Green supply chains

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Why do environmental research in IE/OM?

- Because it's environmental
- Because IE/OM is what really matters
- Because it's different
- Data
- $$

Discussion questions

- What are the most exciting environmental research opportunities you see in IE/OM in Brazil?

- What do you need to know about "the environment" in order to do research on those questions?

The Economist survey on Corporate Social Responsibility, Part I

	good for profits	*bad for profits*
good for society	good management	borrowed virtue
bad for society	pernicious CSR	delusional CSR

The Economist survey on Corporate Social Responsibility, Part II

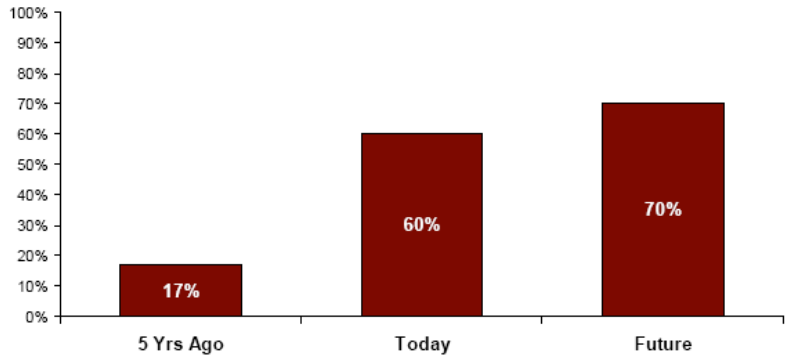
Three layers of CSR:

- corporate philanthropy
- risk management
- competitive advantage

ATKEARNEY

Being "green and ethical" will no longer be an option, it will be a necessity for all participants in the supply chain

Companies deselecting suppliers for failing to meet sustainability criteria [1]
(% of respondents)



Notes: (1) For more than 5% of sourcing events
Source: A.T. Kearney and Institute for Supply Management ™ (ISM) Sustainability Management Survey, January 2007

Wal-Mart goes green

- "Environmental sustainability may well be the most important initiative we undertake at Wal-Mart this decade, maybe even this century. It will have huge impacts on the way things are made, farmed, packaged, transported, displayed and sold worldwide.

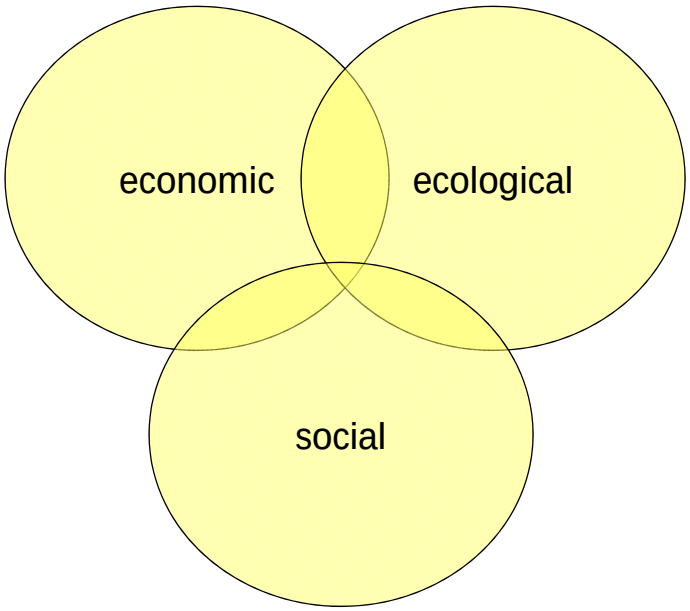
  [...] We buy products from more than 60,000 suppliers in 70 countries.

  [...] We're buying seven million kilos of organic cotton from Turkey and India, and additional supplies from China, Texas and elsewhere. This policy will keep millions of kilos of chemicals out of the environment."

  – *Lee Scott, President and CEO,* Wal-Mart; May 17, 2006

Outline

- What is "sustainability"?
- Recent research projects
  - sustainability in the motion picture and television industry
  - energy-efficiency in small- and medium-sized enterprises
  - adoption of green building practices
- Environmental performance and financial performance
- How does environmental focus help improve financial performance? Examples from green operations
- Trends in green supply chains today
- Conclusion



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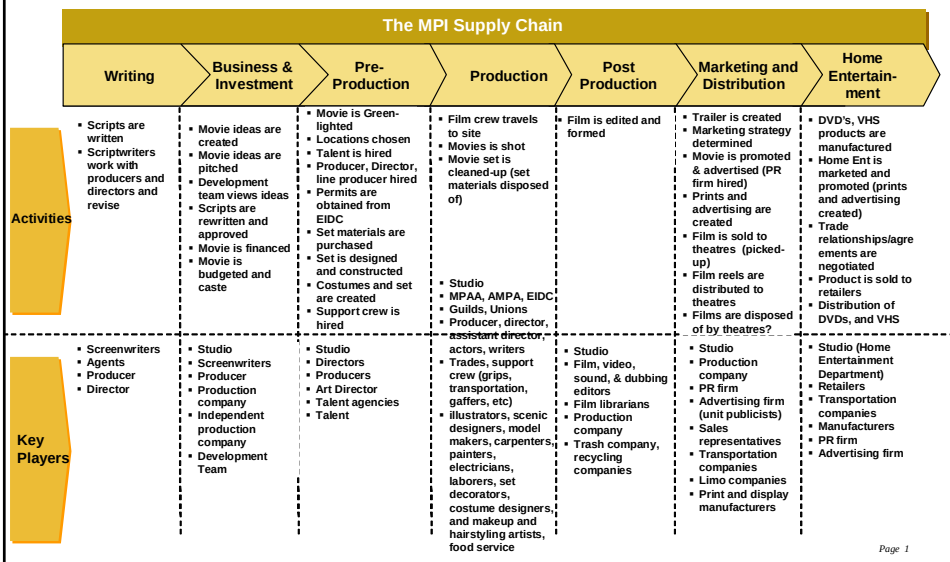
MOTION PICTURE INDUSTRY (MPI) SUSTAINABILITY PROJECT

The MPI Supply Chain and Players



Motion Picture Industry Sustainability study: UCLA / CIWMB

- *Principal investigators:*
  - Professor Charles Corbett
  - Professor Rich Turco
- *Research team (UCLA):*
  - Joanna Hankamer
  - Shannon Clements
  - Jeannie Olander
  - Penny Naud
  - and many others
- *CIWMB contract management:*
  - Brenda Smyth
  - Christy Chew
  - Judith Friedman

Background and organization of study

- Spring 2003: contact between CIWMB and UCLA Institute of the Environment
- Objective:
  - "The purpose of this contract is to provide the means by which the Motion Picture Industry (MPI) can assume a leadership role in developing sustainable practices within the Entertainment Industry. Funding offered by the California Integrated Waste Management Board (CIWMB) will be used to develop information and instruments through which sustainable practices can be assessed, and new practices implemented, within the MPI in the future."
  - Additionally: learn from practices within MPI that can be applied to other industries, building on visibility of MPI

Interviews, cases

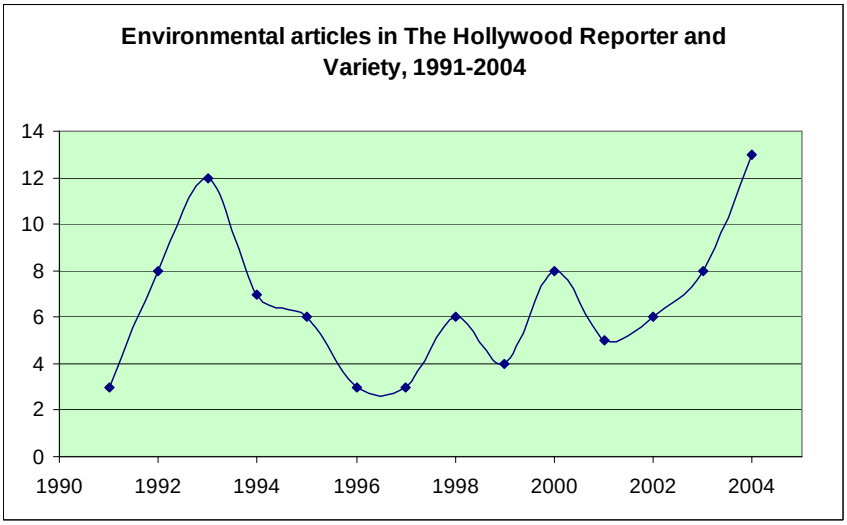
- Conducted interviews with:
  - directors, producers, executive producers, assistant directors, writer, line producers, location managers, grip, assistant cameraman, costume designer, assistant editor, union rep
  - studio, business: VPs and senior VPs of finance, production, physical production, digital production, distribution
  - studio environmental managers: Lewotsky, Billik, Nix
  - others: owner of recyling company, set reconstruction company, environmental consultant, City of Santa Monica (sustainable city program, green building program), California Film Commission, UCLA School of Theatre, Film and Television
- (Also background reading on motion picture industry)

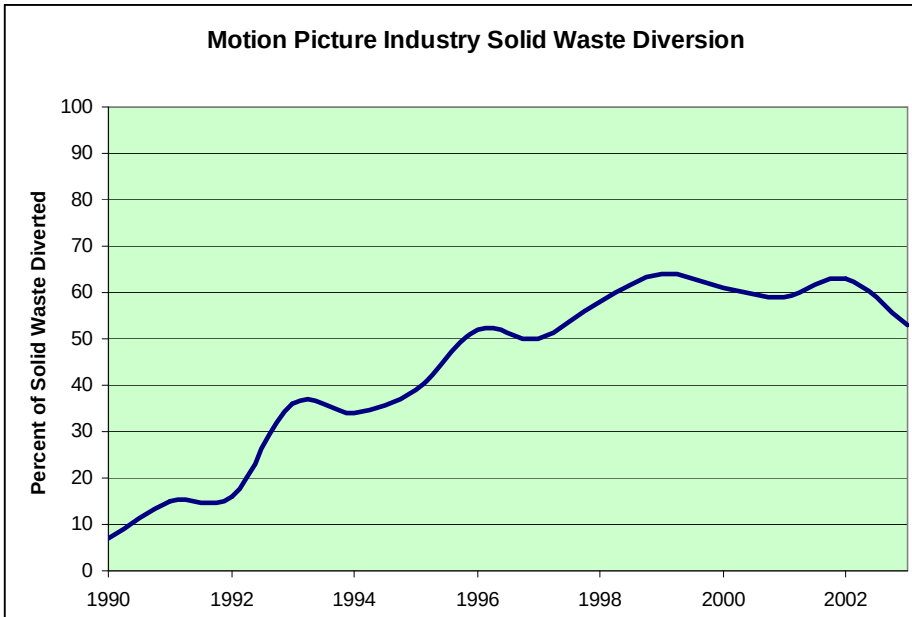
Findings from interviews

- Richer understanding of business side of film and TV industry
- Similarities and differences between film and TV
- Power structure; complex interactions between many parties
- Strong environmental awareness in some areas .....
  - "leave no footprint" when shooting on location
  - some very progressive environmental managers at studios
- ..... but room for improvement in others
  - "we are a clean industry" but many ignore invisible impacts of industry: air pollution, greenhouse gas emissions
  - strong throwaway mentality

The Hollywood Reporter.com

VARIETY.com





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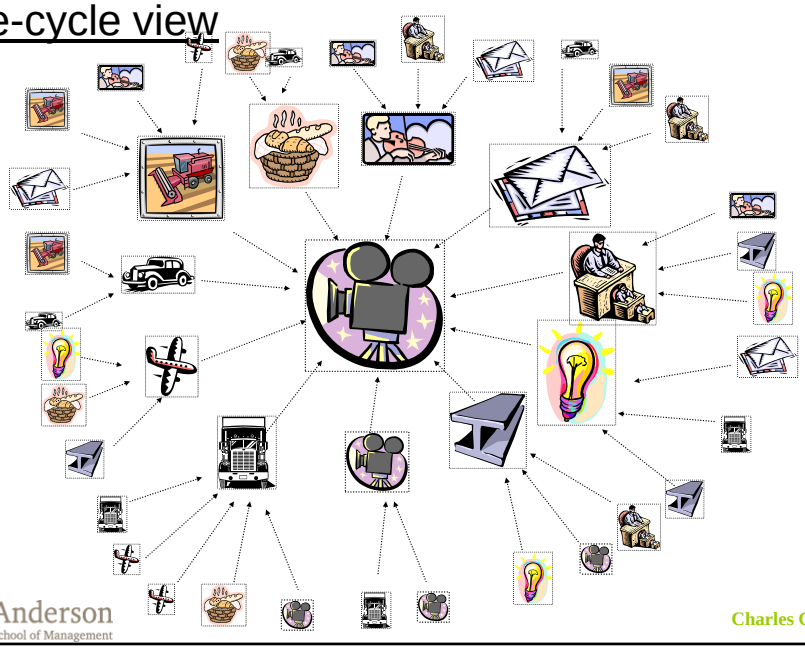
Measuring environmental impacts: life-cycle view



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EIOLCA

- Economic Input-Output Life Cycle Assessment (EIOLCA) method (developed by the Green Design Initiative at Carnegie-Mellon University); www.eiolca.net

- establish economic flows between sectors, using input-output model of US economy, matrix with 465 sectors
  - get life-cycle economic inputs needed to generate $1 final output
- establish environmental impacts per sector per dollar output, using various databases (EPA and other sources)
  - get life-cycle environmental impacts associated with $1 final output
- multiple by size of the sector in US$
  - get total life-cycle environmental impacts associated with the sector

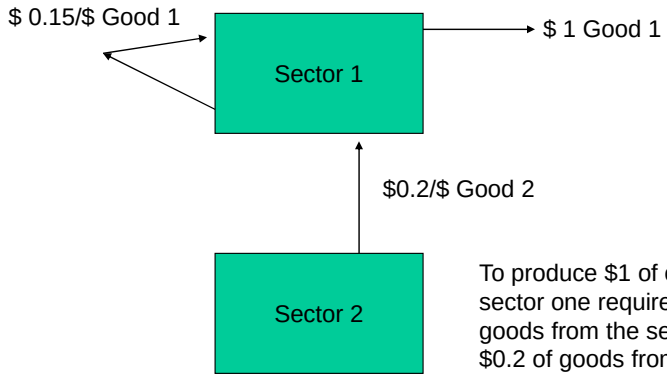
Two Sector Numerical Example

- Reading across: Sector 1 provides $150 of output to sector 1, $500 of output to sector 2, and $350 of output to consumers.
- Reading down: Sector 1 purchases $150 of output from sector 1, $200 of output from sector 2, and adds $650 of value to produce its output
- Transaction Flows ($) are at right.

	1	2	Final Demand
1	150	500	350
2	200	100	1700
Value Added	650	1400	2050

Source: Carnegie Mellon University Green Design Institute. (2008) Economic Input-Output Life Cycle Assessment (EIO-LCA), US 1997 Industry Benchmark model [Internet], Available from: http://www.eiolca.net/Method/eio-lca-method.html, ast accessed October 9, 2009

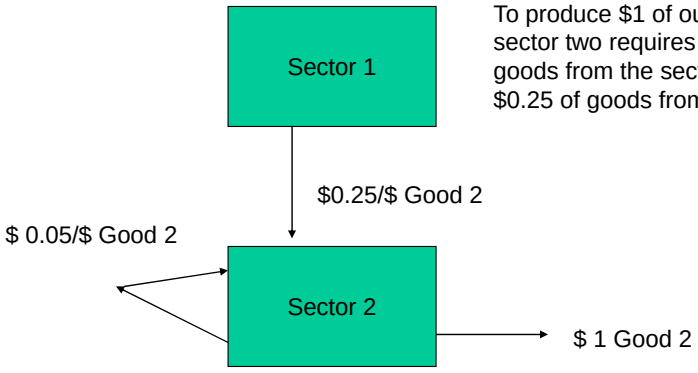
Production of Good 1 in our Two Sector Model



To produce $1 of output from sector one requires $0.15 of goods from the sector itself, plus $0.2 of goods from sector 2.

Source: Carnegie Mellon University Green Design Institute. (2008) Economic Input-Output Life Cycle Assessment (EIO-LCA), US 1997 Industry Benchmark model [Internet], Available from: http://www.eiolca.net/Method/eio-lca-method.html, ast accessed October 9, 2009

Production of Good 2 in our Two Sector Model



To produce $1 of output from sector two requires $0.05 of goods from the sector itself, plus $0.25 of goods from sector 1.

Source: Carnegie Mellon University Green Design Institute. (2008) Economic Input-Output Life Cycle Assessment (EIO-LCA), US 1997 Industry Benchmark model [Internet], Available from: http://www.eiolca.net/Method/eio-lca-method.html, ast accessed October 9, 2009

Leontief Inverse

- [I – A]

$$\begin{vmatrix} 1 & 0 \\ 0 & 1 \end{vmatrix} - \begin{vmatrix} 0.15 & 0.25 \\ 0.20 & 0.05 \end{vmatrix} = \begin{vmatrix} 0.85 & -0.25 \\ -0.20 & 0.95 \end{vmatrix}$$

- $[I - A]^{-1}$

$$\begin{vmatrix} 0.85 & -0.25 \\ -0.20 & 0.95 \end{vmatrix}^{-1} = \begin{vmatrix} 1.254 & 0.33 \\ 0.264 & 1.122 \end{vmatrix}$$

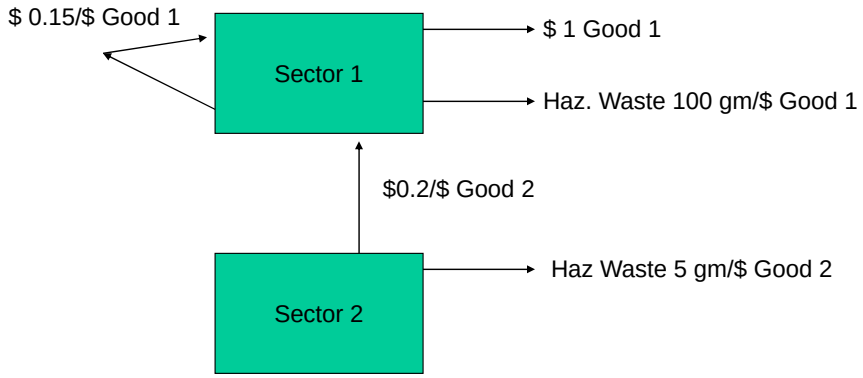
or $X = [I - A]^{-1} * F$

Add Environmental Effects

- Add sector-level environmental impact coefficient matrices (R)
  - » [effect/$ output from sector]
- Example: Hazardous Waste Generation (R)
  - » R_1 = 100 grams/$ in Sector 1
  - » R_2 = 5 grams/$ in Sector 2

Source: Carnegie Mellon University Green Design Institute. (2008) Economic Input-Output Life Cycle Assessment (EIO-LCA), US 1997 Industry Benchmark model [Internet], Available from: http://www.eiolca.net/Method/eio-lca-method.html, ast accessed October 9, 2009

Production of Waste in our Two Sector Model



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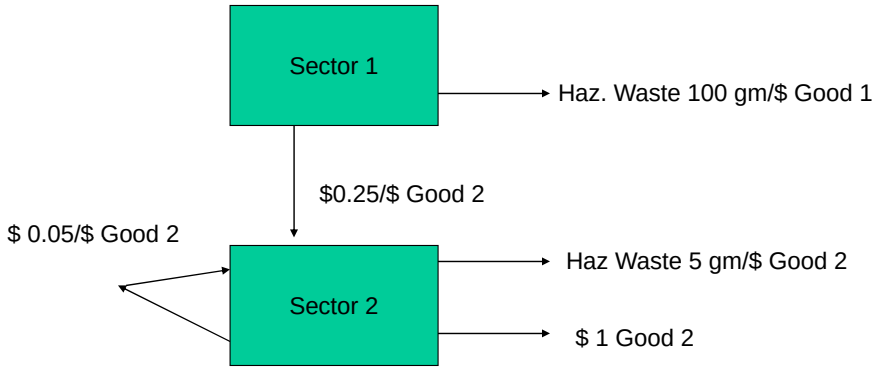

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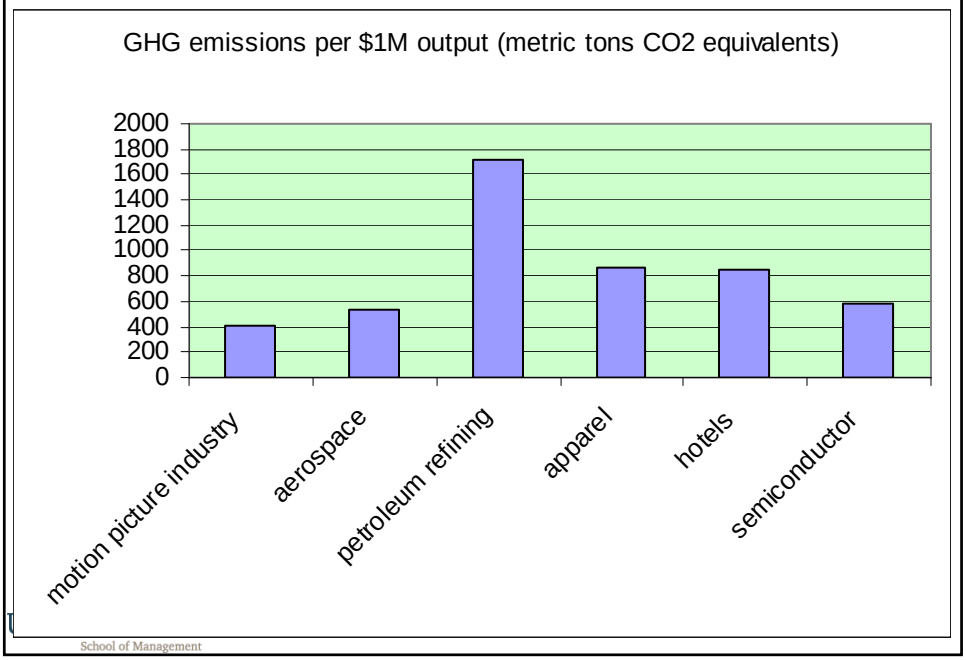
Environmental burden of the MPI per million $

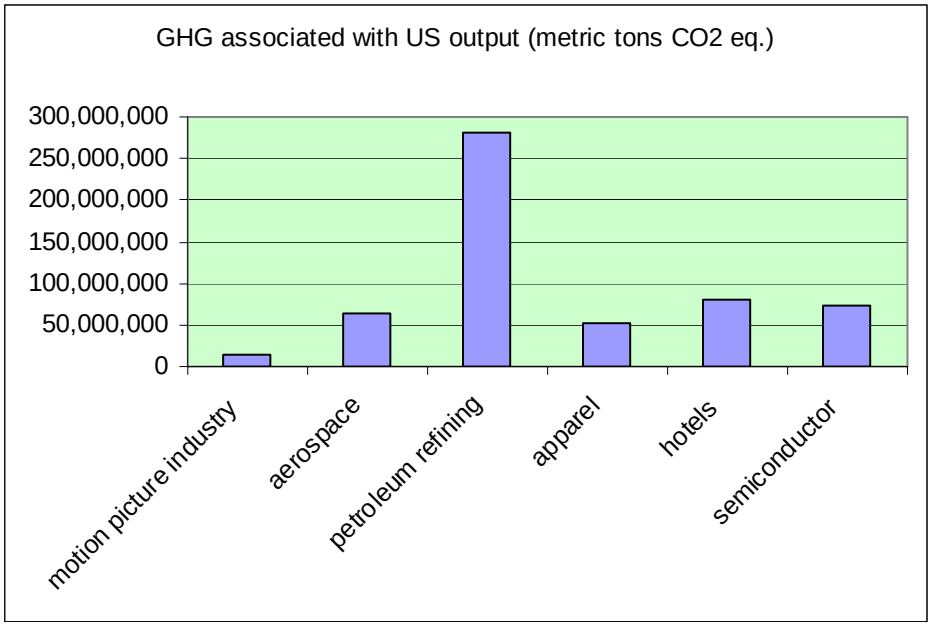
Target:		economic $mill	SO2 mt	CO mt	NO2 mt	VOC mt
MPI	#760101					
	Total for all sectors	2.168203	1.40342	2.919783	1.182493	0.897596
	Motion picture services and theaters	1.494154	0.012407	1.799594	0	0.622056
	Advertising	0.110935	0.000092	0.00102	0	0.000002
	Real estate agents, managers, operators, and lessors	0.078514	0.000039	0.035003	0.000381	0.000009
	Wholesale trade	0.054775	0.000594	0.141186	0.114782	0.025517
	Magnetic and optical recording media	0.024613	0.001639	0.0134	0.000059	0.009195
	Banking	0.017925	0.000493	0.003144	0	0.001061
	Electric services (utilities)	0.016153	1.108101	0.03552	0.542325	0.004432
	Telephone, telgraph communications, and communic	0.015877	0.000051	0.006265	0	0.002249
	Legal services	0.015146	0.00005	0.001776	0	0.000591
	Other repair and maintenance construction	0.014633	0.00001	0.017421	0.021833	0.00009
	Accounting, auditing and bookkeeping, and miscellan	0.013916	0.000208	0.000103	0.000278	0.000045
	Computer and data processing services	0.013242	0.000048	0.002682	0	0.000936
	Theatrical producers (except motion picture), bands,	0.012859	0.000072	0.012059	0	0.004215
	Paper and paperboard mills	0.011599	0.080957	0.083641	0.049445	0.02145
	Noncomparable imports	0.010318	0	0	0	0

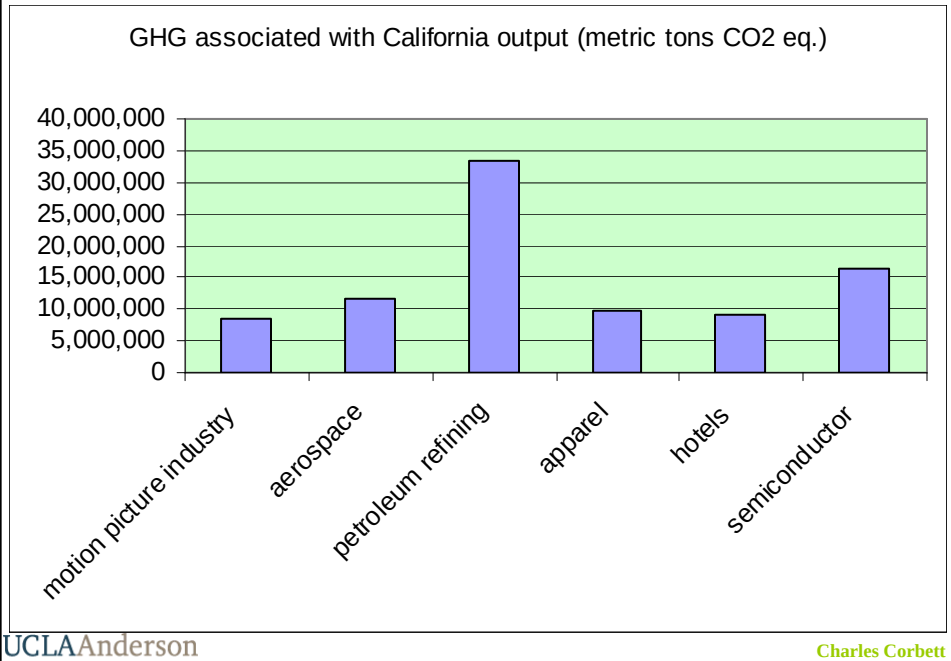
Environmental burden by regional scope

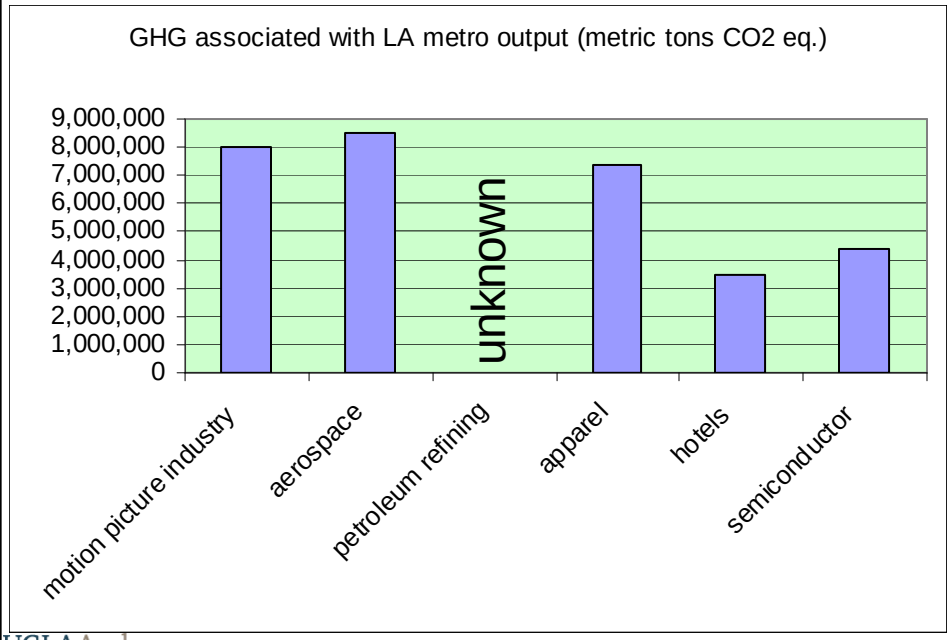
			GHG (metric tons CO2e)
	multiplier:	1.494154	
motion picture industry	size of industry	final sales	
US-wide emissions per $1M output			408
LA metropolitan area	29,184	19,532	7,977,841
California	30,837	20,638	8,429,619
US	55,926	37,430	15,287,885



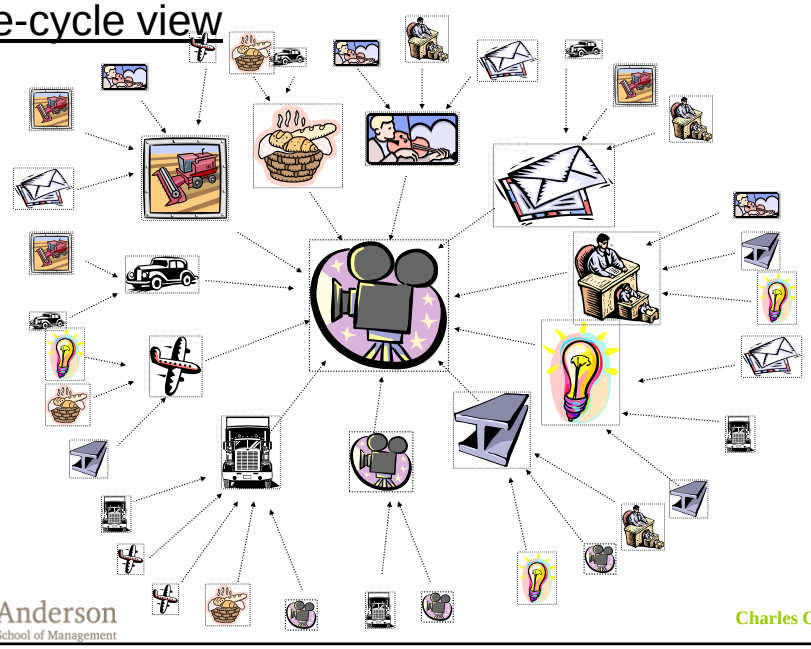
School of Management



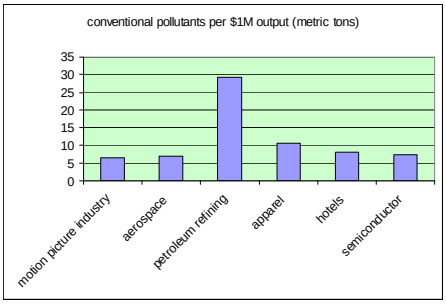

GHG associated with California output (metric tons CO2 eq.)
40,000,000
35,000,000
30,000,000
25,000,000
20,000,000
15,000,000
10,000,000
5,000,000
0
motion picture industry
aerospace
petroleum refining
apparel
hotels
semiconductor

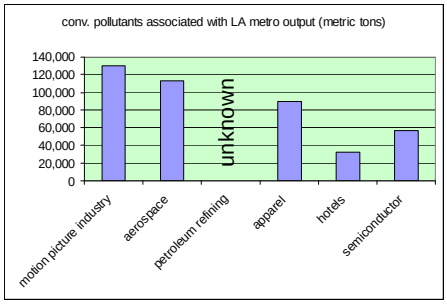

GHG associated with LA metro output (metric tons CO2 eq.)
9,000,000
8,000,000
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
unknown
motion picture industry
aerospace
petroleum refining
apparel
hotels
semiconductor

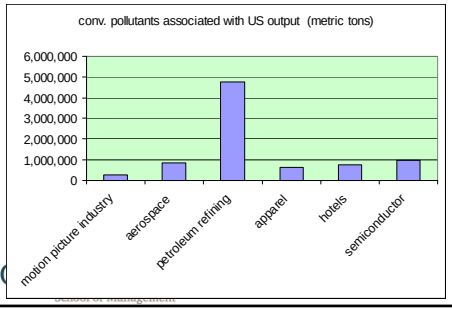
Measuring environmental impacts: life-cycle view

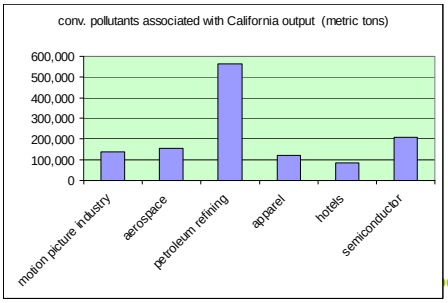


Conventional pollutants

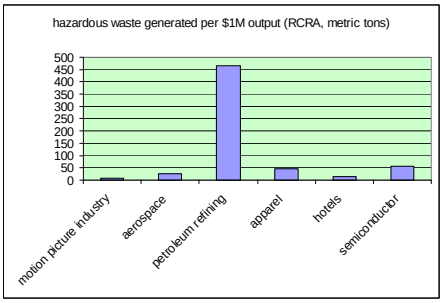


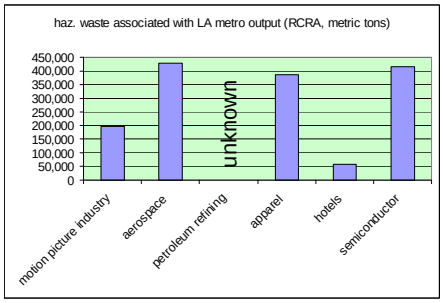


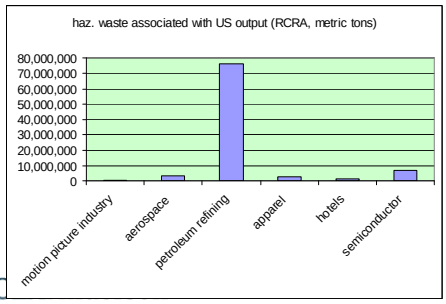


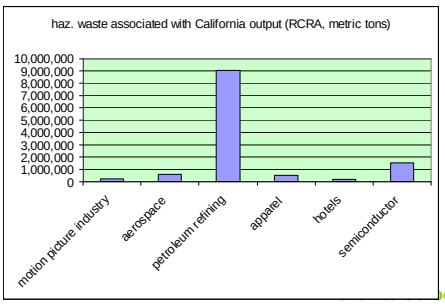


Hazardous waste

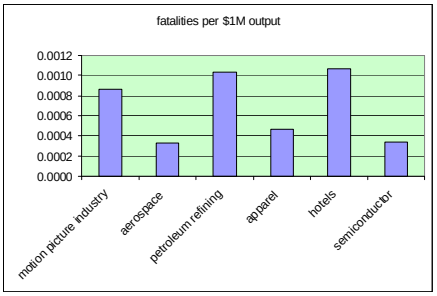


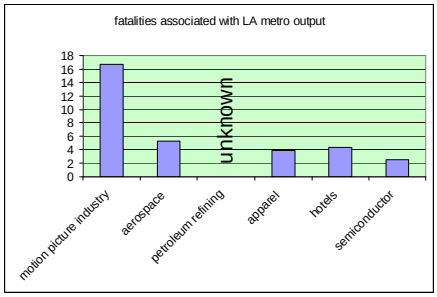


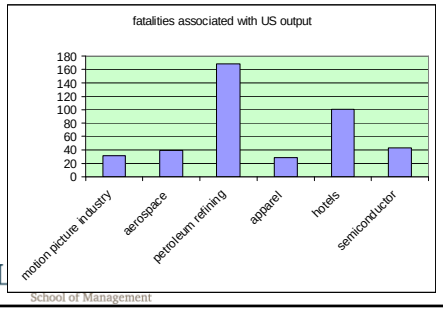


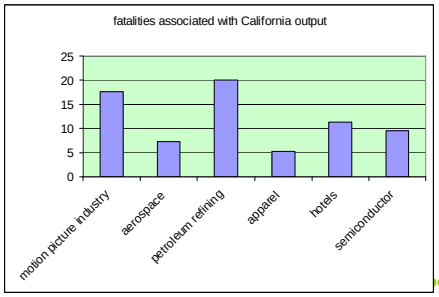


Fatalities









Conclusion so far:

The motion picture industry is relatively "clean" and has already made good progress in reducing waste .....

..... but due to its size, still has significant impacts ....

.... and these impacts are very different from those in "traditional" industries, as they're much more dispersed

What is the motion picture industry doing?

- Very strong personal commitment from many ...
- Several valuable organizations (ECO, EMA, others)
- Examples of best practices
- Some guidelines for green production
  - AIPC 1991 Environmental Guide
  - EMA Green Seal checklist
  - EIDC Environmental Production Guide

Examples of environmental best practic

- *According to Jim*
  - writers use wireless-enabled Motion M1300 Tablet PCs
  - saved 275,000 sheets of paper in one season

- Co-executive producer Jeffrey Hodes:
  - “Last season, we consumed at least 275,000 sheets of paper. There's just no need for this kind of waste. With the M1300, our staff can write their own notes on a digital version of the script and send files instantly. And at the end of a production day, we no longer have to sit around waiting for copies of the rewritten script. The scripts appear instantly on our tablet PCs, saving not only money but time.”

Examples of environmental best practices (II)

- *The Matrix 2 and 3*
- Sets consisting of freeways, tenement buildings, etc
- 97.5% of set material recycled, with help of The ReUse People

Source: Ted Reiff, The ReUse People, "Don't Demolish, Deconstruct"; presentation delivered at the UCLA conference on Motion Picture Industry Sustainability, February 4, 2005

Summary of TRP's Diversion Efforts for the Matrix

- 11,000 tons of usable materials salvaged or recycled with 95+% diverted

- 7,000 tons of concrete - recycled
- 37 tractor-trailer loads of lumber - reused
- 100,000 cubic feet of EPS - reused
- 1,500 tons of steel – reused

Reusing construction waste: it's all logistics

Ted Reiff, President of The ReUse People: "No contractor in the world likes to throw something away, they just don't know what to do with it."

Ted Reiff, President
The ReUse People of California

Examples of environmental best practices (III)

THE DAY AFTER TOMORROW

- Roland Emmerich (director) purchased carbon offsets to make production entirely Carbon Neutral
  - budget: $125M
  - Future Forests estimates: 10,000 tons of CO_2e
  - approx. $20 / ton to offset, total $200,000
- Emmerich, Mark Gordon (producer) and Jeffrey Nachmanoff (scriptwriter) are becoming CarbonNeutral citizens
- Two principles at work:
  - leadership by example
  - what you measure is what you get
- Recently: *Syriana* also carbon-neutral
  - NativeEnergy estimates: 2040 tons CO_2e
  - $24,500 to offset, i.e. $12 / ton

Our dream...

- Every production starts to measure its environmental impacts .....
  - there are many ways to do this
  - there are many resources to help do this
  - see the research report (Spring 2005) for more information
- This will “automatically” reduce those impacts .....
- ..... and every production needs a “green” certification

Monitored Acceptable

www.AHAfilm.org
Film & TV Unit
NO ANIMALS WERE HARMED™
A Program of American Humane™

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Adoption of Profitable Energy Efficiency Related Process Improvements in Small and Medium Sized Enterprises

Suresh Muthulingam*
Charles J. Corbett*
Shlomo Benartzi*
Bohdan Oppenheim**

* UCLA Anderson School of Management
** Loyola Marymount University

Adoption and Non-Adoption of Profitable Energy-Efficiency Related Process Improvements

- Improved management of existing systems
  - Analyze flue gas for proper air fuel ratio
- Modification or replacement of equipment
  - Use more efficient motors ; Insulate steam / hot water lines
- Minimize waste or resource usage
  - Stops leaks is compressed air lines; cover open tanks with floating insulation
- Enhanced productivity
  - Add equipment / workers to reduce production bottleneck
- Enhanced Quality Management
  - Adjust burners for efficient operations
- Preventive maintenance
  - Improved Lubrication Practices

The energy efficiency paradox…

Many profitable energy efficiency initiatives exist…

- Shama (1983), Lovins and Lovins (1993), Jaffe and Stavins (1994)
- IPCC → energy efficiency as a key strategy to reduce CO_2 emissions.
- Estimates Profitable Energy Efficiency initiatives can reduce 4% of total CO_2 emissions in 2030
- Over 2.5 gt CO_2 eqs/year in 2030 (Bernstein et al. 2007)

But a significant proportion is not realized…

- DeCanio (1993)
- United Nations Foundations report (UNF 2007)
- IPCC (2007)

Various studies have postulated theories and explanations for this apparent anomaly…

- Jaffe and Stavins (1994) → Market failure and Non Market failure
- DeCanio (1998) → Organization and Institutional Factors
- Mulder et al. (2003) → Technology adoption and learning by using
- Dierdern et al. (2003) → Real options framework
- Rohdin and Thollander (2006) → Behavioral - bounded rationality to inertia

However, behavioral issues in an industrial context are largely unexplored..

- Kempton et al. (1992) → Much of psychological work has focused on residential energy users at home

We address these issues

Database of energy saving initiatives → US Department of Energy (DoE) from 1980…

- Over 100,000 recommendations
- Over 13,000 firms
  - Anderson & Newell (2004) - Link economic incentives to energy efficiency initiatives

- We identify specific biases and estimate their impact

1. Managerial Myopia
2. Cost Focus
3. Order Effects
4. Offerings and Choice

Contribution: *Previously unobserved biases in the OM context*

Contribution: *Identify behavioral issues using actual field data*

Industrial Assessment Centers (IAC) program of DoE provides free energy assessments to small & medium manufacturing firms

- Firms eligible for assessments need to have…
  - Plant's products are within SIC codes 20 to 39
  - Annual revenues less than $100 million
  - Employee count less than 500
  - Annual energy costs between $100,000 and $2 million
  - Less than 150 miles from the IAC
- Assessments are done by faculty and students of accredited universities
  - 50 universities have served as IAC
  - Currently the program has 26 IAC

IAC program of DOE provides free energy assessments to small & medium manufacturing firms (contd.)

- Typically each assessment involves
  - Data Collection
  - Plant Tours / Interviews with Plant Management
  - Discussion of findings
  - Submission of a written report
  - Follow up to ascertain status of recommendations

A Sample Table in the Executive Summary of a Report

AR #	Description	Energy Savings (kWh/yr)	Demand Savings (kW/yr)	Gas Savings (MMB/yr)	Cost Savings ($/yr)	Implement. Cost		Payback Period (yr)
						Capital ($)	Other ($)	
1	Reduce Sprue, Gating, and Flash	0	0	345	7858	2500	0	0.32
2	Minimize Misuse of Compressed Air	17,363	46.9	0	2,223	0	1300	0.58
3	Migrate to Just-in-Time Production	0	0	0	151,200	0	2000	0.01
4	Install sensor to detect and avoid jams	3,300	14.5	0	15,120	0	1400	0.09
5	Modify Process to Reduce Material use/ Cost	18,000	0	172	44,787	0	1000	0.02
6	Introduce Total Preventive Maintenance	8250	0	0	34,678	0	2000	0.06
Total		**46,913**	**61**	**517**	**$255,866**	**$2500**	**$7700**	**0.04**

Hypothesis 1:

There exist many profitable initiatives that are not adopted.

Hypothesis 2: *Managers focus on costs rather than on savings when evaluating energy efficiency initiatives*

Recommendation 1	
•Initial Cost	$1,000
•Annual Saving	$3,000

✓

Recommendation 2	
•Initial Cost	$10,000
•Annual Saving	$30,000

✗

- Expenditure that fit in present budget cycle need less organizational approvals - Stern and Aronson (1984)
- Managers concerned about their reputation may not undertake investments with large costs - Hirshleifer (1993)
- Capital rationing may cause managers to select lower cost projects - Antle and Eppen (1985); Zhang (1997)
- Accounting information measures may influence managers to maximize short term results - Marginson and Mcaulay (2008)

Hypothesis 3: *The serial position of a recommendation in the report will influence adoption rates.*

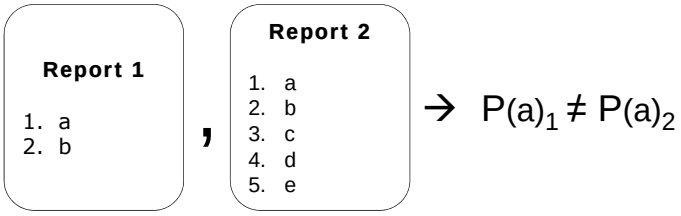
Report 1
1. a
2. Flue Gas
3. b
4. c
5. d

,

Report 2
1. a
2. b
3. Flue Gas
4. c
5. d

→ $P(\text{Flue Gas})_1 \neq P(\text{Flue Gas})_2$

Hypothesis 4: *The number of recommendations in an assessment will influence adoption rates.*



Methodology and Results

- Analysis done in multiple ways
  1. Preliminary Analysis – Cross Tabulation & ANOVA
  2. Conditional Logit Model
  3. Probit Instrumental Variables Model

- Hypothesis related to managerial myopia tested separately from the other hypotheses

Data - Adoption rates are around 50% though average payback is just over a year

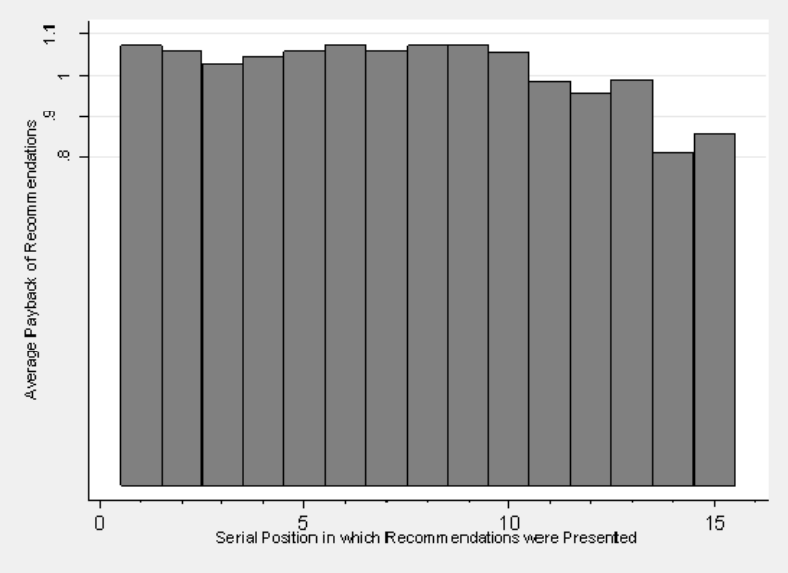
Variable	Mean	S.D	Minimum	Maximum
Adopted**	0.5001	0.50	0	1
Payback (years)	1.0579	1.29	0	9
Implementation Cost (US$)	20,766.82	301,632.42	0	55,429,808
Annual Savings (US$)	19,296.85	130,001.21	1.12	8,519,905
Annual Sales (US $)	41,729,814.57	247,954,127.97	0	25,000,000,000
Employees	175.02	177.78	0*	5,800
Floor Area (square feet)	201,027.04	2,592,045.59	0*	150,000,000
Annual Energy Cost (US$)	727,867.34	2,643,844.22	0*	189,742,848

- Statistics are based on data for the 92,723 recommendations, representing 12,703 assessments.
- Monetary figures are in 2006 US Dollars
- ** Adopted =1 if the recommendation is implemented and 0 otherwise
- *Note:Missing data is coded as 0 for -1) Annual Sales - 755 records, 2) Employees - 101 records 3) Floor Area - 26,596 records, *Note: Data is missing and coded as 0 for -1) Annual Sales - 755 records, 2) Employees - 101 records 3) Floor Area - 26,596 records,

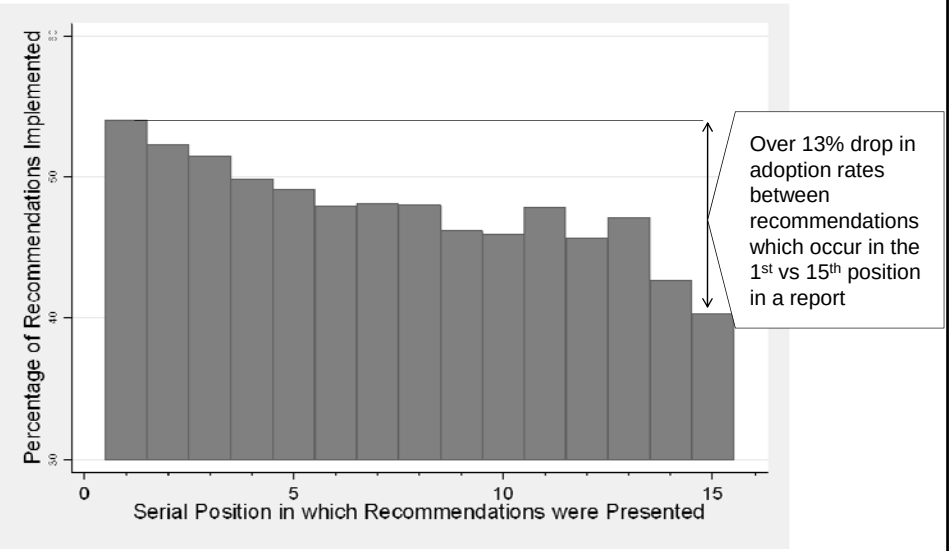
Do profitable opportunities exist?

- Cost of trade credit around 45% per year
- Average 3-year IRR of recommendations not adopted is 84%
- Many possible explanations:
  - myopia
  - opportunity cost (perceived or real)
  - risk aversion (to perceived or real risk)
  - .....

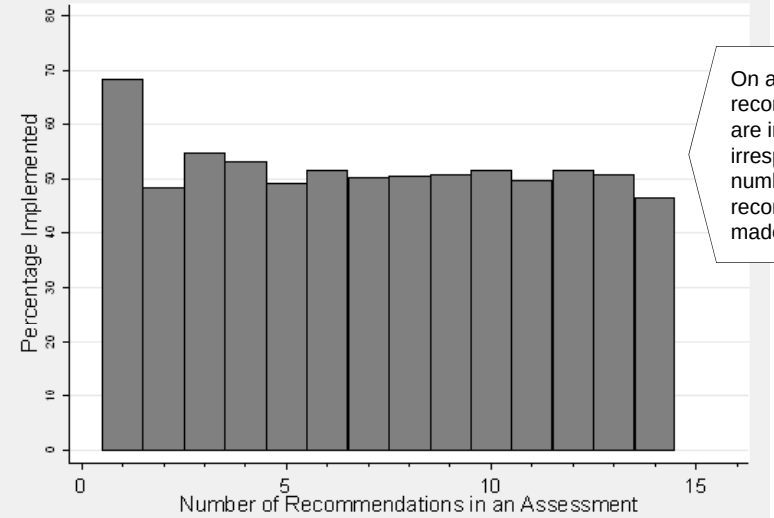
Average payback for recommendations which occur earlier in the report are not shorter than that of those occurring later



But, adoption rates fall as recommendations occur later in the report



Average adoption rates do not seem to be influenced by number of recommendations in a report



On average half the recommendations are implemented irrespective of number of recommendations made to a firm

Specification for Probit Instrumental Variables Model

- Choice problem is defined by the latent variable model.

- $Y_i^* = \alpha + Financial_i * \beta + Category_i * \gamma + Serial_i * \delta + Number_i * \omega + Int\_NPB_i * \psi + Variance_i * \varphi + Controls_i * \lambda + \varepsilon_i$ (2)

- Y_i^* → net benefit of adopting the recommendation i
- $Financial_i$ → vector of financial variables
- $Category_i$ → vector which classifies the type of recommendation i,
- $Serial_i$ → serial position of the recommendation,
- $Number_i$ → number of recommendations
- Int_NPB_i → interaction of # of recommendations with the payback
- $Variance_i$ → variance in payback of the recommendation,
- $Controls_i$ → vector of controls (sales, plant area, year, IAC, SIC, employees)
- ε_i → error term.

Findings

Cost vs. savings:

- $1 extra in *one-time* implementation costs reduces adoption likelihood by much more than $1 lower *annual* savings

Effect of serial position:

- Moving a recommendation from 4th to 5th position reduces likelihood of adoption by 0.043 (4.3%).
- That is equivalent to increasing cost of implementation by $22,595 from average levels. (Average is around $20k, so this is equivalent to doubling the implementation cost.)

Conclusions for consultants:

- put savings and benefits in the same scale (NPV, or annuity)
- think about sequence!

Outline

- What is “sustainability”?
- Recent research projects
  - sustainability in the motion picture and television industry
  - energy-efficiency in small- and medium-sized enterprises
  - adoption of green building practices
- Environmental performance and financial performance
- How does environmental focus help improve financial performance? Examples from green operations
- Trends in green supply chains today
- Conclusion

Adoption of Voluntary Environmental Standards:
An Empirical Study of the LEED Green Building Standards

Suresh Muthulingam
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Charles J. Corbett
Professor of Operations Management and Environmental Management
Joseph J. Jacobs Term Chair in Entrepreneurial Studies
UCLA Anderson School of Management

Green building and LEED standard

- Buildings have a significant impact on the environment (in the USA)
  - 70% of electricity consumption,
  - 39% of energy use,
  - 39% of CO_2 emissions,
  - 30% of waste output (136 million tons annually),
  - and 12% of potable water consumption.
- "Green Building" evolved to reduce negative environmental impact

Green building and LEED standard

- The LEED Green Building Rating System -> launched in 1998 (created by United States Green Building Council - USGBC)

- LEED provides standard for various building types
  - LEED-NC, LEED-EB, LEED-CI, LEED-CS
  - LEED-NC has the largest adoption to date

GREEN BUILDING FACTS

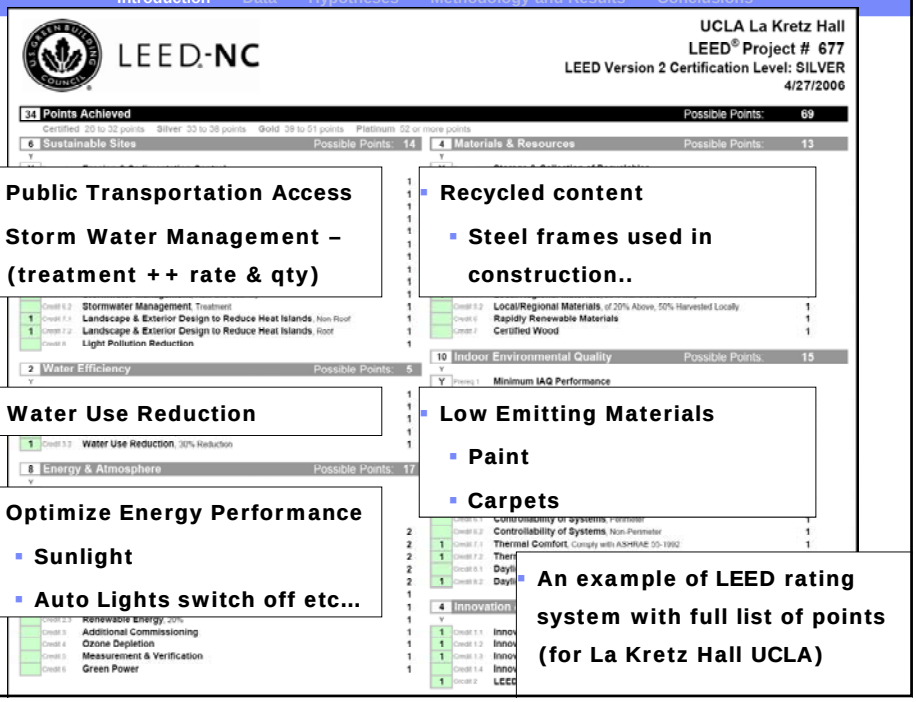
LEED	New Construction	Commercial Interiors	Existing Buildings	Core & Shell	Neighborhood Development	Schools	Retail	Total
Registered Projects	6442	1001	978	1341	234	227	86	**10,309**
Certified Projects	978	216	70	59			2	**1,325**

- There are LEED projects in all 50 states and 41 countries.

Source: http://www.usgbc.org/ShowFile.aspx?DocumentID=3340, last accessed April 1, 2008

Green building and LEED standard

- LEED facilitates design, construction, & operation of high performance Green Buildings -> Recognizes performance in five areas
  - sustainable site development,
  - water savings,
  - energy efficiency,
  - materials selection,
  - indoor environmental quality
- The total number of points earned determine certification level.
  - LEED Certified -> 26 to 32 points, + certain prerequisites
  - LEED Silver -> 33 to 38 points,
  - LEED Gold -> 39 to 51 points
  - LEED Platinum -> 52 to 69 points



Value of green building

Figure ES-1. Financial Benefits of Green Buildings Summary of Findings (per ft^2)

Category	20-year NPV
Energy Value	$5.79
Emissions Value	$1.18
Water Value	$0.51
Waste Value (construction only) - 1 year	$0.03
Commissioning O&M Value	$8.47
Productivity and Health Value (Certified and Silver)	$36.89
Productivity and Health Value (Gold and Platinum)	$55.33
Less Green Cost Premium	($4.00)
Total 20-year NPV (Certified and Silver)	$48.87
Total 20-year NPV (Gold and Platinum)	$67.31

Source: Capital E Analysis

Kats (2003): Report to California's Sustainable Building Task Force

(From Kats 2003)

Figure III-1. Level of Green Standard and Average Green Cost Premium

Level of Green Standard	Average Green Cost Premium
Level 1 – Certified	0.66%
Level 2 – Silver	2.11%
Level 3 – Gold	1.82%
Level 4 – Platinum	6.50%
Average of 33 Buildings	1.84%

Source: USGBC, Capital E Analysis

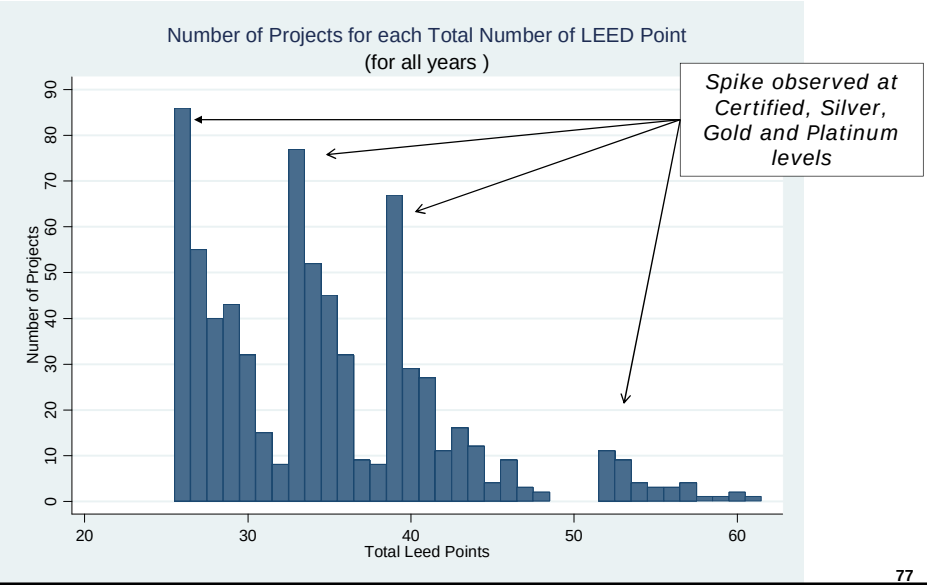
Background

- Understand how organizations make decisions related to LEED certification…
- Conducted a workshop in UCLA on Mar 10, 2006
- 4 panelists & 25 participants
  - Architects, designers, consultants, developers, real estate professionals
  - USGBC, Toyota, KB Home, Turner Construction, Swinerton, etc…

The data for the study includes…

- 721 buildings certified to LEED NC standard by May 2008
- These buildings include projects from various countries
  - United States - 688
  - Canada - 18
  - China – 4
  - India - 6
  - Others -5

The spikes at the certification levels indicate organizations respond to cut-off levels



Conclusion

- The design of standards matters: firms respond!
- This may also true for the other standards (packaging, FSC, EPEAT, carbon footprint, etc)
- The OM/IE community should get involved with designing these standards, before it's too late

Outline

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- Trends in green supply chains today
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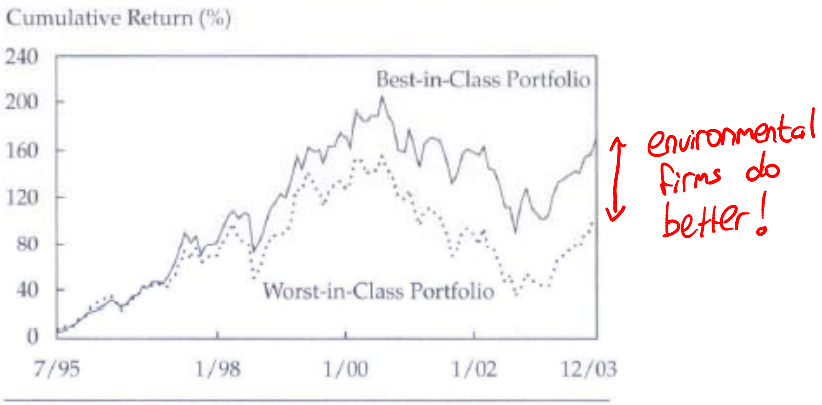
The “eco-efficiency premium puzzle”

Figure 1. Cumulative Returns of Two Portfolios, July 1995–December 2003



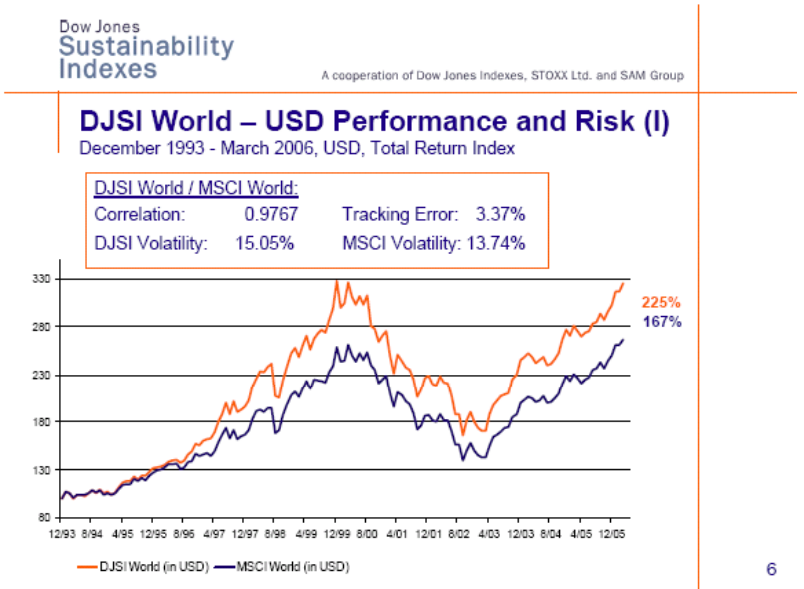
Derwall J, Guenster N, Bauer R, et al. “The eco-efficiency premium puzzle”. *Financial Analysts Journal* 61 (2): 51-63 MAR-APR 2005

How do “social / environmental” funds do?

- Cohen, Fenn, Naimon (1995):
  - use IRRC data; split companies between “high” and “low” polluters
  - investing in “low” polluters yields same or superior return
- Konar and Cohen (RES, 2001): using TRI and lawsuits
  - finds: cleaner companies have higher Tobin’s Q
- Hart and Ahuja (Bus Str & the Env, 1996):
  - use IRRC data; finds: cleaner companies have higher ROA
- Kiernan (Env Q Mgmt, 2001); Klassen and McLaughlin (Mgmt Sci, 1996); King & Lenox (several); others
- Derwall, Guenster, Bauer, Koedijk (Fin An Jnl 2005):
  - market seems to price eco-efficiency too low
- Overall: outperform, or at least no penalty!
- Review of 167 studies over 35 years: weak but positive link

Source: http://www.sustainability-indexes.com/htmle/news/monthlyupdates.html; accessed April 15, 2006

Dow Jones Sustainability Index



Conclusion so far

- Environmental, social and financial performance *can* and *do* go hand-in-hand
- But:
  - precisely how does this work?
  - and why is it so often not recognized?

Operations perspective

How can environmental focus help improve financial performance?

- Green operations
  - simple changes save money
  - often following TQM approach
- Trends in green supply chains

Green operations in Hollywood

- *According to Jim*
  - writers use wireless-enabled Motion M1300 Tablet PCs
  - saved 275,000 sheets of paper in one season

- Co-executive producer Jeffrey Hodes:
  - "Last season, we consumed at least 275,000 sheets of paper. There's just no need for this kind of waste. With the M1300, our staff can write their own notes on a digital version of the script and send files instantly. And at the end of a production day, we no longer have to sit around waiting for copies of the rewritten script. The scripts appear instantly on our tablet PCs, saving not only money but time."

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Source: "Motion Picture Industry Sustainability", 2006, study by UCLA Institute of the Environment, funded by California Integrated Waste Management Board

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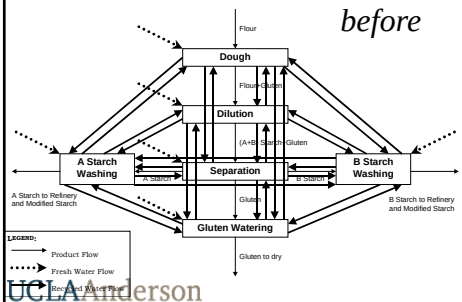
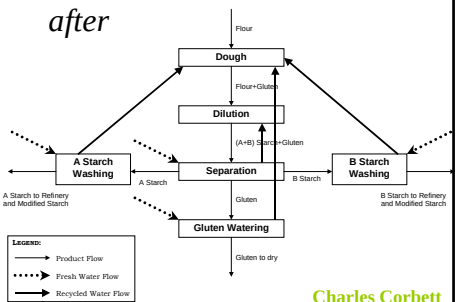
Government regulation => plant optimization

- Rajaram and Corbett (*Operations Research* 2002)
  - New wastewater regulations in the Netherlands trigger productivity study
  - Mathematical programming-based redesign of plant
  - Saved $3M per year, avoid $100M wastewater plant, reduce energy by 50 MWH per day and water by 2500 m3 per day

before



after



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Value of green building

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Source: Capital E Analysis

Kats (2003): Report to California's Sustainable Building Task Force

Wal-Mart likes green building too

- Wal-Mart's prototype Eco-Mart in Lawrence, Kansas: skylights installed in half the store ... sales significantly higher
- Elsewhere, up to 40% increase in sales due to skylights

Source: USGBC, "Building Momentum"

Green operations: recap

- Green operations can lead to financial improvements in unexpected ways
- The benefits are often large *after the fact* ...

  ... but difficult to predict *in advance*
- Why?

  Because the benefit comes from extending your horizons ... so by definition you don't know what you will find.
- How does this work with green supply chains?

How does extending your horizons help?

- Physical therapy
  - focusing on knee need not solve knee pain
- Economics
  - domestic economic policy does not work without understanding global economics
- "Thinking outside the box"
- "Creative destruction" (Schumpeter)

Carbon footprinting in supply chains

- How does it work?

- Is it worthwhile?

Types of carbon footprints

- Corporate greenhouse gas accounting (Greenhouse Gas Protocol): Scope 1 and 2
  - Whirlpool: on-site emissions plus electricity consumption
  - *not* materials, employee commuting, transportation, product use, disposal
- Corporate value chain: Scope 3
  - Whirlpool: includes "embedded carbon", ie. materials, employee commuting, transportation, product use, disposal, in Whirlpool's entire upstream and downstream value chain
- Product life cycle: built on life-cycle assessment (LCA)
  - Whirlpool: includes all life-cycle emissions associated with making, using, and disposing of a single product

Carbon labels

- This year, UK-based supermarket chain Tesco pledged to put "carbon labels" on its 80,000 product lines which would show consumers how much greenhouse gas went into their production.

Green supply chains: carbon footprints

The Washington Post

Wal-Mart Aims To Enlist Suppliers In Green Mission

By Ylan Q. Mui
Washington Post Staff Writer
Tuesday, September 25, 2007; Page D02

Wal-Mart announced yesterday that it will begin asking its suppliers to measure their carbon footprint and find ways to reduce it, part of an effort by the world's largest retailer to transform itself into a more environmentally friendly company.

Wal-Mart said it would start by looking at seven categories that are ubiquitous in its shoppers' lives: DVDs, toothpaste, soap, milk, beer, vacuum cleaners and soda. It will work with the Carbon Disclosure Project, a nonprofit group of 315 institutional investors that control $41 trillion in assets, to collect data on greenhouse gas emissions, emissions reduction targets and strategies for dealing with climate change for its suppliers in those product categories.

Source: http://www.washingtonpost.com/wp-dyn/content/article/2007/09/24/AR2007092401435.html, last accessed April 1, 2008

HermanMiller

Carbon footprinting at Herman Miller

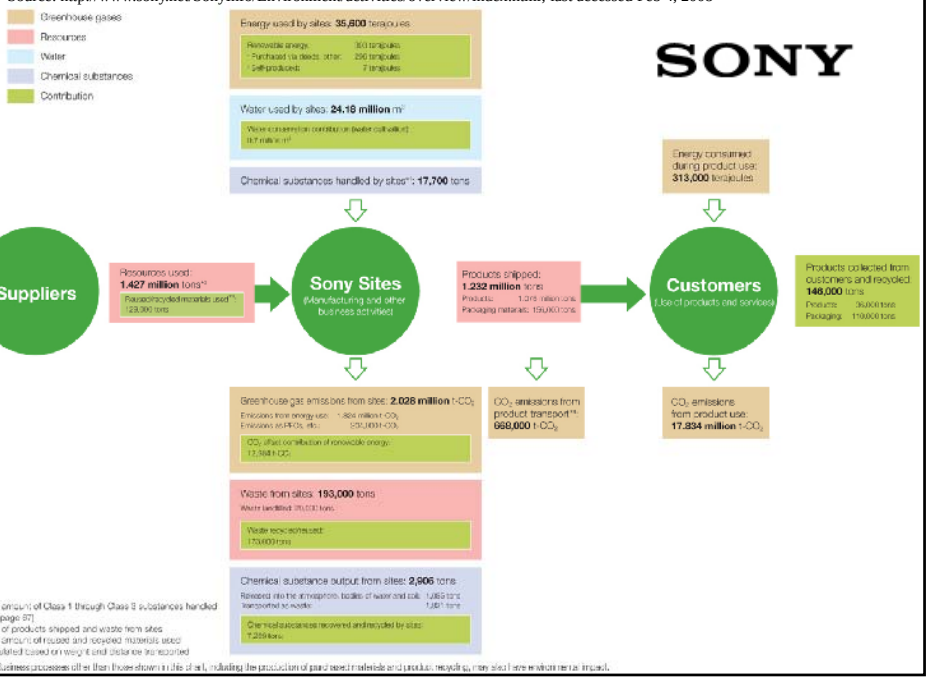
- "Carbon footprint is absolutely new territory," said W. Drew Schramm, a senior vice president at Herman Miller and a member of the committee on social responsibility at the Institute for Supply Management. "We're not sure how we'll measure it, we're not sure how we'll deal with it, but we've told our suppliers, 'Get ready, because we're going to ask you a lot of questions.' "

UCLA Anderson School of Management

Source: "Making new demands on the U.S. supply chain", Claudia Deutsch, *The International Herald Tribune*, November 8, 2007

Charles Corbett

Source: http://www.sony.net/SonyInfo/Environment/activities/overview/index.html; last accessed Feb 4, 2008



Source: http://www.sony.net/SonyInfo/Environment/activities/data/products/index.html; last accessed Feb 4, 2008

SONY

Environment

Environmental Data

Environmental Data for Products

Greenhouse Gas Emissions from Product Use (Unit: t-CO2)

	Fiscal 2000	Fiscal 2001	Fiscal 2002	Fiscal 2003	Fiscal 2004	Fiscal 2005	Fiscal 2006
Television	12,067,418	10,818,776	11,961,737	11,738,773	12,908,566	12,393,225	13,599,236
Video	407,618	280,299	197,346	228,719	527,432	322,432	372,547
Audio	1,964,006	2,461,309	1,365,062	2,055,160	2,043,388	1,586,781	1,609,150
IT	67,893	132,360	143,076	207,479	161,243	109,593	73,821
Professional use	1,008,853	871,437	538,146	432,057	511,678	616,053	1,369,409
Game	256,561	529,577	1,095,122	447,826	331,595	295,299	810,242
Total	15,772,350	15,093,758	15,300,489	15,110,014	16,483,902	15,323,383	17,834,405

Rationale

Production volume x (Operating power consumption x Estimated hours of operation per year + Standby power consumption x Estimated standby time per year) x Years used x CO2 conversion rate

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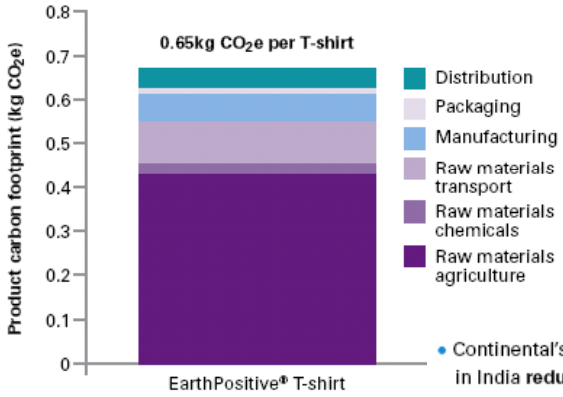
Steps in Scope 3 Reporting

1. Map/Inventory The Value Chain
2. Screen the Value Chain
3. Prioritize Sources & Activities
4. Collect Data
5. Calculate & Aggregate Emissions
6. Report

1. Create a complete process map and/or inventory of sources and activities in the company's value chain - including all suppliers and customers; all inputs (purchased materials) and outputs (sold products); etc.
2. Conduct screening assessments to estimate all scope 3 activities
3. Prioritize scope 3 activities based on their relative size and significance
4. Collect GHG data according to a data collection hierarchy (decision tree), giving preference to company- or product-specific data where available
5. Aggregate data for each scope 3 category
6. Report inventory of scope 1, scope 2, and scope 3 emissions
   - Report each scope 3 category in separate line items

***Chart 11* Continental Clothing T-shirt**



- Continental's use of on-site renewable electricity in India **reduces the carbon footprint** of its T-shirts **by 89%**.
- Interestingly, although Continental manufactures in India and distributes to business customers in the UK, US and Europe, **distribution** has a relatively **low impact** on the overall product footprint.
- Therefore, it can focus reduction efforts on more important sources, such as **farming and manufacturing** processes.

Source: *Product carbon footprinting: the new business opportunity, Experience from leading companies;* The Carbon Trust 2008

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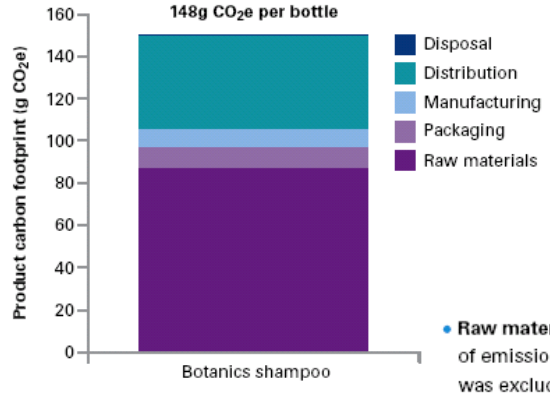
***Chart 10* Boots Botanics shampoo**



- **Raw materials and distribution** are the key drivers of emissions, apart from consumer use (which was excluded from the original assessment).
- Once it knew where to focus, Boots quickly identified and implemented emission reduction measures that resulted in a **20% decrease in emissions** across the product's life cycle:
  - Increased recycled content of plastic bottles to 30%.
  - Redesign of the distribution network to allow individual products to be shipped direct to stores.

Source: *Product carbon footprinting: the new business opportunity, Experience from leading companies;* The Carbon Trust 2008

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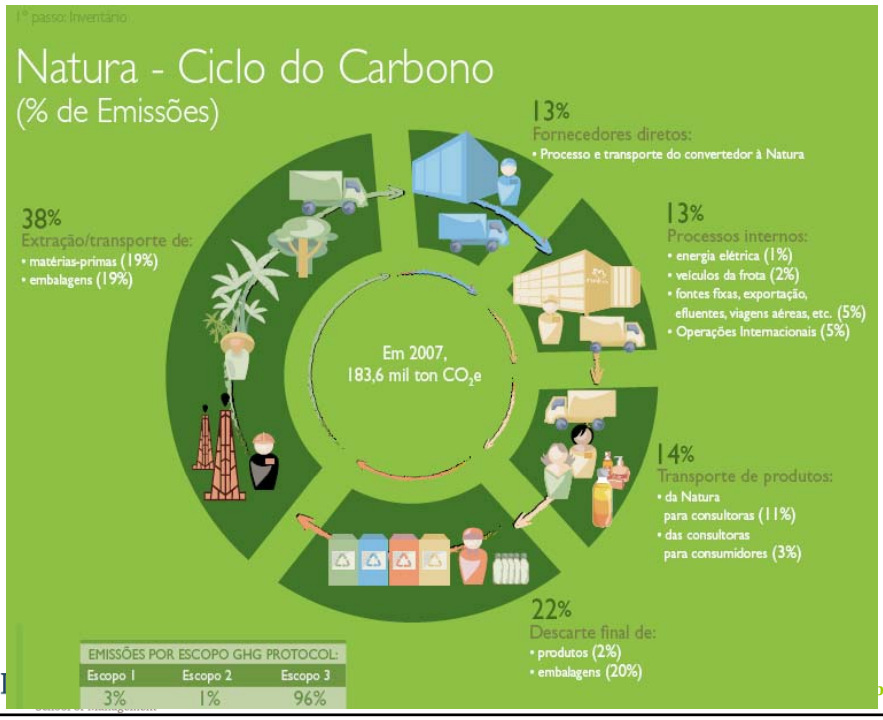

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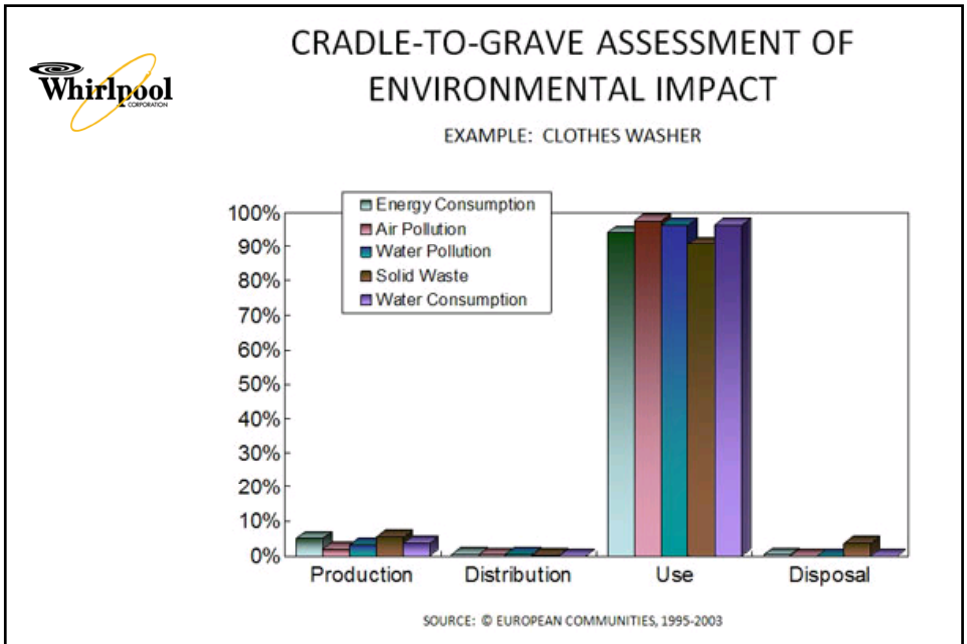

Source: http://www.whirlpoolcorp.com/responsibility/environment/performance/product_performance.aspx, last accessed Oct 6, 2009

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Wrap-up

- Why do environmental research in IE/OM
- Examples:
  - motion picture industry
  - energy efficiency
  - green building
- Environmental and financial performance go hand-in-hand
- The “Law of the (un)expected side benefits”
- Carbon footprinting to find these hidden opportunities

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