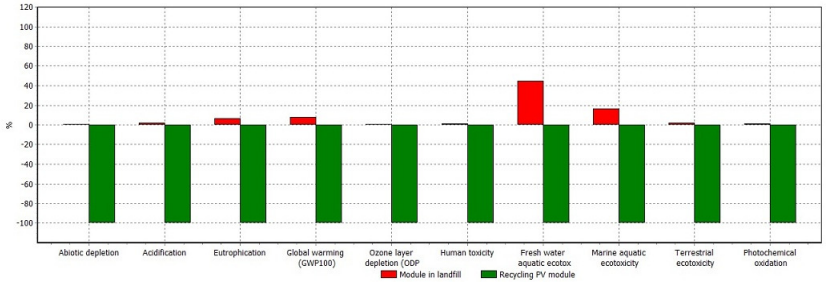
Comparing two EOL scenarious

Deutsche Solar (high value) vs landfill scenarious for 1 Sic monochristalline modulus:

RECYCLING CONVENIENCE



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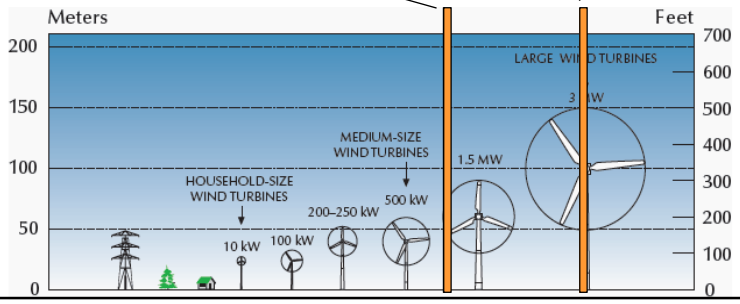
An example from literature

CONTEXT: on-shore;
20 year scenario

SCOPE: assess sustainability of electricity production

850 kW
➢a rotor diameter of 52 m

3 MW
➢rotor diameter of 90 m



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The benchmarked turbines

Component	Item	Wind turbine (3.0 MW)		Wind turbine (850 kW)	
		WEIGHT	MATERIALS	WEIGHT	MATERIALS
Foundation	Reinforced concrete	1220 t	1200 t concrete	495 t	480 t concrete
			20 t steel		15 t steel
Tower	Painted steel	276 t	275 t steel	70 t	69.07 t steel
			1 t paint		0.93 t paint
Nacelle	Generator	8,5 t	5,525 t steel	1.84 t	1.47 t steel
			2,975 t copper		0.37 t copper
	Gearbox	23 t	22,54 t steel	6.2 t	6.08 t steel
			0,23 t copper		0.062 t copper
			0,23 t aluminium		0.062 t aluminium
	Frame, Machinery & Shell	37 t	31,45 t steel	13,9 t	12,644 t steel
			2,96 t aluminium		0,6 t aluminium
			1,258 t copper		0,537 t copper
			0,011 t glass fibre		0,18 t glass fibre
Rotor	Hub	8,5 t	8,5 t cast iron	4.8 t	4.8 t steel
	Nose cone	11,5 t	11,5 t glass fibre	5,6 t	5,6 t glass fibre
	Blade (3 per rotor)	6,6 t	4,35 t glass fibre	5.02 t	3.01 t glass fibre
			2,25 t epoxy		2.01 t epoxy

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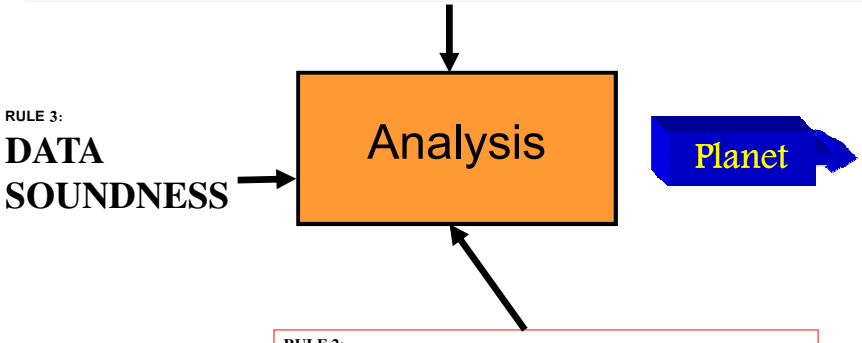
Application of the frame

RULE 1:
SPECIFICATION on PHYSICAL TRANSFORMATIONS

RULE 3:
DATA SOUNDNESS



RULE 2:
SPATIAL AND TEMPORAL CONSISTENCY

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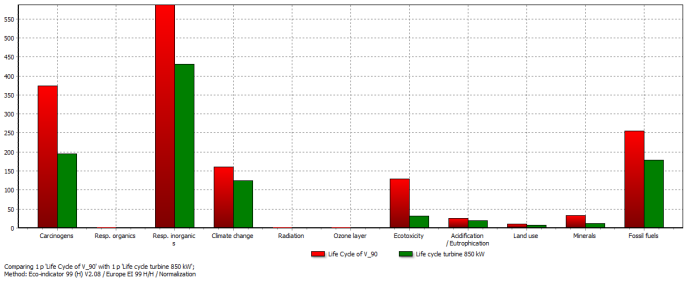
PLANET: LCA (Ecoinvent Database): R1 & R2&R3

- Manufacturing and erection ('Environmental Statement 2004' of Vestas and from the Australian National Accounts) + mainly fuel (diesel) [24]. Transportation distances have been considered equal to 100 km.
- Operation and maintenance (personnel is transported by diesel car)+ (Gear and gearbox are assumed to be replaced once during this period)
- Disposal scenario (90% of steel, cast iron and copper are recycled while the remaining parts are sent to landfill) + (Transportation distances are assumed to be, in average, equal to 200 km.)



*Normalized comparison between 3MW wind turbine and a 850 kW wind turbine life cycles (*SIMA-PRO(R) *v.7.3 - Eco Indicator 99)*

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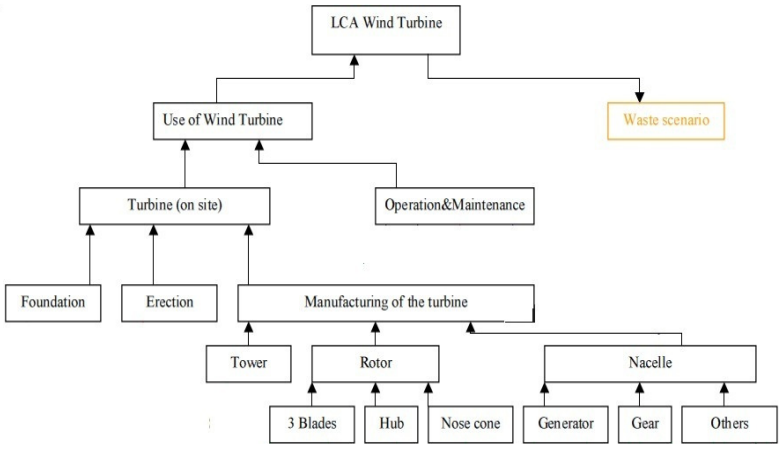
LCA: Life cycle of the wind turbine in SimaPro 7.3



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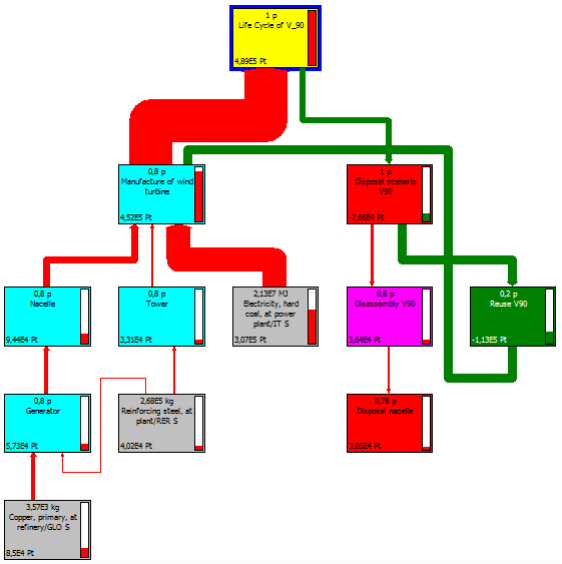
LCA: Network of the life cycle of the 3MW turbine



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PROFIT & PEOPLE: missing!

- Vestas, "General Specification V90 – 3.0 MW 60 Hz Variable Speed Turbine." 2004

As well as in

- G. Stonge, "Energy Development." 2011.

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Partial Conclusions: missings

- The 850 kW has a lower negative influence on the environment. (Nevertheless, it must be also taken into account that in favorable weather and wind conditions the output energy of the turbine of 3 MW is greater than that of the turbine of 850 kW.)

- The waste scenario is very important to the environmental profile of the wind power
(The benefits come, above all, from the almost complete recycling of the steel (90%), the cast iron (90%) and the copper (90%)

- The most sensitive scenario is the manufacturing phase, in particular the use of the electricity mix used for the production of the materials

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LCA is taking things too simple than they are

EPD
Environmental
Product
Declaration

Manufacturing i.e. transforming matter using energy will surely perturbs the state of our world!

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Why a frame…

I. The frame needs to be applied to have a wider view of problems: more data and efforts are thus required to do so otherwise……

II. Benchmarking frame is easy to use and congruent

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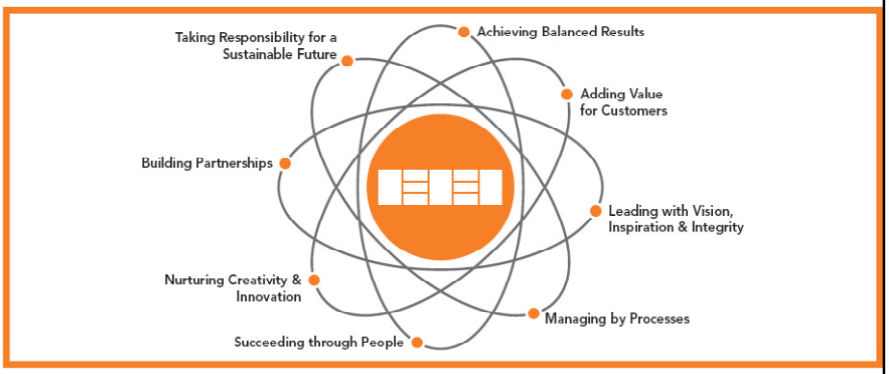
European Foundation for Quality Management



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CONCEPT	START UP	ON THE WAY	MATURE
Succeeding through People	Approaches are in place to involve people and their talents are recognised	The full potential of people is increasingly enabled, to the benefit of the people and the organisation	A culture of trust and empowerment exists and the full potential of people is released
Nurturing Creativity and Innovation	Although new ideas and innovations are sometimes encouraged, the approach to acting on them is ad hoc	Innovation is seen as essential to creating distinctive value and is increasingly evident in some aspects of the organisation	There is a systematic approach to innovation, throughout the organisation, creating distinctive value for stakeholders
Building Partnerships	A process exists for selecting and working with partners	The relationships with partners are based on shared goals and more effective ways of working	The organisation and its key partners are interdependent. A trusting relationship exists. Plans and policies are co-developed on the basis of shared knowledge
Taking Responsibility for a Sustainable Future	Legal and regulatory requirements are understood and met	The organisation's approaches positively support the aims of economic, social and ecological sustainability	Sustainable corporate behaviour is an integral part of the organisation's purpose. Societal expectations are measured and actioned

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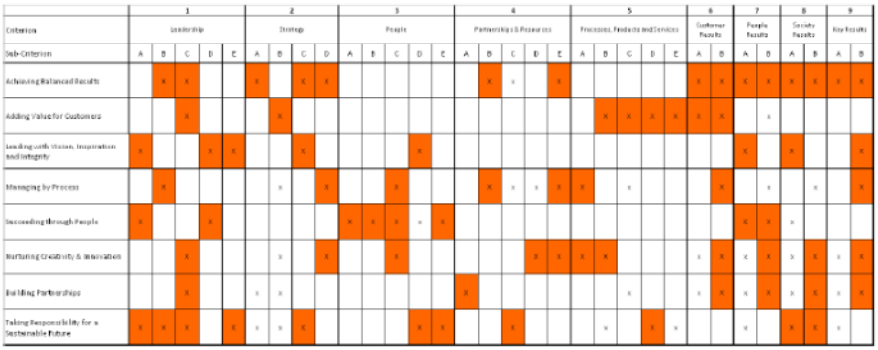

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RADAR

Approach:
- Sound
- Integrated

Results:
- Relevance and usability
  - Scope
  - Integrity
  - Segmentation
- Performance
  - Trends
  - Targets
  - Comparisons
  - Causes

Plan and develop APPROACHES

Required RESULTS

DEPLOY Approaches

ASSESS AND REFINE Approaches and Deployment

Deployment:
- Implemented
- Systematic

Assess and Refine:
- Measurement
- Learning and Creativity
- Innovation and Improvement

Total Quality & Environmental Mgmt

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Total Quality Management (TQM) is widely recognized as an effective strategy for improving corporate performance. The basic elements of TQM are as follows:

- Primacy of the customer
- Measurement systems that provide continuous feedback
- More extensive use of external information (benchmarking)
- * A focus on processes rather than departments or events
- Strong emphasis on training
- Extensive use of teams
- Suggestions systems designed to promote continuous improvement
- A robust program of recognition and reward
- CEO commitment and involvement

Total Quality & Environmental Mgmt

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Environmental issues are increasingly seen as an integral component of continuous improvement in both the corporate and environmental fields.

This has lead to a movement called Total Quality Environmental Management (TQEM).

TQEM extends traditional quality tenets to the management of corporate environmental matters as well as those of process efficiency and product performance.

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TQEM: Performance Measures: Environmental Metrics

The progress of design projects should be clearly assessed with appropriate measures to help members of the design team achieve environmental goals. Consistent measures of impact reduction in all phases of design provide valuable information for design analysis and decision making.
It **is** important to establish measures that cover resource efficiency, waste generation in all media, ecosystem sustainability, and human health.

Life cycle design is likely to be more successful when environmental aspects are part of a firm's incentive and reward system.

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Paradox :

Uniqueness of measurement

- When searching for the uniformity of views about eco-approaches (UNIVOCAL UNDERSTANDING) , i.e. by adopting a top-down approach
- We are (NOT UNDERSTANDING) the sytem which is characterised by variety

- *<<Any attempt to impose uniform solutions of global environmental problems will threaten the diversity of the earth's regions and cultures in the same way that economic globalization does now..>>*

Komiyama, 2006

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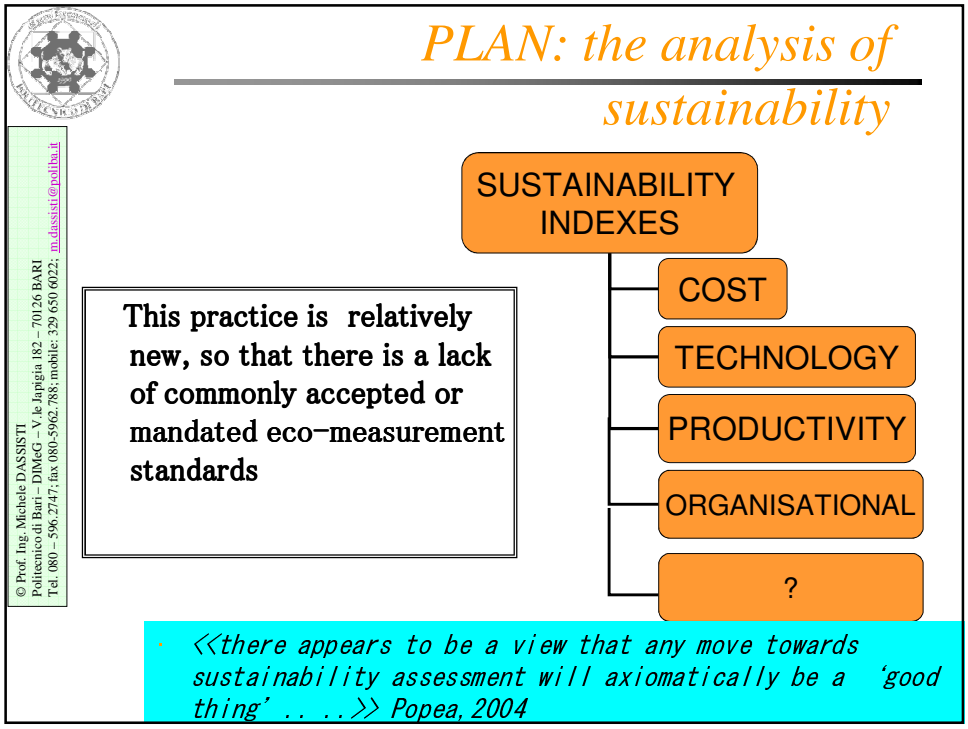
OFFICIAL PERFORMANCES

By Electrolux – Sustainability Repor, 2006

Investors rank Electrolux

Several socially responsible investment indices include the Electrolux Group as a constituent company, including Dow Jones STOXX Sustainability Index and the FTSE4Good Series. The Group is also ranked highly by Oekom Research in Germany, KLD Research and Analytics Inc. which has ranked Electrolux among its Global Climate 100 Index. In 2006 Electrolux topped an environmental performance review of the companies listed on the Stockholm Stock Exchange that was conducted by one of Sweden's most prominent sustainability fund managers, Banco Fonder. Electrolux was recognized for integrating environmental thinking in all aspects of operations, for reporting practices and striving to be transparent about performance.

Dow Jones Sustainability Indexes


PLAN: the analysis of sustainability
SUSTAINABILITY INDEXES
COST
TECHNOLOGY
PRODUCTIVITY
ORGANISATIONAL
?
This practice is relatively new, so that there is a lack of commonly accepted or mandated eco-measurement standards
<<there appears to be a view that any move towards sustainability assessment will axiomatically be a 'good thing' . . . .>> Popea, 2004
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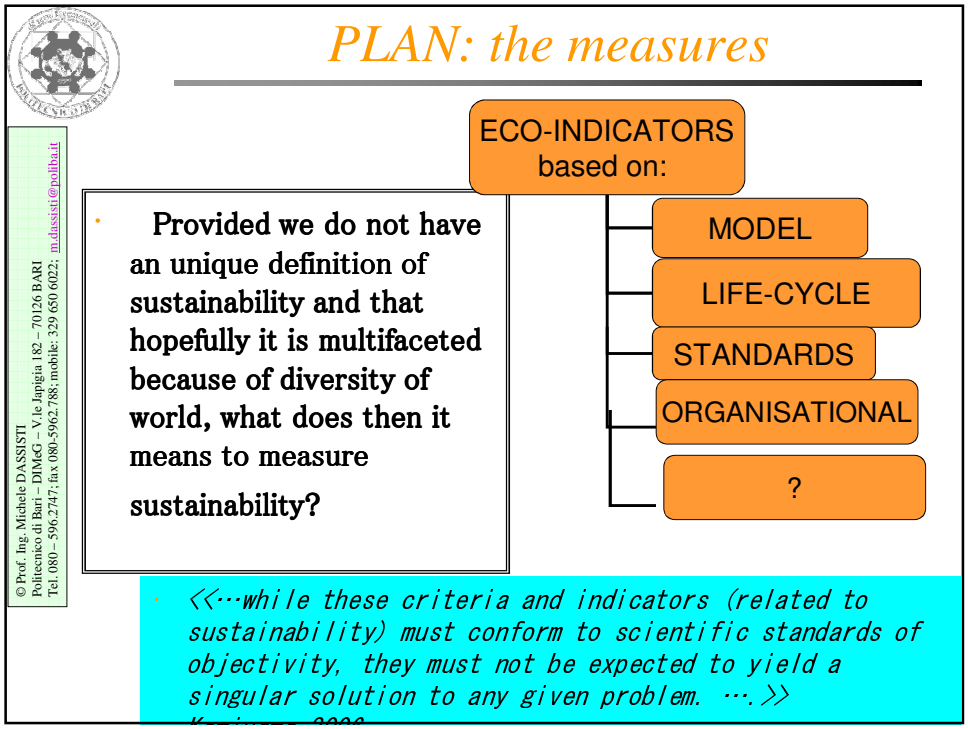
PLAN: the measures
ECO-INDICATORS based on:
MODEL
LIFE-CYCLE
STANDARDS
ORGANISATIONAL
?
Provided we do not have an unique definition of sustainability and that hopefully it is multifaceted because of diversity of world, what does then it means to measure sustainability?
<<…while these criteria and indicators (related to sustainability) must conform to scientific standards of objectivity, they must not be expected to yield a singular solution to any given problem. ….>>
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Sensitivity analysis

- In SETAC's 'Code of practice' (1993) sensitivity and uncertainty analysis are recommended, but the methodology is not very well developed.
- In the ISO 14040 sensitivity analysis is requested (ISO 1997a).

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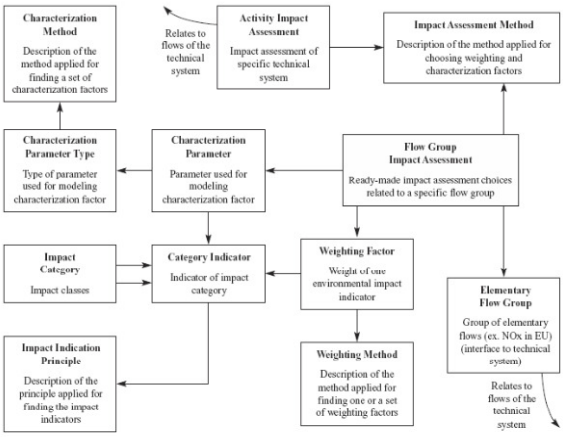
Sensitivity analysis

Analysis of uncertainty and sensitivity is important but too seldom carried out. Life cycle assessments are normally made without quantitative estimations of accuracy or precision.



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Eco_efficiency: criticisms

- One cannot use efficiency or the conventional Pareto optimal efficiency as the goal or overall vision of sustainable development.

1. because of path dependency and technological lock-in, inefficient technologies and management practices may become the dominant ones

2. efficiency in production reduces costs and eventually prices of end-products. This can boost up demand and eventually the overall macroeconomic growth environmental impacts

3. even if the most efficient environmental solution is known, it risks the space needed for future sustainability. Due to uncertainty, it is impossible to know what will be required in the future

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Eco_efficiency

- Eco-efficiency (EE) EE is defined as reduced resource use and/or waste and emission generation per unit of output of production
- Or as Brattebo puts it “units of value generation per unit of environmental influence”

The basic notion of efficiency has been and continues to be central for the dominant economics theory of neoclassical economics.
In neoclassical economics, efficiency is applied in the ‘maximum power’ sense

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Manufacturing

- Manufacturing industry has great relevance in modern history.
- The first industrial revolution – based on the manufacturing industry – was a divide between ‘‘ancient and new worlds’’.
- And, as such, it is a fundamental part of the first Kondratiev long wave that depicts economic development related, but not exclusively, to technological innovations.

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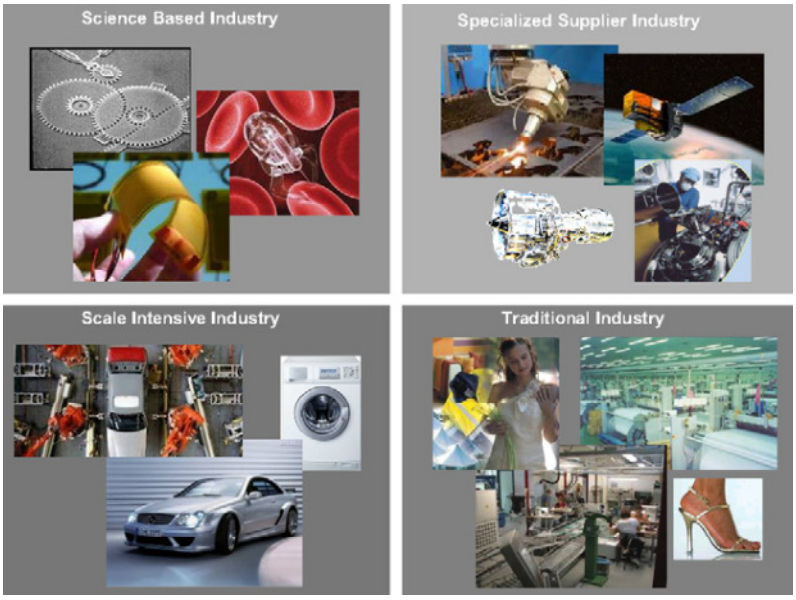
Manufacturing



Jovane,2008

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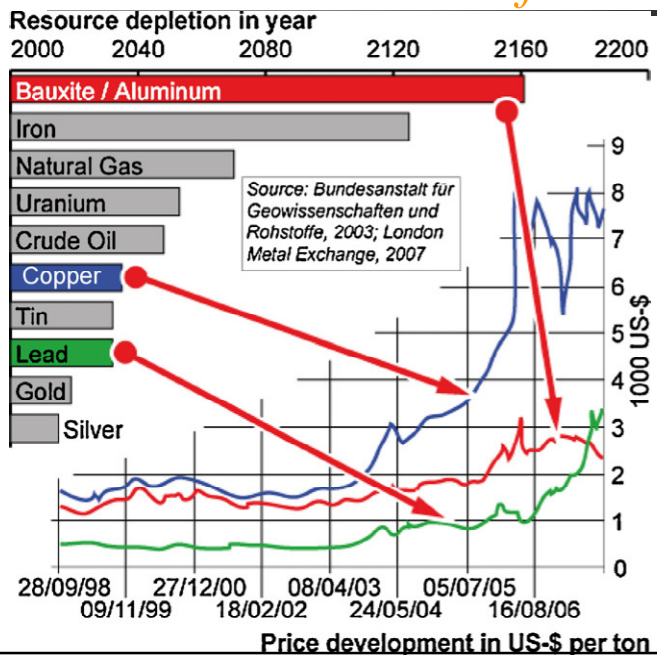
Finitedness of resources



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Manufacturing Sustainability

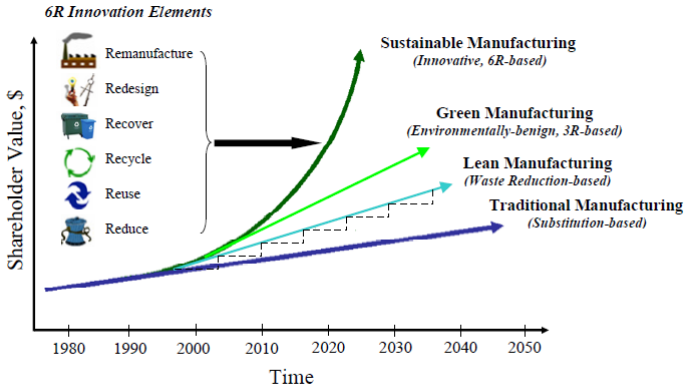

Figure 2 *The evolution of sustainable manufacturing for the 21st century*

I.S. Jawahir,2007

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Sustainable manufacturing

- *Creation of manufactured products that use processes that are non-polluting, conserve energy and natural resources, and are economically sound and safe for employees, communities, and consumers."* *USA- Dept. Of Commerce*

The lesser the better??
LINEAR THINKING

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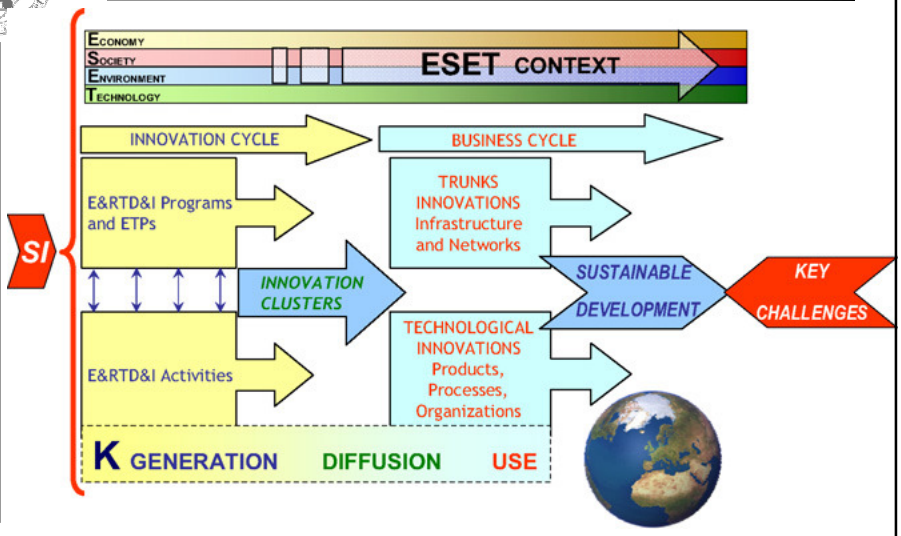
Competitive Sustainable Manufacturing



education, research and technological development and innovation (E&RTD&I) [Jovane,2008]

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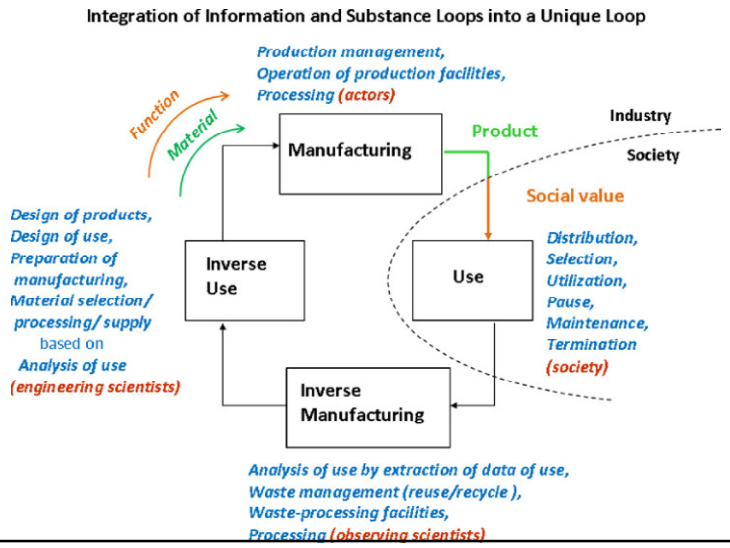
Function: the main issues

sustainability requires integration of manufacturing and inverse manufacturing, i.e. closed loop manufacturing



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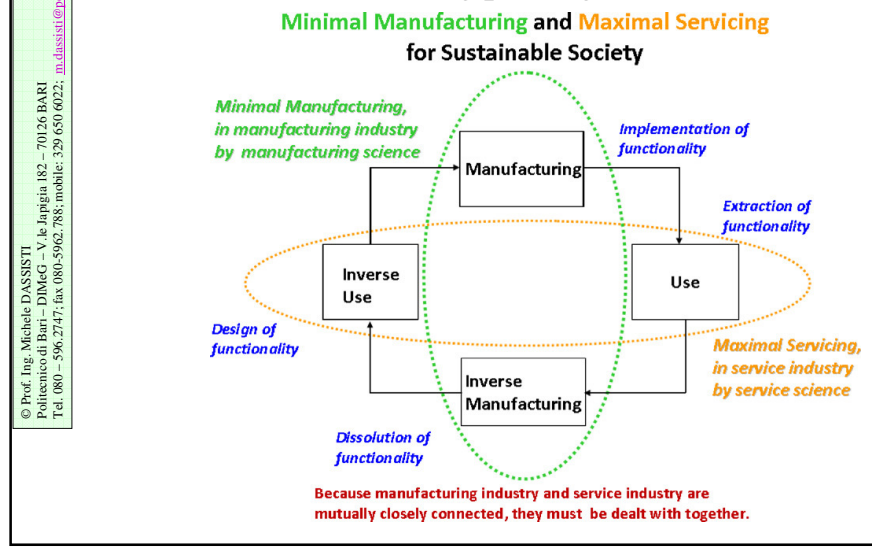
Closed-loop manufacturing

Yoshikawa introduces the minimal manufacturing and maximal servicing paradigm for sustainability



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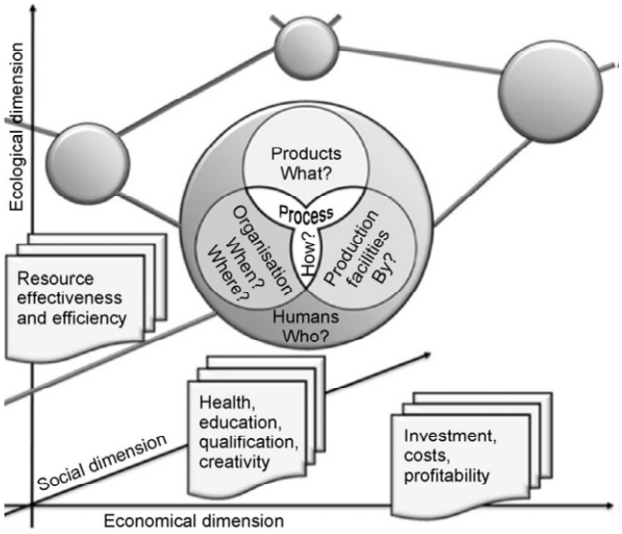
Sustainable value-creating modules in a global network



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Sustainable Manufacturing

"Sustainable manufacturing adds value to materials, components, or products while maintaining the availability of natural resources and environmental quality for future generations. "

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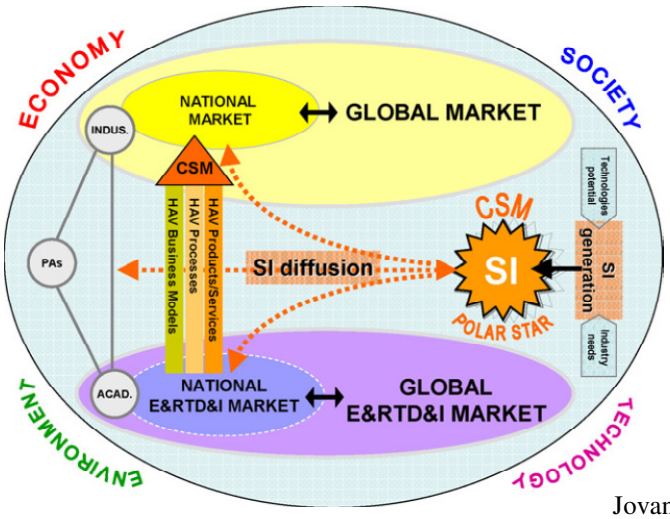
MANUFUTURE framework®

Strategic Intelligence &
Competitive Sustainable Manufacturing



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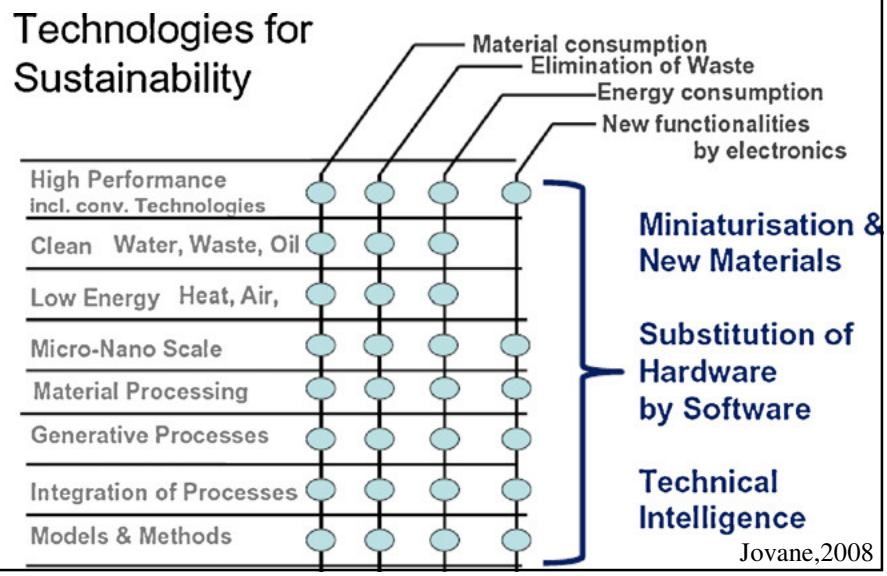
Technologies for sustainability



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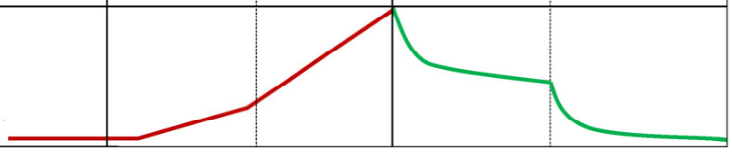
Technologies for sustainability

Years	~ 17c	18c ~ 20c		21c ~	
Name of Age	Age of survival	Age of development		Age of sustainability	
	Manual works	Mechanization	Intelligent mechanization	Green IT (A)	Green IT (B)
Works in factory	Muscle works by human	Muscle works by power machinery		Energy conservation of power machines	
	Brain works by human		Brain works by information machinery		Energy conservation of information machinery
Technology	Manual tools	Power machinery	IT control	Energy conserving design of machine and systems with IT control	Energy conserving element, device and systems
Energy consumption					

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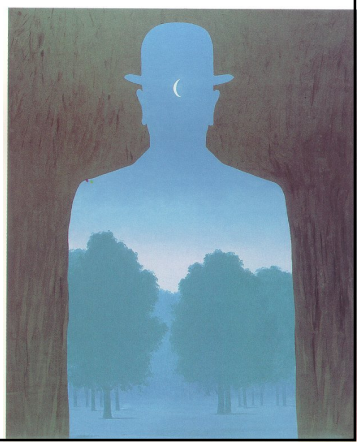
SUSTAINABILITY: it is a business?

- New approach with old habits?
- Attempt to preserve the present?

6-R's:

Reduce, Reuse, Recycle, Redesign (or Rethinking), Recover , Remanufacture,



LINEAR THINKING!

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DO: the Re-X wave

- 6 R's: Reduce, Reuse, Recycle, Redesign (or Rethinking), Recover and Remanufacture
- The 7th R: Regulation (systemic view..)

- *<< Sustainable manufacturing processes are those which demonstrate improved energy efficiency, and environmental impact, reduced manufacturing cost, producing minimum wastes and providing enhanced personal health and operational safety.>>* Jawahir, 2007

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8th R's rule: Re-lifening

- This principle brings to the extreme the idea of recycle, reuse, recover and remanufacture., all sharing the idea of prolonging the useful functions of artifacts as longer as possible in the future, by introducing the challenge to avoid the losses of cycling effects that is intrinsic in the other R's

- *<<The law of entropy should be replaced by the law of regeneration. The present law does not make sense for the world we need to create.'' ..>>* Cohen-Rosenthal, 2004

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Paradox: zero limit

- **when extending this idea of minimization (ACTION) according also to the input/output analysis applied to manufacture up to its extreme consequences: it is obvious to think it is possible to have a zero-waste industrial cycle (NOT ACTION), hopefully by creating symbiotic chains between industries (null negative gradient).**

- *<<many well-meaning environmentalists seem to imagine that the biosphere is a perfect recycler …. i.e., to achieve `zero emissions´ in the industrial landscape by recycling all wastes.. The idea of `zero emissions´ is based on the (false) idea that every biological waste is `food´ for some other organism….. >>*

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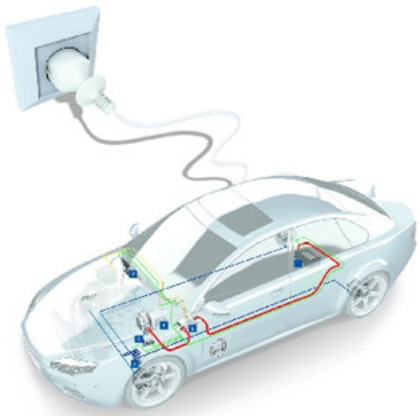
Sustainability & Automotive



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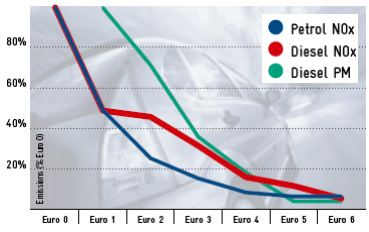
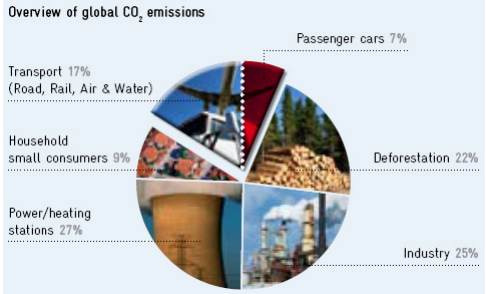
Main tendency in the automotive design: environment

Vehicles are an important source of pollution:

- Pollutant exhaust (NO_X, CO, HC, PM_X)
- **CO_2 emission: a key priority**
- Recycling at the end of life
- Noise





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Sustainability awareness

AUTOMOTIVE INDUSTRIES

<<With increasing awareness of the effect of automotive manufacturing and the automobile use on the environment as well as dwindling fossil fuels, the industry is shifting to sustainability.>>

Some of the relevant initiatives are:

- Designing a car so that it is made up of recyclable materials (from cradle-to-cradle concept), while improving its reliability and service life.
- Increasing efforts in automobile research and development of energy efficient cars, e.g., hybrids.
- Reducing use of energy during production. For example, switching off machines when not in actual production or application of energy efficient technology.
- Reducing usage of hazardous materials during production.
- Handling and disposing well whatever waste is produced (the policy is to reduce this waste to a minimum).

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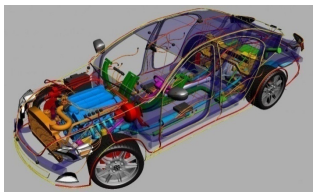
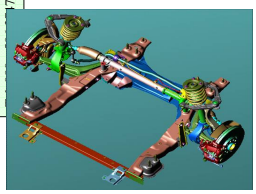
Light recyclable materials

Bumpers



Chassis

Springs



Plastics

Chassis

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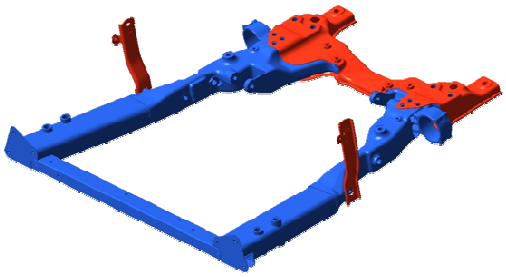
- *Hybrid architecture*

multi-material approach , internal body in thermoplastics (PA,PP) , metallic structure outside (Al,steel)

✓Weight reduction 30%
✓Cost reduction 5,3%
✓Modular Design



Aluminium

Steel

Lightweight engine subframe: Thickness optimization

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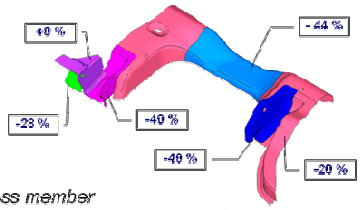
Thickness optimization on the current stamped sheet frame, the existing die could be maintained using tailored blanks

Results:

+ Weight reduction of 8%

+ Low investments

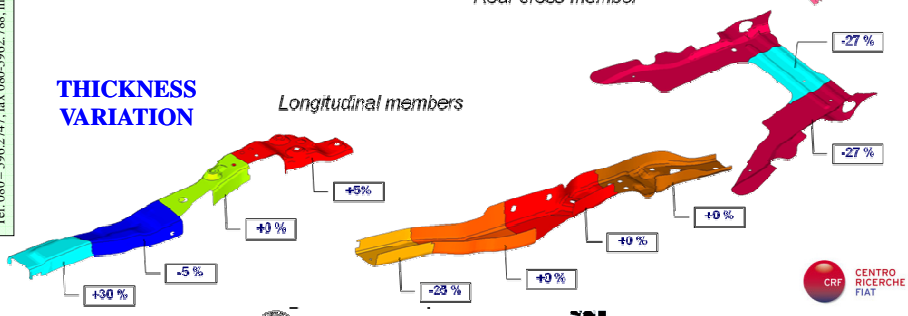
- Technological feasibility is still to be assessed



Rear cross member

THICKNESS VARIATION

Longitudinal members



CENTRO RICERCHE FIAT

Lightweight engine subframe

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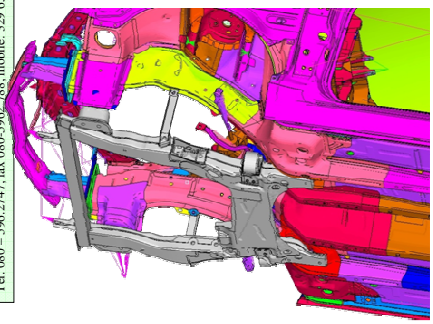
Target: to develop a front engine subframe with the same performance (static and dynamic stiffness, crash behaviour) but lighter (30%) than the existing one; the lightening cost efficiency is required to be better than those typical of "full aluminium" solution



CENTRO RICERCHE FIAT

How it is possible to make the lightweight

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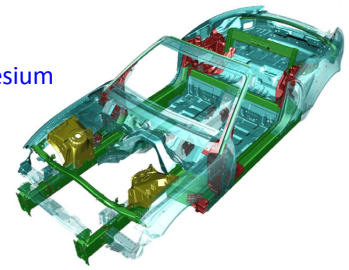
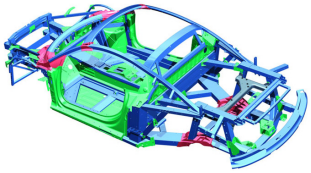
- Materials
  - Ultra High Strength Steel
  - Lightweight metal: **Aluminium**, Magnesium
  - **Plastics**, Composites, Nanoreinforced materials, Biomaterials
- Joining technology
  - Laser welding
  - Riveting, clinching
  - Adhesive bonding
- Optimization
  - Topology optimization
  - Space frame structures





Eco-design for Solving Recycling Problems

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Automotive steel/copper contamination on automotive shredder residues –ARS-affects the quality of recycled steel and do not to allow the reuse of this material on new automotive parts.

There are many ways of dealing with the problem:

1. diluting the recycled scrap with virgin metal;
2. treating Cu-bearing steel in the furnace to remove the Cu;
3. Increasing the tolerance of sheet steel for Cu by adding P;
4. Upgrading Cu-bearing steel severely into new mill shapes;
5. Using the scrap for other possible applications;
6. Hot roll in a reducing atmosphere to avoid the oxide formation;
7. Divert the steel scrap to iron casting, where the Cu content can be used as a graphitizer …and so on.

Environmental Innovations on products and process

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The expected technological developments are:

Nanomaterials & nanotechnologies promoting:

dematerialization, cleaner superficial treatment, and new treatments for industrial residues and effluents as well.

Near net shape techniques, in which the initial production of the item is very close to the final :

superplastic forming for plastics and composites;
sintering for metals and metals composites molded injection;
rapid prototyping to simulate by computer aided design (CAD) and to produce by computer aided manufacture (CAM) complex shapes in a melting-pot of materials.

Ecomaterials for strucutral uses (bodyshop) - more recylcable and free from toxic substances

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Eco-design fostering cars recyclability: The case of Renault Modus

- **Modus** inaugurated a new segment of the compact mono-space., **95 % recyclable**, and was the first Renault model totally **eco-designed by the software OPERA** -Overseas Program for Economic Recycling Analyses–.
- Its interior has numerous storage compartments in the dashboard, the front floor and doors, where we can find the environmental thought of eco-designed parts.
- **Its dashboard incorporates around 50% of recycled PP corresponding to almost 5 kg.**
- The OPERA is expected to be speeded the recycled PP evolution in Renault vehicles helping them to reach their goal of 50 Kg per vehicle in 2016.

CETEM
CENTRO DE TECNOLOGIA MINERAL

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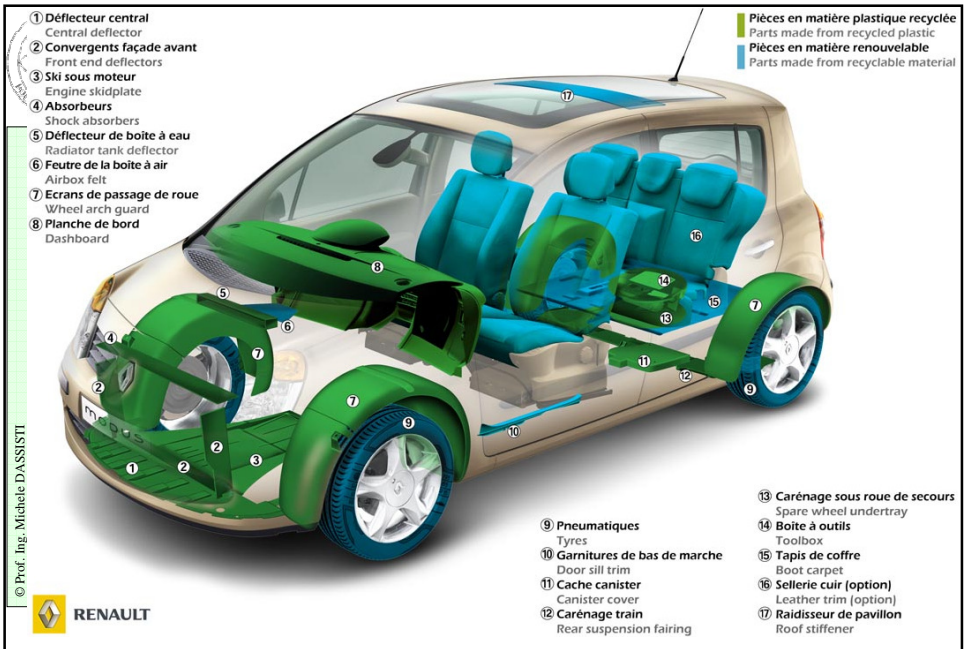
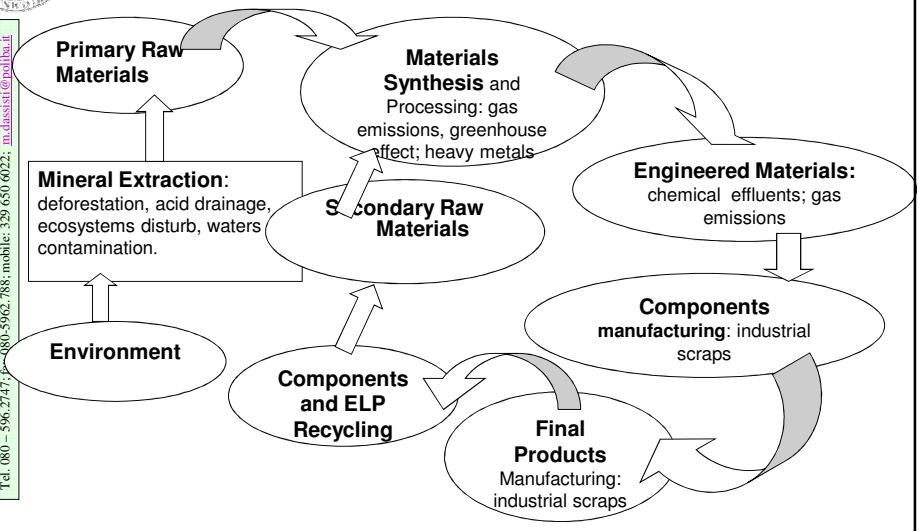


Closing Life Cycle Materials loop by Recycling



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Eco-X syntagms: codification or real solutions?

- X= design, redesign, innovation, conception, QFD, labelling, optimization, balance, centric sustainability, development planning, advantage strategy, magination, tracking, technology, restructuring,.. .

- *<<the eco-support system for life on the planet (e.g. biodiversity), a factor of recognising the regional carrying-*
- *capacity of nature with regard to human populations*
- *and human lifestyles, going back to Jean-Jacques Rousseau (1712-1778)... >> Stahel 2007*

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An example…

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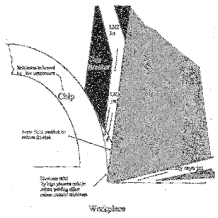
Metalworking Fluids (MWFs) have a history of harming the environment and the health of workers, resulting in pressures to re-design them in accordance with sustainable manufacturing principles.



Another research example: unusual working conditions?

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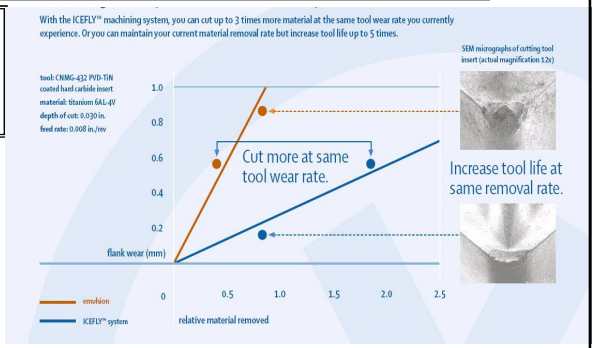
- **Politecnico di Bari**
- University of Kentucky

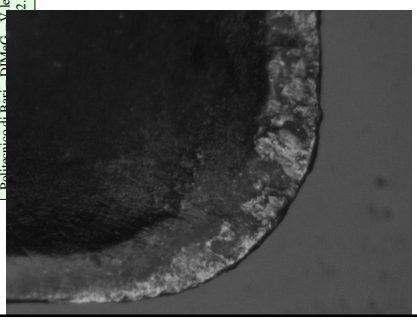
Cryogenic

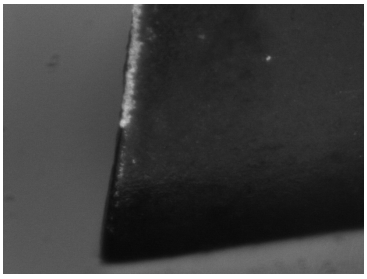


- *<<To achieve this goal, scientists and engineers cooperate in international and multidisciplinary groups and organisations. They utilise imagination, judgement and take initiative to apply science, technologies and practical experience to shape competitive processes and products.>> Seliger 2008*

Cryo-cutting

- Freezing process (–)
- Setting (––)





- Manufacturing process (+)
- Material processing (++)

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New opportunities for synergies?”

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ICT

vs

Sustainability

Knowledge main issues

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Objective:

to realize a common reference for the meaning of terms (semantics) adopted by different systems in order to allow them to interoperate

Ontology

(e.g., for business and enterprises: *Enterprise Ontology*)

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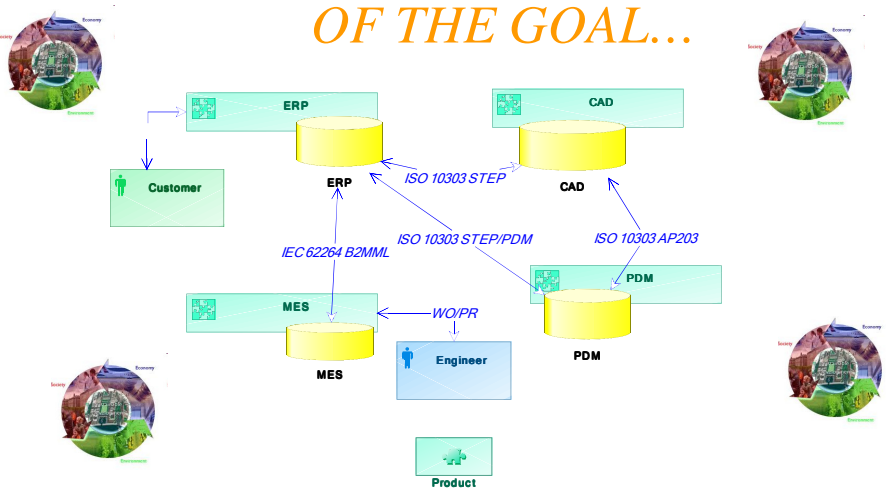
Nancy-Université
Université Henri Poincaré

SUSTAINABILITY AS A PART OF THE GOAL…



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Sustainability & ontology

- To share ***common understanding*** of the structure of information among people or software agents
- To enable ***reuse*** of domain knowledge
- To make ***domain assumptions*** explicit
- To ***analyze*** domain knowledge
- To ***separate*** domain knowledge from the operational knowledge

[Noy&McGuinness 2001]

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DISAMBIGUATION: a common widget

- What is a spinde, without a context?

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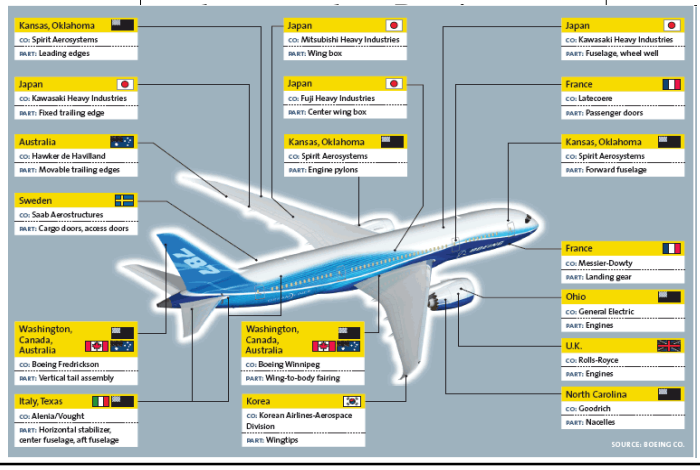
"Babel tower" effect

*Sketch it in the **USA***
*Design in **India***
*Feed materials from **Australia***
*Produce components in **China***
*soft components in **Singapore***
*Assemble in **Europe***



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Interoperability:

- from Oxford Dictionary: *"…able to operate in conjunction"*
- from the IEEE Std 610.12 *"…is the ability of two or more **systems** or components to **exchange** and use **information**"* [IEEE 1990]
- From software point of view *"… is the ability of different types of computers, networks, operating systems, and applications to work together effectively, without prior communication, in order to exchange information in a useful and meaningful manner"*. [Panetto 2007]

Interoperability ≠ Cloning

Interoperability ≠ Compatibility

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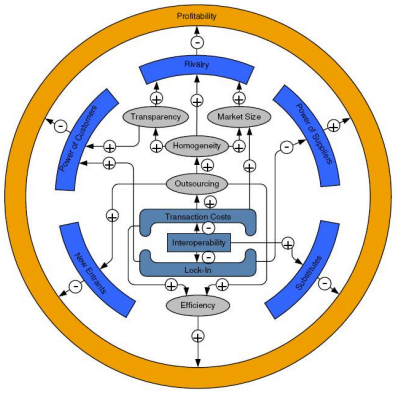
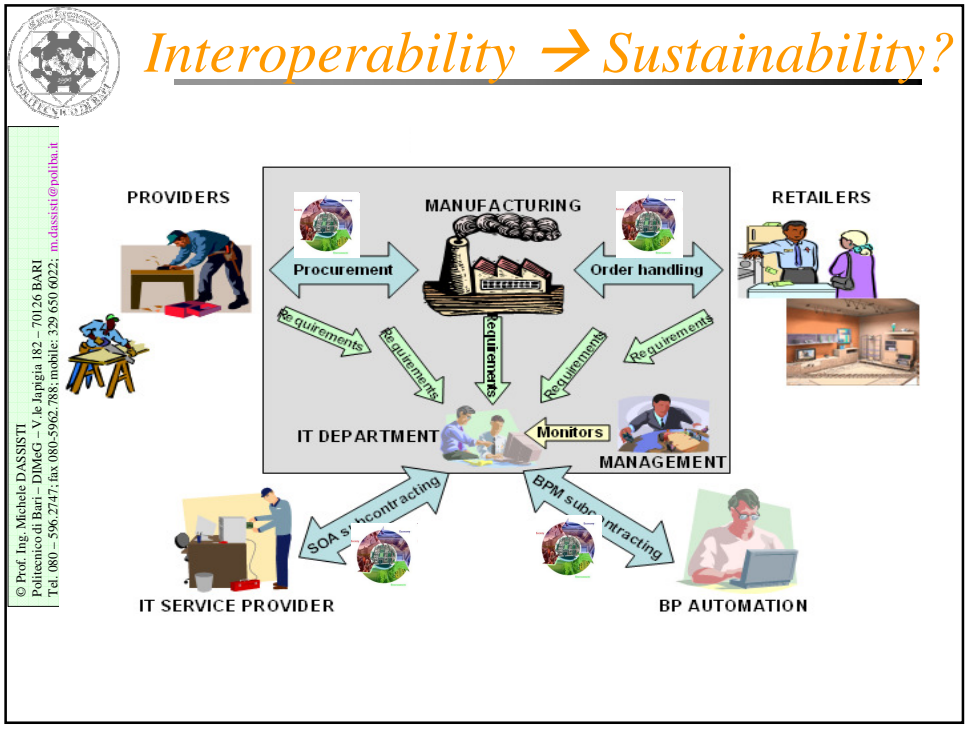
Profitability of interoperability!

- It is expected Iop Increases profitabilit
- *….<<we estimate that imperfect interoperability costs th US automobile industry approx. $1billion per year and delays in itrnoduction of new models by at least two months>>*

Brunneimer, 2002



Source: Athena, 2006


Interoperability → Sustainability?
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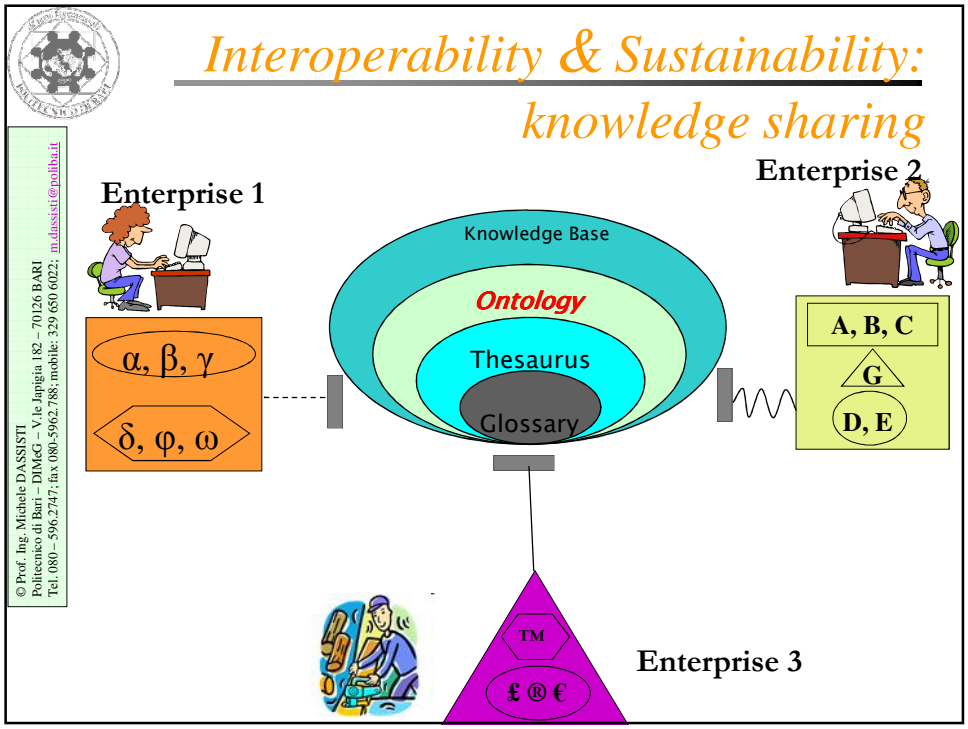
PROVIDERS
MANUFACTURING
RETAILERS
Procurement
Order handling
Requirements
IT DEPARTMENT
Monitors
MANAGEMENT
IT SERVICE PROVIDER
BP AUTOMATION


Interoperability & Sustainability:
knowledge sharing
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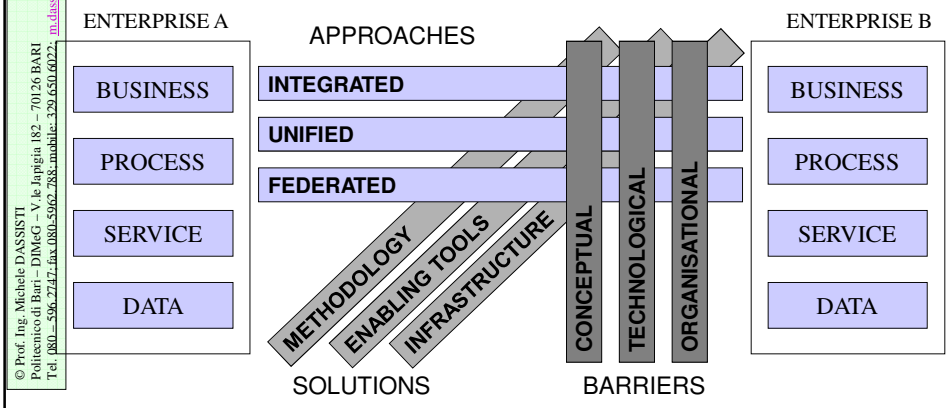
Enterprise 1
Enterprise 2
Knowledge Base
Ontology
Thesaurus
Glossary
α, β, γ
δ, φ, ω
A, B, C
G
D, E
TM
£ ® €
Enterprise 3

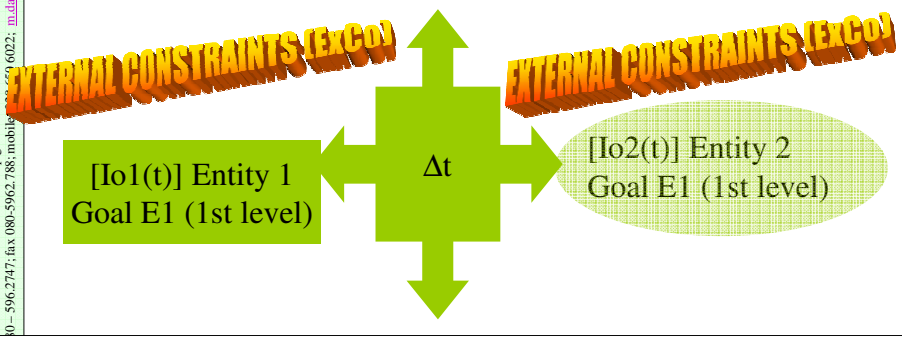
Interoperability: recomposing the fragmentation!



Source: **Enterprise Interoperability Framework (EIF)** Interop Network

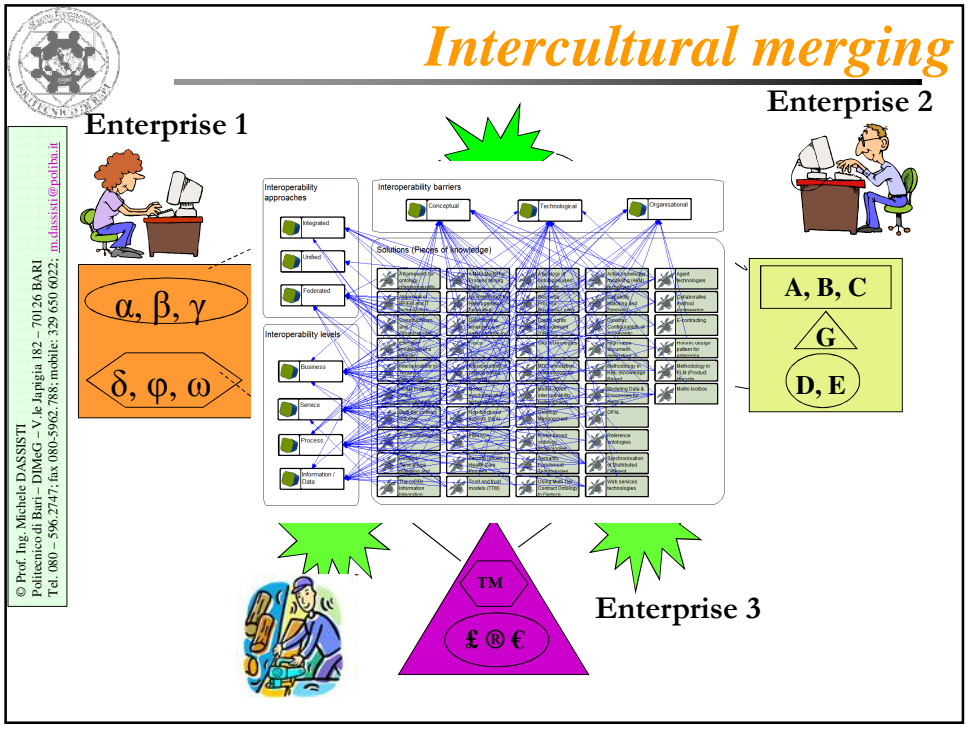
SHARE THE SAME GOAL

2nd level cooperation goal - CG2



$$CG2 = f$$

$$[Io1(\Delta t), Io2(\Delta t), ExCo, G_{E1}(\Delta t), G_{E2}(\Delta t)]$$


Intercultural merging
Enterprise 1
Enterprise 2
Enterprise 3
α, β, γ
δ, φ, ω
A, B, C
G
D, E
TM
£ ® €
Interoperability approaches
Integrated
Unified
Federated
Interoperability barriers
Conceptual
Technological
Organisational
Interoperability levels
Business
Service
Process
Information / Data
Solutions (Pieces of knowledge)
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Democracy Web: Comparative Studies in Freedom
Welcome to Democracy Web!
« epistemology has to be included explicitly in the description of natural phenomena…» F. Capra
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Always optimising

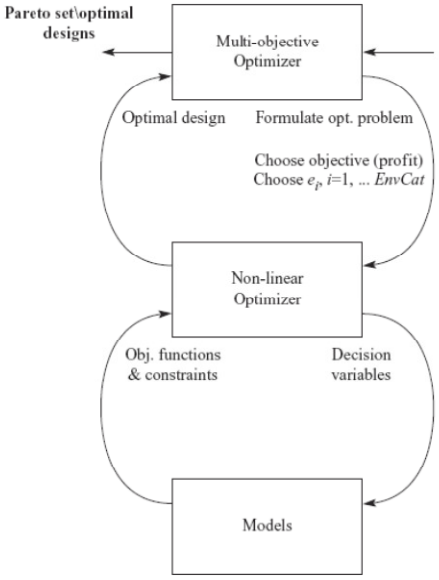

Figure 11.4 A generalized multi-objective optimization framework

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Process analysis approach

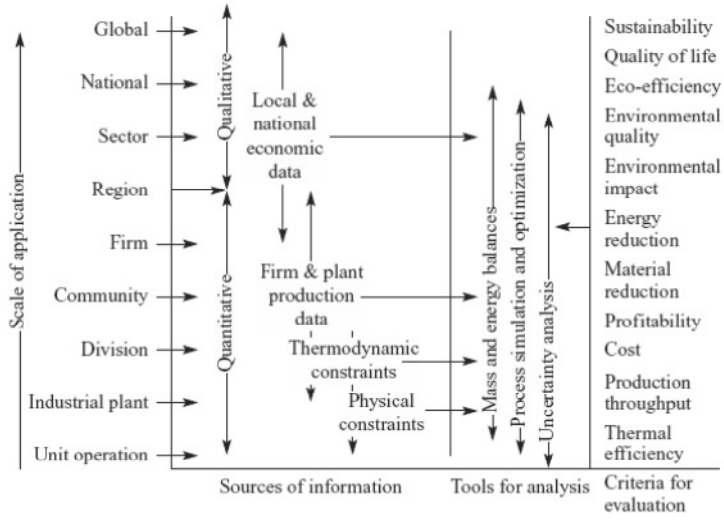

Figure 11.1 A conceptual framework for a process analysis approach to industrial ecology

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Process simulation approach

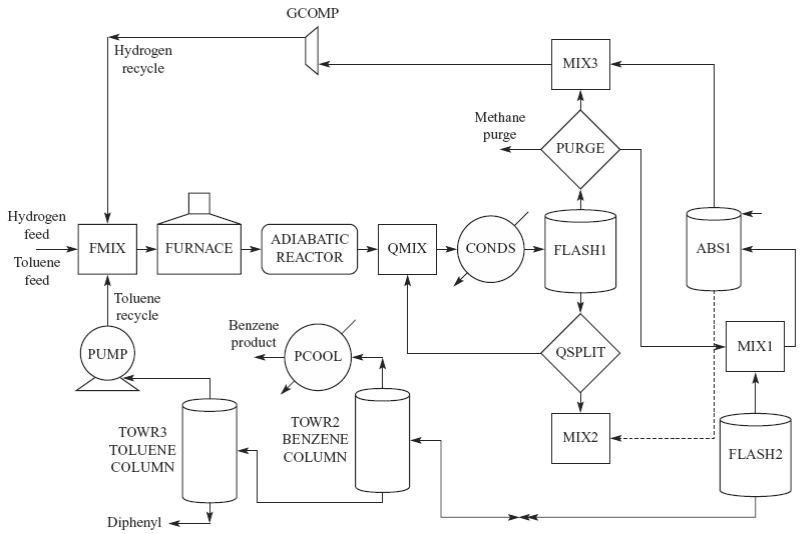

Figure 11.2 The process flowsheet for the production of benzene through the hydrodealkylation of toluene

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Process simulation approach

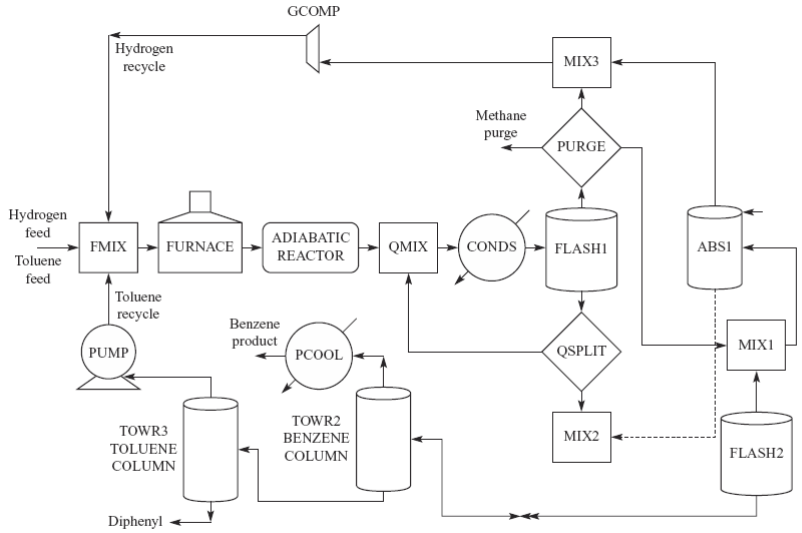

Figure 11.2 The process flowsheet for the production of benzene through the hydrodealkylation of toluene

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Process simulation approach

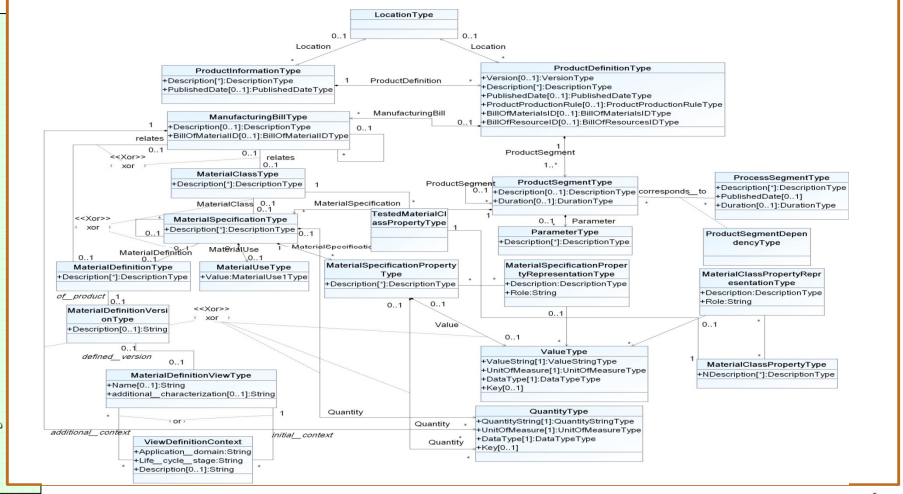
Mass and Energy Balance

Conventional components		In	Out	Relative diff.
H_2	LBMOL/HR	2047.48	2047.41	3.66387e-05
CH_4	LBMOL/HR	2414.51	2414.54	−1.39574e-05
C_6H_6	LBMOL/HR	374.131	374.139	−2.16750e-05
C_7H_8	LBMOL/HR	227.842	227.837	2.21647e-05
$C_{12}H_{10}$	LBMOL/HR	16.8401	16.8394	4.22304e-05
Total balance				
MOLE	LBMOL/HR	5080.8	5080.76	7.66967e-06
MASS	LB/HR	95679.1	95679.5	−4.68125e-06
ENTHALPY	BTU/HR	−6.60813e+07	−6.60813e+07	1.48284e-05

Stream results

Stream ID		S01	S02	S03
From:		CONDS	FLASH	FLASH
To:		FLASH	PURGE	QSPLIT
H_2	LBMOLE/HR	2047.4828	2046.7644	0.6433
CH_4	LBMOLE/HR	2414.5081	2390.8028	23.7389
C_6H_6	LBMOLE/HR	374.1306	17.8004	356.3382
C_7H_8	LBMOLE/HR	227.8422	3.5885	224.2486
$C_{12}H_{10}$	LBMOLE/HR	16.84	0.096816	16.8336
TOTAL	LBMOLE/HR	5080.8038	4458.9569	621.8079
TEMP	DEGREES F	100	100	100
PRES	PSIA	465	465	465
ENTHALPY	BTU/LBMOLE	−13006	−16927	15105
V	FRACTION	0.8776	1.0	0.0
L	FRACTION	0.1223	0.0	1.0
ENTROPY	BTU/LBMOLE-R	−21.6285	−15.6219	−64.704
DENSITY	LBMOLE/CUFT	0.0463	0.0774	0.6473
AVG MW		18.8314	9.9133	82.785

MODELLING THE REALITY

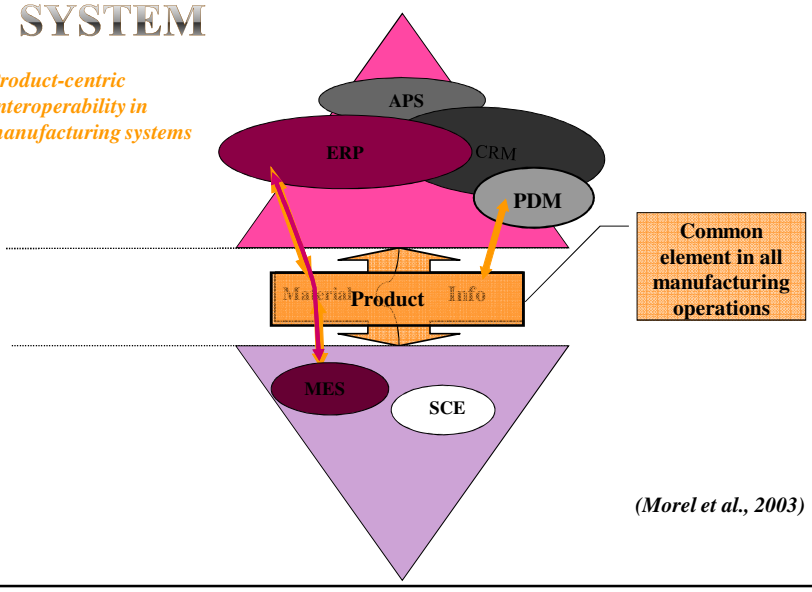


"There is no a better model of a cat than the cat, better if it is the same cat "

Nancy-Université
Université Henri Poincaré

PRODUCT AS INFORMATION SYSTEM

Product-centric Interoperability in manufacturing systems



Common element in all manufacturing operations

(Morel et al., 2003)

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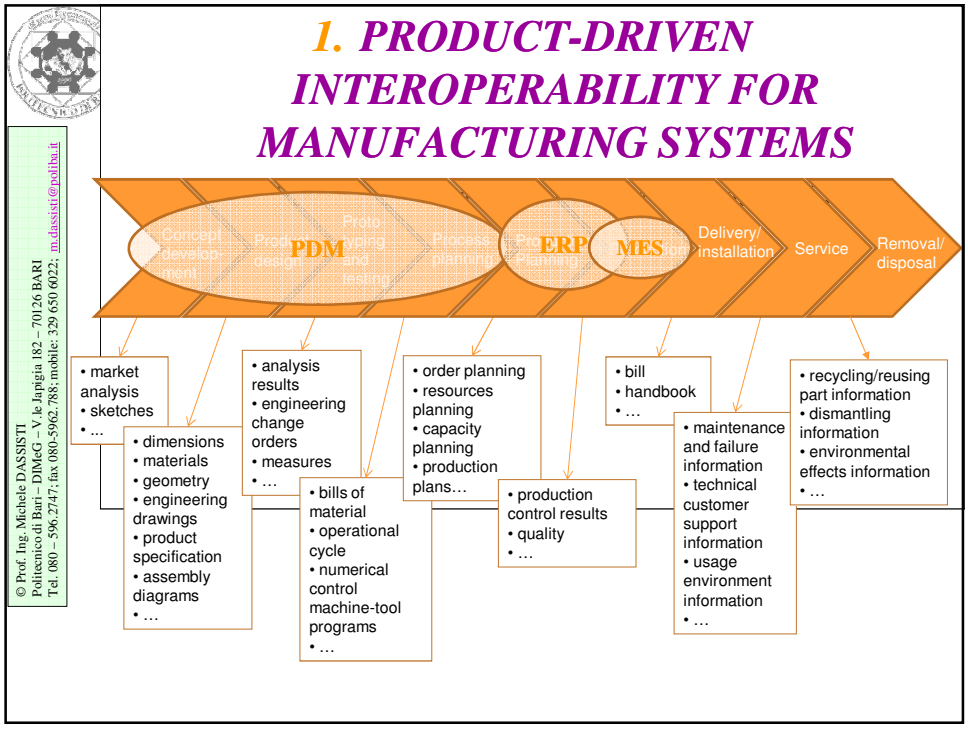
1. PRODUCT-DRIVEN INTEROPERABILITY FOR MANUFACTURING SYSTEMS
PDM
ERP
MES
Delivery/ installation
Service
Removal/ disposal
• market analysis • sketches • ...
• dimensions • materials • geometry • engineering drawings • product specification • assembly diagrams • ...
• analysis results • engineering change orders • measures • ...
• bills of material • operational cycle • numerical control machine-tool programs • ...
• order planning • resources planning • capacity planning • production plans…
• production control results • quality • ...
• bill • handbook • ...
• maintenance and failure information • technical customer support information • usage environment information • ...
• recycling/reusing part information • dismantling information • environmental effects information • ...
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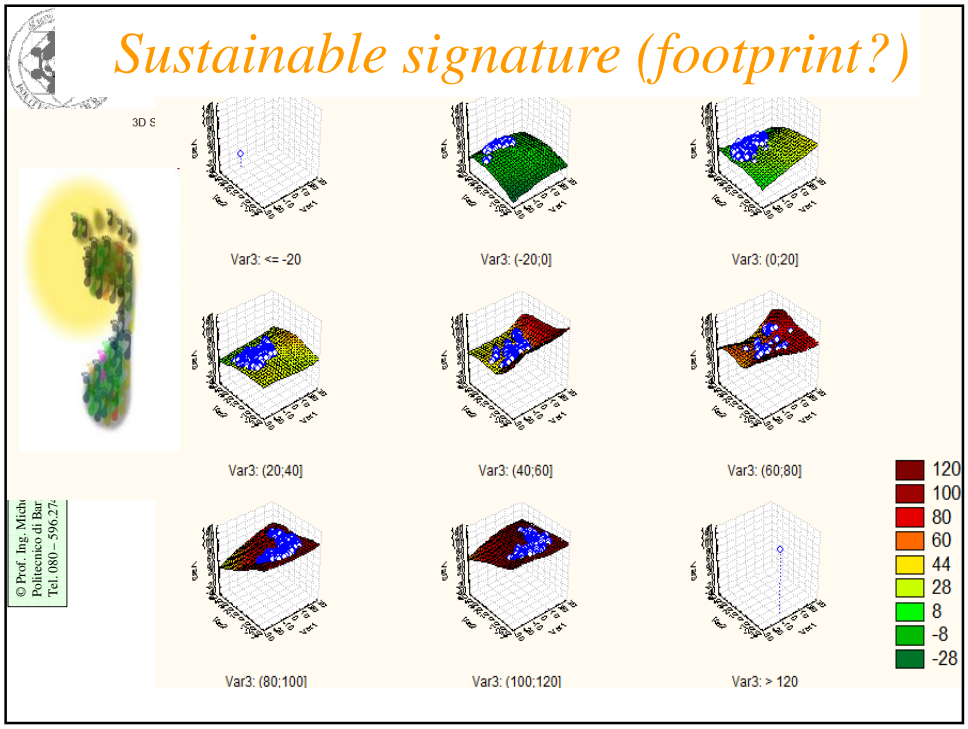
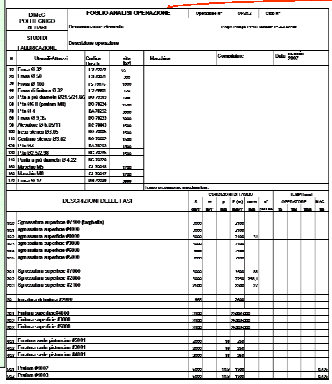

Sustainable signature (footprint?)
Var3: <= -20
Var3: (-20;0]
Var3: (0;20]
Var3: (20;40]
Var3: (40;60]
Var3: (60;80]
Var3: (80;100]
Var3: (100;120]
Var3: > 120
120
100
80
60
44
28
8
-8
-28

METRICS CAN BE IMPROVED

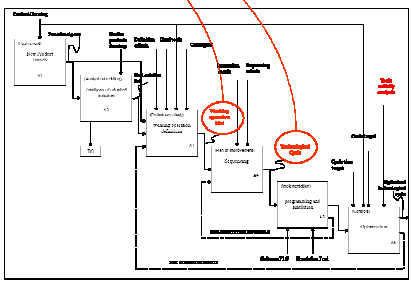
Tool Management System Model

Improvement Model

Complete product traceability by technological cycle formal structure



Tool Management system Model using a BPR approach IDEF0-based



BOSCH

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WHEN's

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Can we change abruptly?

The manufacturing industry has generated wealth, jobs and quality of life, while promoting and sustaining services, education, research and development

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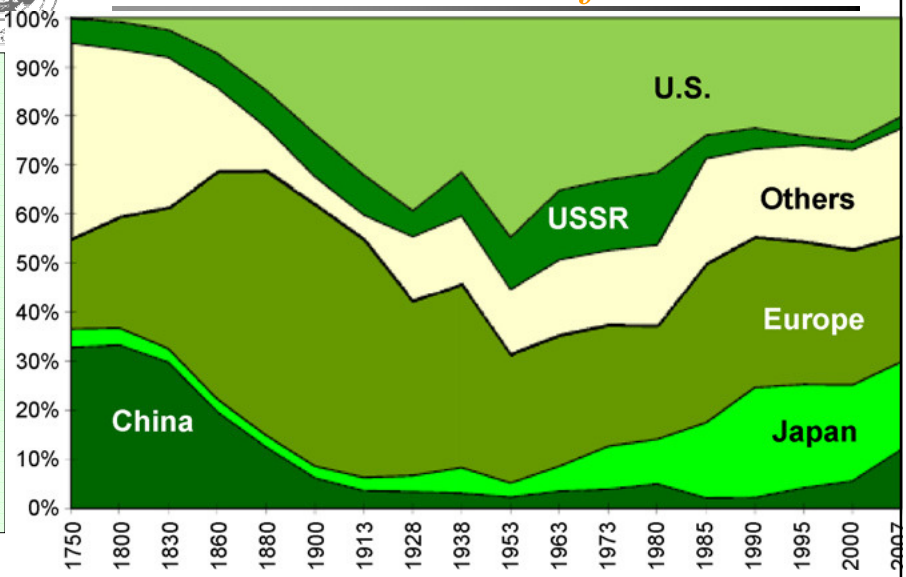
Finitedness of resources



A different perspective of industrial outputs….

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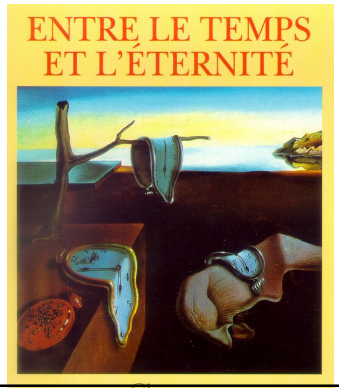
MANUFACTURING: its non-reversible effects on the world

- So we humankind have an hysteresis in behavioral changes while experiencing almost immediate reactions in the mutations of our world.

Manufacturing might have non-linear effects on our way of living



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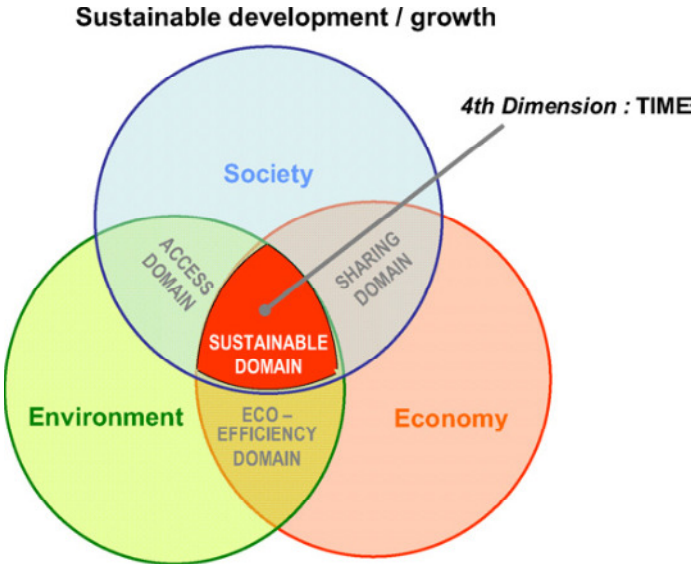
Another pillar?



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CONCLUSIONS

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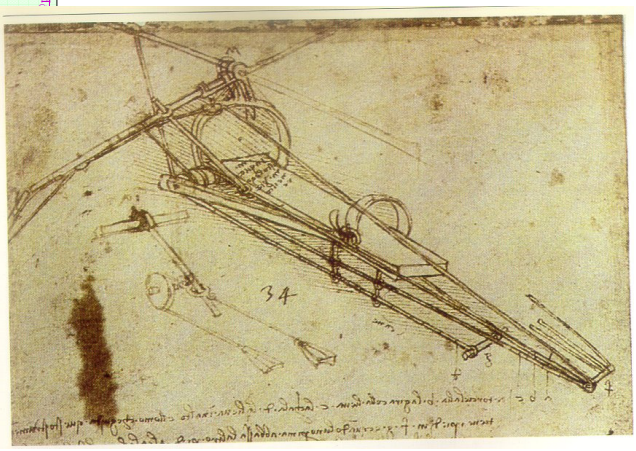
Oximoros?

- **Innovation in tradition**
- **Chaos and harmony**
- **Industrial ecology**
- **Sustainability and production**

<<The ideal ecosystem, in which the use of energy and materials is optimized, wastes and pollution are minimized and there is an economically viable role for every product of a manufacturing process, will not be attained soon.>> Frosch, 1989

Best practice diffusion



One didactical example: new generations challenges

- Wood sail boats at Politecnico di Bari

Velante

MilleUnaVela

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One didactical example: ecological materials

- Challenge: at least 85% in weight of wood

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One didactical example: ecological materials

- Wood processing (–)
- Adhesives (––)

- Wood end–of–life (+)
- Propulsion (++)

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New Job Opportunities

CAREER

Graduated Industrial Ecologists will be able to analyse sustainability dilemmas in real life, to create and initiate innovative technological solutions, and to come up with tools and strategies for management and policy in the field of Industrial Ecology. Industrial Ecology is a new scientific field that provide graduates promising opportunities in different fields:

- **Intermediate functions in large companies considering sustainability issues**
- **System design functions in companies and governments**
- **Initiators of innovation in industry and (non) governmental organizations**
- **Scientific research in the field of industrial ecology or related fields like green engineering, environmental sciences, or innovation and transition management.**

Until now almost all graduates of the programme find a suitable job within a year after graduation. Alumni of the programme can be found in industry, consultancy firms and governmental agencies.A small fraction ends up as Industrial Ecology scientists working at universities and research institutes, developing the field.

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New Job Opportunities

New Job Opportunities

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Thank you

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http://hychange-lab.poliba.it/

Most of the images have been taken from free access on Google the Sept.16, 2010

DEBATES

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1. _____
2. _____
3. _____
4. _____
5. _____

What is sustainability?

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- <<To maintain the quality. All the machines that are producing nowadays to be asable after a longtome after that.>> ***Ilia Stanchev***.
- <<Way to protect the quality of life for humanity in the time>> ***Alexander Ecanomau.***
- <<Ability to save the balance nature and technical progress, as long as we can>> ***Emil Mihaglov***
- <<Ability or property of a system to be optimised in a beginning of project and this will save the idea, the same system in time>> ***Nedko Perchemliev***
- <<It has to do with a balaced life>> ***Denise Beskou***
- <<TO assure to our children and grandchildren good life. We have to save the balance in nature>> ***Mirela Georgieva***
- <<Don't know>> ***Mourtzikou Argyroula &Andigoni Aposfolopoulou & Mirto Micholou***
- <<Petrouleum man will die>> ***Francesco Del Vecchio***
- <<Wel development from every point of view: environmental, economical and political>> ***A. Penchev***
- <<The way to make Earth a better place to be. Change the way we live and consume in a most ECO-friendly way>> ***Dimosthenis Boeklagis***
- <<Property of a product to preserve highest quality of itself through longest possible period of time>> ***Dobromora Lekova***
- <<Ability to maintain a certain level of rate, for example, conserving balance by avoiding depletion of natural resources>> ***Vareli Styliani***
- <<It is the same timng as life. We must protect our environment for life>> ***Alexopullous Argyrios***