# Lecture #43

# ERDM


## Karl Haapala

### Course Assistant


## April 26, 2004

# Lecture Overview

- Life Cycle Analysis Tools
- Sustainable Companies
- Eco Industrial Parks
- Initiatives Suggested for Michigan Tech

# Product Manufacturing

- **Processes**
  - **INPUTS**
    - **Energy and raw materials**
  - **OUTPUTS**
    - **Products and by-products**

# Product Manufacturing

- Closing the loop
  - Software analysis
    - Redirection & elimination of energy and waste
  - Eco industrial parks
    - By-products -> products and energy sources
- Cradle to Grave
  - Linear view of products
  - Purchasing products

# Life Cycle Assessment

- **Life Cycle Assessment / Analysis**
  - Pre-production (e.g. material sources)
  - Production (e.g. is child labor being used?)
  - Transportation (e.g. how far will your product need to travel and how easy is it to transport?)
  - Use (e.g. is it harmful? How useful is it?)
  - Disposal (e.g. will it degrade? Is it recyclable?)

**http://www.a420.com/design/SD-life-cycles.htm**

- **"Cradle to Cradle"**

# Life Cycle Assessment


http://www.epa.gov/ORD/NRMRL/std/sab/LCA.htm

# LCA Tools

- **Many tools available!**
  - Boustead Consulting Database and Software
  - ECO-it: Eco-Indicator Tool for environmentally friendly design - PRé Consultants
  - EcoPro - sinum Corporate Environmental Management
  - EDIP - Environmental design of industrial products - Danish EPA
  - EIOLCA - Economic Input-Output LCA at Carnegie Mellon University
  - GaBi 3 - (Ganzheitliche Bilanzierung) - University of Stuttgart (IKP)/PE Product Engineering
  - IDEMAT - Delft University Clean Technology Institute Interduct Environmental Product Development
  - KCL-ECO 3.0 - KCL LCA software
  - LCAiT - CIT EkoLogik (Chalmers Industriteknik)
  - LCNetBase - Life cycle assessment using traceble US data - Sylvatica
  - SimaPro 5.0 for Windows - PRé Consultants
  - SPOLD - Society for the Promotion of Life-cycle Assessment Development
  - TEAM(TM) (Tools for Environmental Analysis and Management) - Ecobalance, Inc.
  - Umberto - An advanced software tool for Life Cycle Assessment - Institut für Umweltinformatik

**http://www.life-cycle.org/ (updated February 29, 2004)**

# LCA Tools – SimaPro 5.1

- **SimaPro 5.1**
  - Most widely used of LCA tools
  - Released in 1990 by PRé Consultants, The Netherlands
- **Uses**
  - Environmental performance of products and services – "Weak Point Analysis"
  - Eco-indicator scores for commonly used components, materials and processes
- **Includes**
  - Inventory databases with thousands of processes
  - The most important impact assessment methods
- **www.pre.nl**

# LCA Tools – GaBi 4

- **GaBi 4**
  - Developed by the Institute for Polymer Testing and Polymer Science (IKP) at the University of Stuttgart in co-operation with PE Product Engineering GmbH, Germany
- **System Characteristics**
  - Modular structure - impact assessment & inventory data and weighting models are separated
  - Life cycle phases (production, utilization and disposal) can be modified separately
- **Visualization**
  - Processes are arranged in Sankey diagrams, allowing a quick overview of mass, energy, or even cost flows shown proportional to quantity
- **www.gabi-software.com**

# LCA Tools - Umberto

umberto

- **Umberto**
  - Produced by the Institute for Environmental Informatics (ifu), Hamburg, Germany
- **Use**
  - Serves to visualize material and energy flow systems
  - Data is from external information systems or newly modeled and calculated
  - Identify improvement potentials on a consistent basis - taking ecological and economic aspects into account
  - Companies
    - Optimize processes and improve competitiveness
  - Research organizations
    - Material flow analysis or LCA of products

- **www.umberto.de/english/index.htm**

# LCA Tools - EcoScan


- **EcoScan 3.0**
  - Based on experiences of major companies for a fast / easy impact & cost analysis
  - Produced by TNO Industrial Technology, The Netherlands
- **Use**
  - Specify aspects in Product Life Cycle form for stages (e.g. production, usage or disposal)
  - Assign environmental points utilizing eco-indicator databases
  - Compare products using charts and graphs

- **www.ind.tno.nl/product_development/sustainable_concepts/ecoscan/index.html**

# Sustainable Companies

- **How do you measure "Sustainability?"**
  - **Dow Jones Sustainability Indexes**
    - Launched in 1999, the DJSI are the first global indexes tracking the financial performance of the leading sustainability-driven companies
    - "Corporate Sustainability is a business approach that creates long-term shareholder value by embracing opportunities and managing risks deriving from economic, environmental and social developments."

    (http://www.sustainability-indexes.com)

  - **Ethibel Sustainability Index**
    - An independent consultancy agency for socially responsible investments
    - "Sustainability criteria" is divided into four areas: internal social policy, environmental policy, external social policy, and the ethical economic policy
    - Index includes 180 global companies

    (http://www.ethibel.org)

# Sustainable Companies

- **What defines a Sustainable Company?**
  - **Leading sustainability companies display high levels of competence in addressing global and industry challenges in a variety of areas (according to DJSI):**
    - Strategy: Integrating long-term economic, environmental and social aspects in their business strategies while maintaining global competitiveness and brand reputation.
    - Financial: Meeting shareholders' demands for sound financial returns, long-term economic growth, open communication and transparent financial accounting.
    - Customer & Product: Fostering loyalty by investing in customer relationship management and product and service innovation that focuses on technologies and systems, which use financial, natural and social resources in an efficient, effective and economic manner over the long-term.
    - Governance and Stakeholder: Setting the highest standards of corporate governance and stakeholder engagement, including corporate codes of conduct and public reporting.
    - Human: Managing human resources to maintain workforce capabilities and employee satisfaction through best-in-class organizational learning and knowledge management practices and remuneration and benefit programs.

# Sustainable Companies

- **The Global Reporting Initiative (GRI)**
  - **Started in 1997 & became independent in 2002**
    - **An official collaborating centre of the United Nations Environment Programme (UNEP) and works in cooperation with UN Secretary-General Kofi Annan's Global Compact.**
  - **GRI is a multi-stakeholder process and independent institution whose mission is to develop and disseminate globally applicable Sustainability Reporting Guidelines**
    - **Voluntary reporting on the economic, environmental, and social dimensions of organization's activities, products, and services**
    - **GRI issued guidelines in 2002 and will again in 2006**

    **http://www.globalreporting.org/**

# Sustainable Companies

- **Case: Interface, Inc. (Atlanta, Georgia)**
  - **"Our vision is to lead the way to the next industrial revolution by becoming the first sustainable corporation, and eventually a restorative enterprise."**
  - **Getting there (goal: by 2020!) –**
    - **Sustainability is built into business decisions**
      - **The Interface Model (http://www.ifsia.com)**
    - **Committed to shifting from linear industrial processes to cyclical ones**
      - **The Natural Step (http://www.naturalstep.org)**

# Sustainable Companies

- **The Interface Model**
  - **The path toward sustainability requires effort on seven ambitious fronts:**

1. **Eliminate Waste — The first step to sustainability, QUEST is Interface's campaign to eliminate the concept of waste, not just incrementally reduce it.**
2. **Benign Emissions — We're focusing on the elimination of molecular waste emitted with negative or toxic impact into our natural systems.**
3. **Renewable Energy — We're reducing the energy used by our processes while replacing non-renewable sources with sustainable ones.**
4. **Closing the Loop — Our aim is to redesign our processes and products to create cyclical material flows.**
5. **Resource Efficient Transportation — We're exploring methods to reduce the transportation of molecules (products and people) in favor of moving information. This includes plant location, logistics, information technology, video-conferencing, e-mail, and telecommuting.**
6. **Sensitivity Hookup — The goal here is to create a community within and around Interface that understands the functioning of natural systems and our impact on them.**
7. **Redesign Commerce — We're redefining commerce to focus on the delivery of service and value instead of the delivery of material. We're also engaging external organizations to create policies and market incentives that encourage sustainable practices.**

# Sustainable Companies

- **The Natural Step**
  - **An international non-profit advisory and research organization working to accelerate global sustainability (Started in Sweden in 1989 led by Dr. Karl-Henrik Robèrt)**
  - **The Four Systems Conditions for Sustainable Human Society (The Natural Step):**
    1. **Eliminate our contribution to systematic increases in concentrations of substances from the Earth's crust.**
       **This means substituting certain minerals that are scarce in nature with others that are more abundant, using all mined materials efficiently, and systematically reducing dependence on fossil fuels.**
    2. **Eliminate our contribution to systematic increases in concentrations of substances produced by society.**
       **This means systematically substituting certain persistent and unnatural compounds with ones that are normally abundant or break down more easily in nature, and using all substances produced by society efficiently.**
    3. **Eliminate our contribution to systematic physical degradation of nature through over-harvesting, depletion, foreign introductions and other forms of modification.**
       **This means drawing resources only from well-managed eco-systems, systematically pursuing the most productive and efficient use both of those resources and land, and exercising caution in all kinds of modification of nature.**
    4. **Contribute as much as we can to the goal of meeting human needs in our society and worldwide, going over and above all the substitution and dematerialization measures taken in meeting the first three objectives.**
       **This means using all of our resources efficiently, fairly and responsibly so that the needs of all people on whom we have an impact, and the future needs of people who are not yet born, stand the best chance of being met.**

# Eco Industrial Parks

- **Definition**
  - **"An eco-industrial park or estate is a community of manufacturing and service businesses located together on a common property. Member businesses seek enhanced environmental, economic, and social performance through collaboration in managing environmental and resource issues. By working together, the community of businesses seeks a collective benefit that is greater than the sum of individual benefits each company would realize by only optimizing its individual performance.**
  - **"The goal of an EIP is to improve the economic performance of the participating companies while minimizing their environmental impacts. Components of this approach include green design of park infrastructure and plants (new or retrofitted); cleaner production, pollution prevention; energy efficiency; and inter-company partnering. An EIP also seeks benefits for neighboring communities to assure that the net impact of its development is positive."**

**http://www.indigodev.com/Ecoparks.html**

# Eco Industrial Parks

- **Industrial Ecology – Six Principle Elements (H. Tibbs)**
  1. **Industrial Ecosystems**
     - Fostering cooperation among various industries whereby the waste of one production process becomes the feedstock for another.
  2. **Balancing industrial input and output to the constraints of natural systems**
     - Identifying ways that industry can safely interface with nature, in terms of location, intensity, and timing, and developing indicators for real-time monitoring.
  3. **Dematerialization of industrial output**
     - Striving to decrease materials and energy intensity in industrial production.
  4. **Improving the efficiency of industrial processes**
     - Re-designing production processes and patterns for maximum conservation of resources.
  5. **Development of renewable energy supplies for industrial production**
     - Creating a world-wide energy system that functions as an integral part of industrial eco-systems.
  6. **Adoption of new national and international economic development policies**
     - Integrating economic and environmental accounting in policy options

**http://www.sustainable.doe.gov/business/parkintro.shtml**

# Eco Industrial Parks

- **EIP Design – the "industrial ecosystem"**
  - **Natural Systems**
    - An industrial park can fit into its natural setting in a way that minimizes environmental impacts while cutting operating costs.
  - **Energy (Energy Cascading)**
    - More efficient use of energy is a major strategy for cutting costs and reducing burdens on the environment.
  - **Material Flows**
    - Companies perceive wastes as lost opportunities that ideally are potential products to be re-used or marketed.
  - **Water Flows (Water Cascading)**
    - Park infrastructure may include mains for several grades of water and provisions for collecting and using storm water run off.
  - **Park Management and Support Services**
    - As a community of companies, an EIP needs a more sophisticated management and support system than a traditional industrial park.
      - changes in the mix of companies
      - links into regional by-product exchanges
      - shared support services
  - **Sustainable Design and Construction**
    - Optimize the efficient use of resources and to minimize pollution generation
    - Reduce the impacts by careful site preparation and ecologically appropriate buildings and park systems.
    - Designed to be durable, maintainable, and readily reconfigured to adapt to change
- **Waste EQUALS Food!**
  - One emerging strategy for EIP planning involves anchoring the park around resource recovery companies (recycling, reuse, remanufacturing, and composting firms)

**http://www.globallearningnj.org/global_ata/Eco_Industrial_Parks.htm**

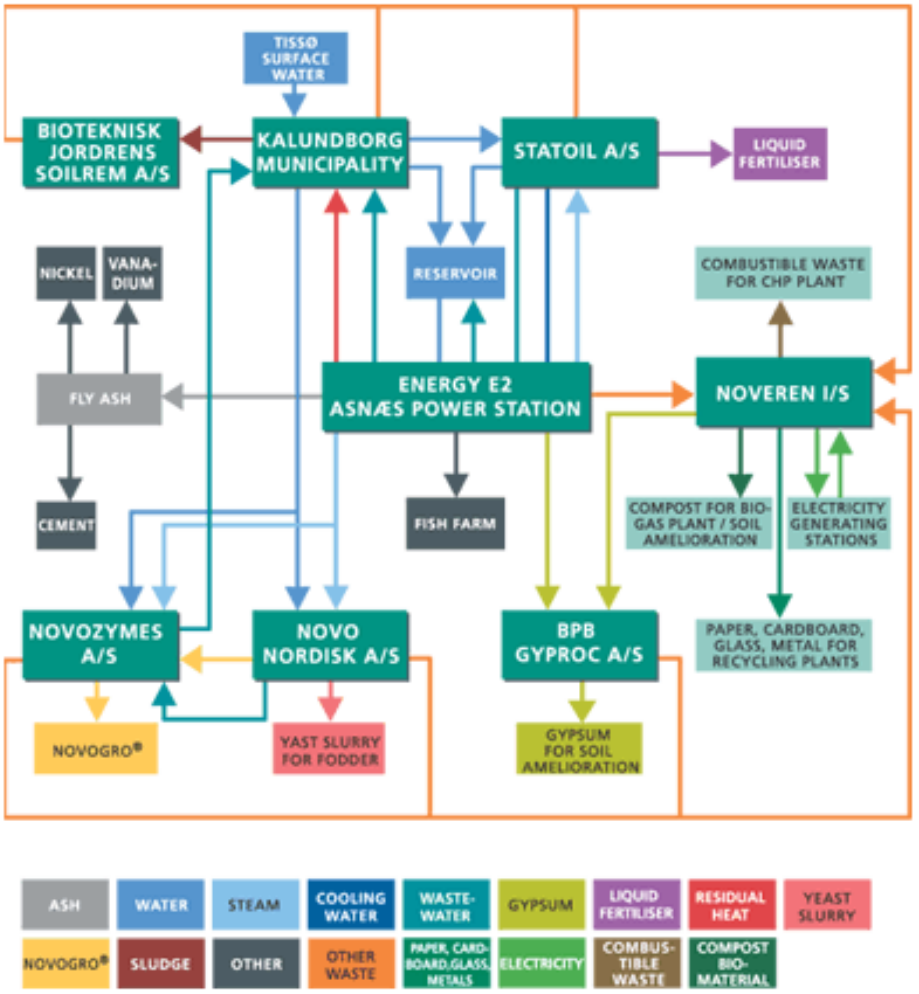
# Eco Industrial Parks

## Industrial Symbiosis of Kalundborg

- Energy E2 Asnæs Power Station
- BPB Gyproc A/S - plasterboard factory
- Novo Nordisk A/S - pharmaceutical plant
- Novozymes A/S, - enzyme producer
- Statoil A/S – oil refinery
- Bioteknisk Jordrens Soilrem A/S – soil remediation
- Noveren I/S - waste company
- Kalundborg Municipality

**Exploit each other's residual or by-products on a commercial basis.**

**Developed over 20 years by industrial forces – was not planned!**

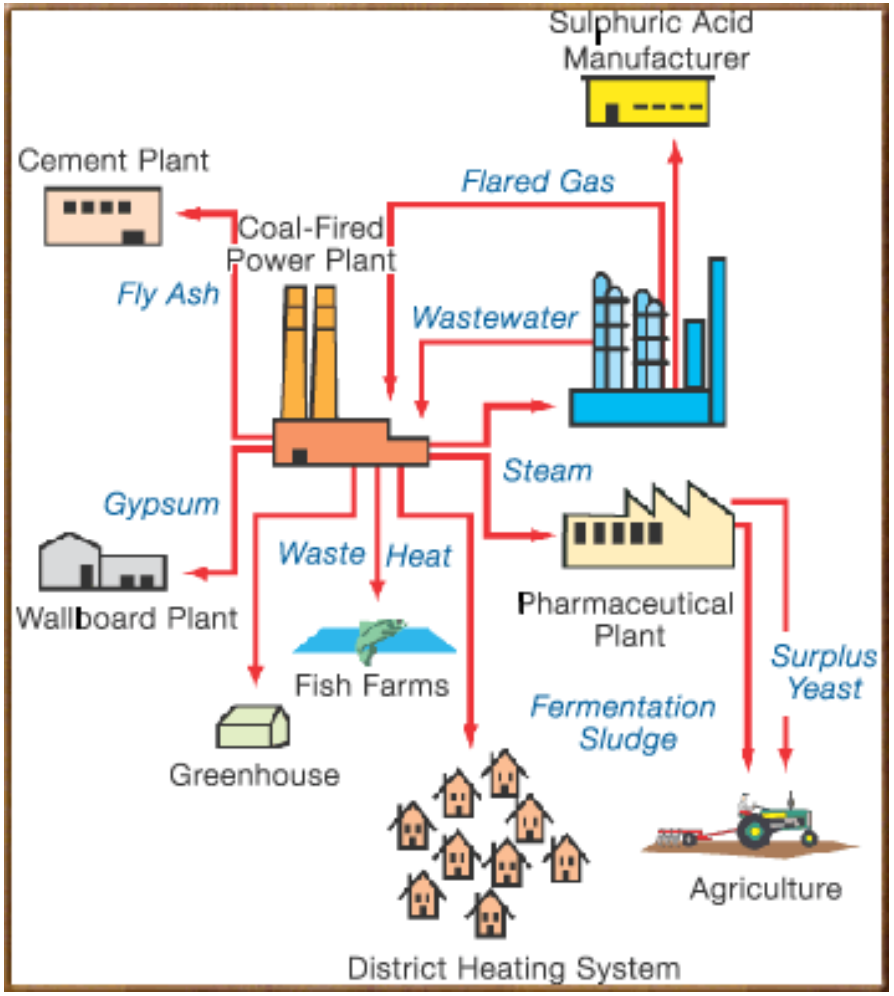


# Eco Industrial Parks

- Kalundborg, Denmark is an industrial port city of 20,000, approximately 110 km west of Copenhagen

- Advantages of the Symbiosis
  - Recycling of by-products. The by-product of one company becomes an important resource for another company.
  - Reduced consumption of resources, e.g. water, coal, oil, gypsum, fertilizer, etc.
  - Reduced environmental strain: reduced CO2 and SO2 emissions, reduced discharges of wastewater and less pollution of watercourses etc.
  - Improved utilization of the energy resources. Waste gases are used in the energy production.

http://www.symbiosis.dk/



# Conclusions

- **Sustainability tools and methods will aid companies and society toward sustainability**

- **Ultimately involves all of society (consumers, government, and industry)**
  - **Defining sustainability**
  - **Defining environmental, industrial, and societal goals**

# Sustainability Initiatives for the Michigan Tech Campus

## ERDM Student Suggestions

## April 26, 2004

MichiganTech

Environmentally Responsible Design & Manufacturing (MEEM 4685/5685)
Dept. of Mechanical Engineering – Engineering Mechanics
Michigan Technological University