"Green Engineering: How to Develop a Green Workforce"

Sean McGinnis, PhD

Director – VT Green Engineering Program
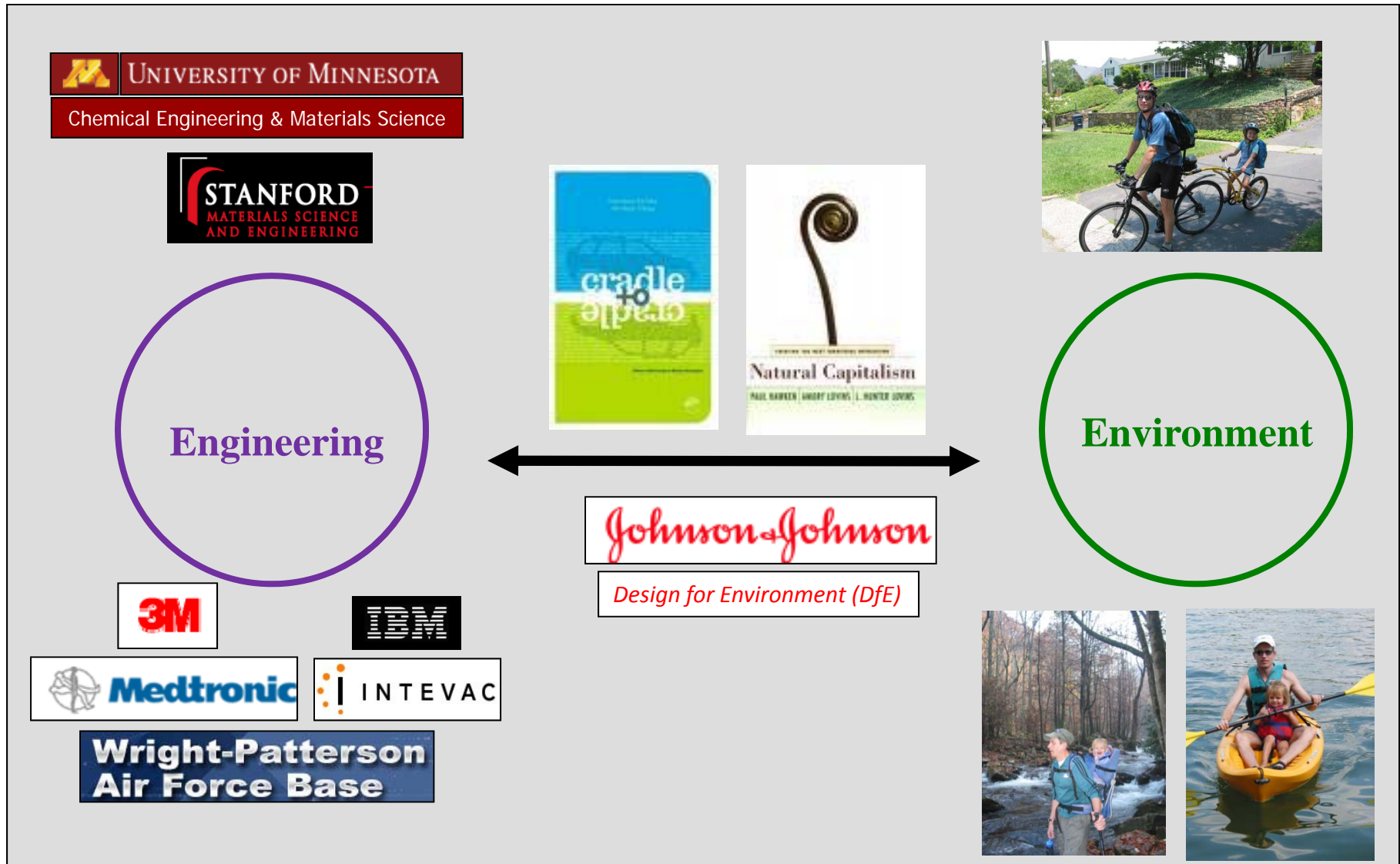
Certified Life Cycle Professional, LEED® AP
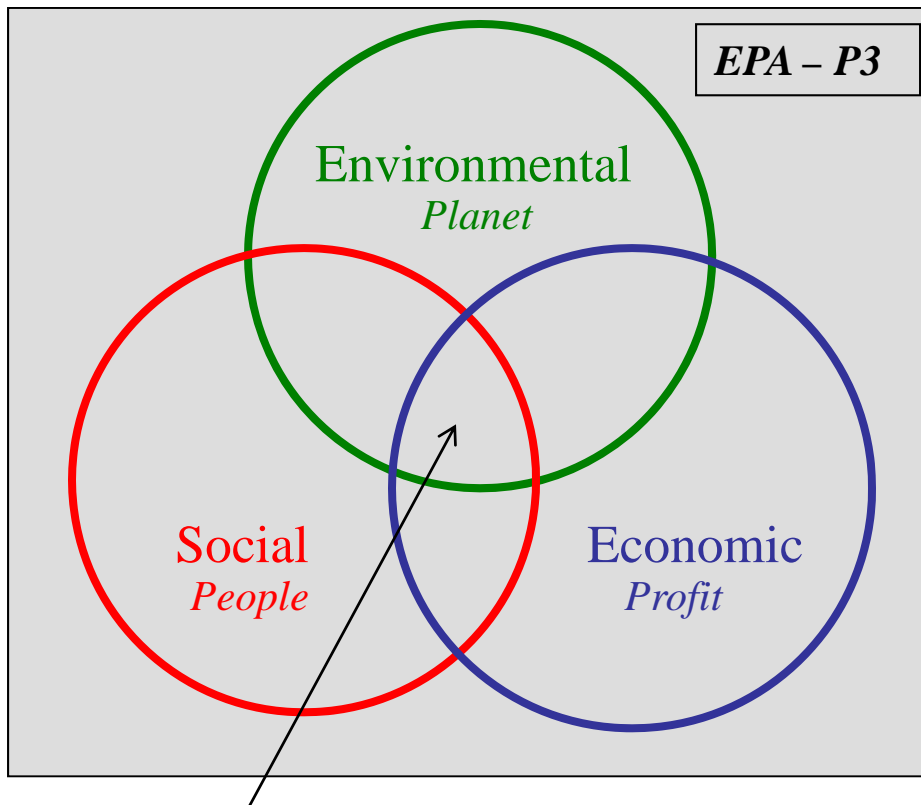
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NASA GEMF

October 1, 2009

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Highlight Real and Direct Connections Between Engineering & the Environment

Consider All Facets of Sustainability For Decisions

EPA – P3

Environmental
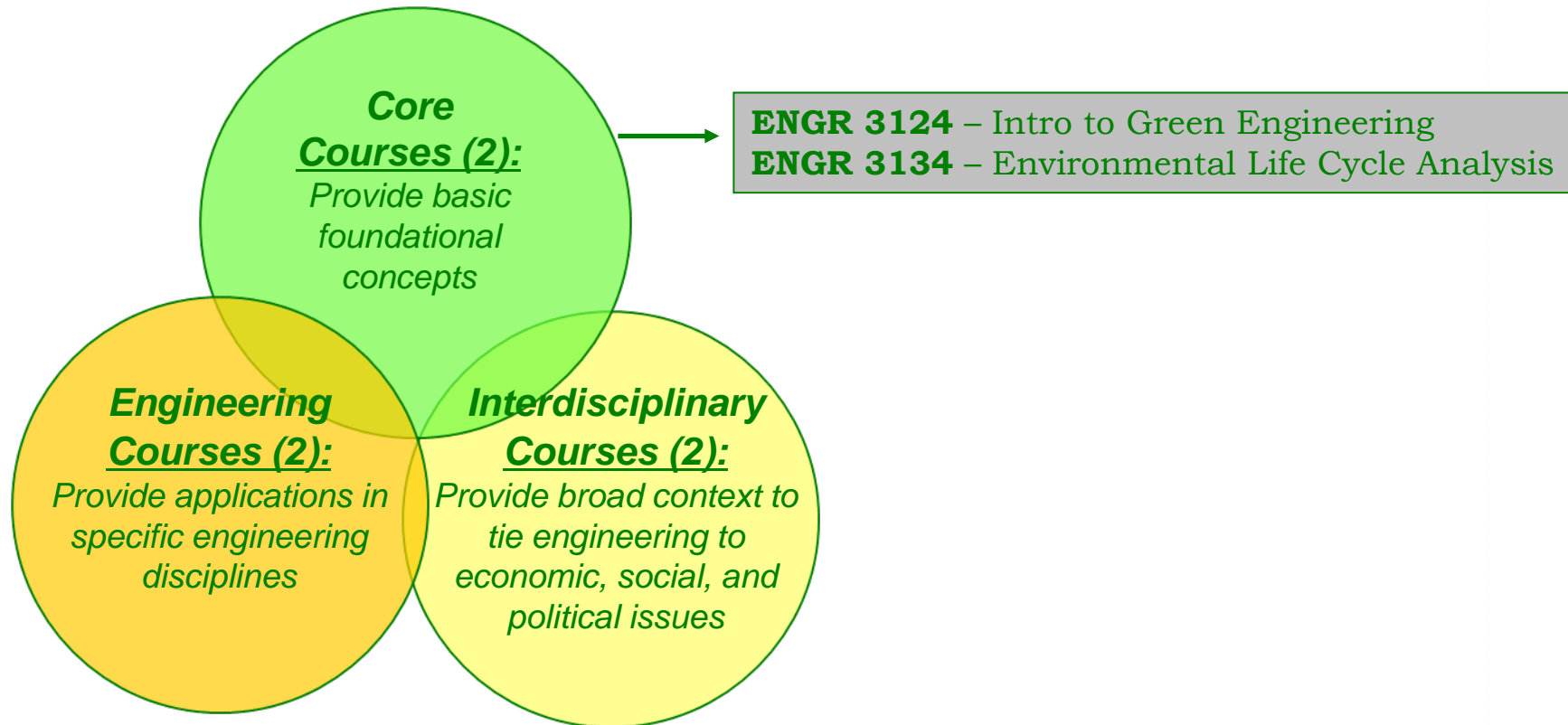*Planet*

Social
People

Economic
Profit

- **VT Green Engineering**
  - *The design of materials, processes, systems, and devices with the objective of <u>minimizing</u> total environmental impact over the <u>entire life cycle</u> while meeting <u>other</u> required performance, economic, and societal constraints.*
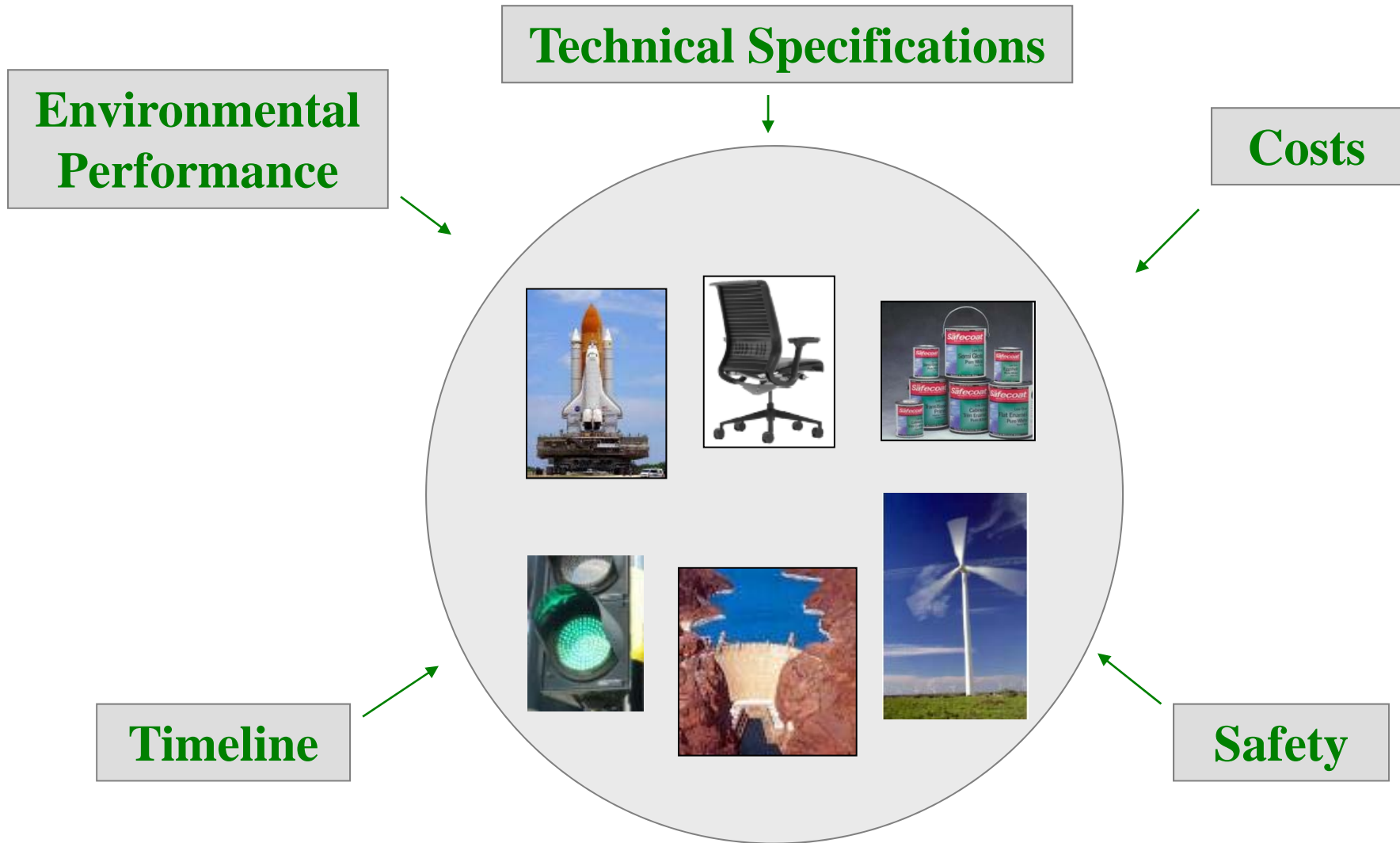
Develop Specific Curricula to Promote Connections Across Disciplines

- **VT Green Engineering Minor**
  - *www.eng.vt.edu/green*

Core Courses (2): *Provide basic foundational concepts*

Engineering Courses (2): *Provide applications in specific engineering disciplines*

Interdisciplinary Courses (2): *Provide broad context to tie engineering to economic, social, and political issues*

ENGR 3124 – Intro to Green Engineering
ENGR 3134 – Environmental Life Cycle Analysis

Consider Environmental Performance as a Primary Design Constraint

Technical Specifications

Environmental Performance

Costs

Timeline

**Safety**

Use Life Cycle Assessment (LCA) As a Decision-Making Tool

1. Define the goals, scope, and boundaries (ISO 14040)

3. Translate inventory outputs to potential environmental impacts (ISO 14042)

Energy Audit

Carbon Footprint

Design

IMPACTS

Manufacturing

Inputs
Energy
Water
Materials
Chemicals

Extraction

Use

Disposal

Outputs
Heat
Water
Materials
Chemicals

Atmosphere:
Climate Change
Ozone Depletion
Smog Formation
Acidification
Human Health

Hydrosphere:
Eutrophication
Acidification
Aquifer depletion
Ecotoxicity
Human Health

Biosphere:
Soil depletion
Deforestation
Resource Depletion
Ecotoxicity
Human Health

LCA Product Comparison
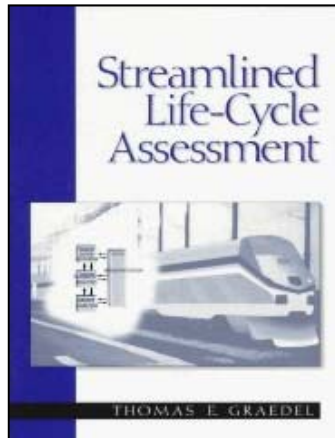
4. Interpretation (ISO 14043)

2. Develop a detailed inventory including all inputs and outputs (ISO 14041)

To Interpret LCA and Make Decisions, Acknowledge the Subjective Nature of Weighting
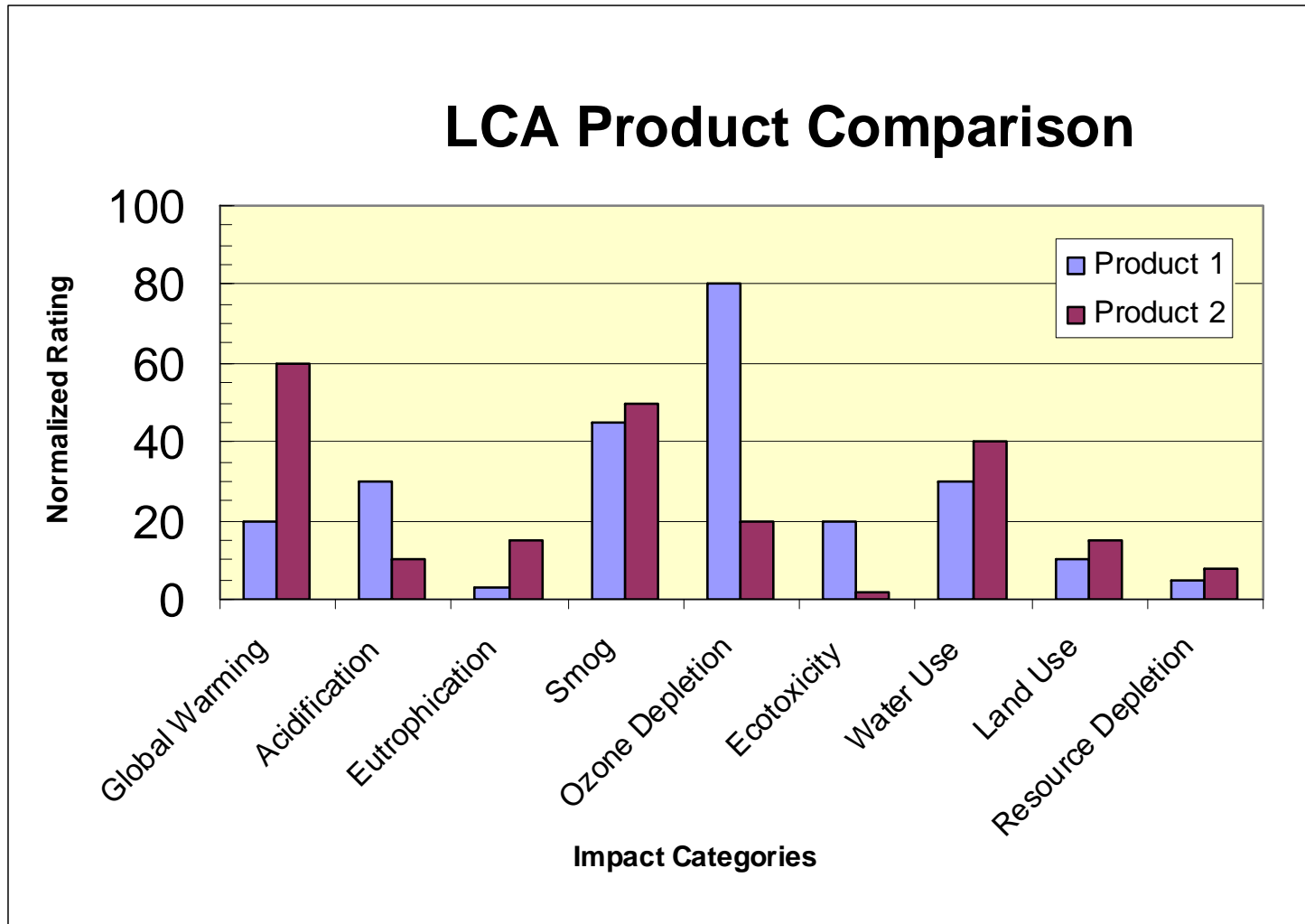
Integrate Existing LCA Methodologies
Into Your Current Design Processes

- **Example -** *AT&T Environmentally Responsible Product (ERP) Assessment Matrix*

Thomas Graedel
Prentice Hall, 1998.

Life Stage	ENVIRONMENTAL STRESSOR				
	Materials Choice	**Energy Use**	**Solid Residues**	**Liquid Residues**	**Gaseous Residues**
Premanufacture	*1,1*	*1,2*	*1,3*	*1,4*	*1,5*
Product Manufacture	*2,1*	*2,2*	*2,3*	*2,4*	*2,5*
Product Delivery	*3,1*	*3,2*	*3,3*	*3,4*	*3,5*
Product Use	*4,1*	*4,2*	*4,3*	*4,4*	*4,5*
Disposal	*5,1*	*5,2*	*5,3*	*5,4*	*5,5*

$$R_{ERP} = \Sigma\Sigma M_{i,j}$$

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Integrate These Sustainability Concepts Across All Aspects of Your Organization

- AWARENESS → SKILLS → ACTIONS (DECISIONS)

- This transition will take time, but should begin immediately.

- In both education and organizations, separate and distinct environmental programs are less effective than integrated programs.

- Stand-alone programs, with a smaller focus and champion(s), may help build support for more comprehensive integration.

- Every job is really a green job with associated responsibilities if you value the concepts of sustainability – environment, economics, and social equity.

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