## Virtual Local Section Agenda

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Neil Yeoman

“Firsthand Experience of Superstorm Sandy”

AIChE Virtual Local Section
Nov 15, 2012
Virtual Local Section Agenda

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Welcome

Dan Lambert, VLS Chair
Questions and Comments

- Ask your question or make comment any time
- “Raise your hand” if you want to ask a question
  - We will call your name so you can ask your question
  - We unmute you (people will see you if webcam is on)
  - Please let us know where you are from and work
  - We will answer your question
- Send a chat message to Amanda Robben or Dan Lambert if you have a question
  - We will read the question for you
  - We will answer your question
Chat

Welcome From Chair

Dan Lambert, chair
Thursday, January 27, 2011
## Agenda

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If you are a VLS member, please remember to vote in the VLS election.

Voting is open now until November 29.

Voting link: http://virtual.aiche.org
UPCOMING CONFERENCES

http://www.aiche.org/resources/conferences

- **Sustainability in (Bio) Pharmaceuticals**
  - Sheraton Old San Juan, San Juan Puerto Rico
  - November 11 – 14, 2012

- **4th ICBE—International Conference on Biomolecular Eng**
  - Hyatt Regency Pier 66, Fort Lauderdale, FL
  - January 13-16, 2013

- **2013 Spring Meeting & 9th Global Congress on Process Safety**
  - Hyatt, San Antonio, Texas
  - April 28 - May 2, 2013
UPCOMING WEBINARS

http://www.aiche.org/resources/webinars

Safety in LNG Value Chain
- Presented by Georges Melhem and Henry Ozog
- Wednesday, December 12, 2012, 2:00pm-3:00pm EST

Strategies for Addressing ABET Safety Curriculum Requirements
- Wednesday, February 6, 2013, 2:00pm-3:00pm EST
- Presented by Thomas Spicer and Kimberly Ogden

Leadership Is Everyone’s Responsibility
- Presented by Greg Shaffer
- Wednesday, February 20, 2013, 2:00pm-3:00pm EST
New in VLS
4th Thursday 9:00 pm EDT

- It's Time to Change How We Promote the Profession
  - Dr. John Anderson
  - Thursday, December 20, 2012 VLS

- Entering a New Golden Age of Chemical Engineering
  - Phil Westmoreland, 2013 AIChE President
  - Thursday, January 24, 2013

- Chocolate Processing is Delicious
  - Hershey ChEs
  - Thursday, February 28, 2013
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<td><strong>Neil Yeoman</strong></td>
<td><strong>Laura Gimpelson</strong></td>
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<td><strong>Yangzi “Isabel” Tian</strong></td>
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**Election Starts November 3**
VLS Recognized

- The VLS was named prominently in AIChE accomplishments in 2012 by AIChE president Dave Rosenthal and 2013 AIChE president Phil Westmoreland
- Thanks to all the VLS leaders and members who made this happen
VLS Members from Europe
Speaker Introduction

Dan Lambert, VLS Chair
Keynote Speaker
Dr. Mary Ann Curran

- Internationally-recognized expert in Life Cycle Assessment (LCA)
  - Worked for the US EPA’s National Research Laboratory
  - Her research turned to industrial pollution prevention
  - New environmental management approach, LCA

- After 32 years of federal service, entered private practice as an LCA consultant (BAMAC, Ltd)

- Education
  - BS ChE University of Cincinnati
  - MSc Lund University, Lund, Sweden
  - PhD Erasmus University

- AIChE Fellow
Disclaimer

Neither the American Institute of Chemical Engineers (AIChE), the presenters and author(s) of this work, their employer, nor their employers' officers and directors, warrant or represent, expressly or by implication, the correctness or accuracy of the content of the information presented. As between (1) the AIChE, the presenter and author(s) of this work, their employers, and their employers' officers and directors, and (2) the user/viewer of this work, the user/viewer accepts any legal liability or responsibility whatsoever for the consequence of its use or misuse.
SUSTAINABILITY THROUGH LIFE CYCLE MANAGEMENT: WHAT IS LIFE CYCLE ASSESSMENT?

Mary Ann Curran, PhD, FAIChE
Cincinnati, Ohio 45244
macurran@cinci.rr.com
STAGES

Raw Material Acquisition

Material Processing

Production

Use and Maintenance

End-of-Life Management

Product System Boundary

Air Emissions

Water Effluents

Solid Waste

Study Boundary
CHARACTERISTICS OF LIFE CYCLE ASSESSMENT

- Examines system-wide effects (cradle-to-grave)
- Analyzes multi-media (air, water, waste, etc.)
- Analyzes multi-attributes (all impacts)
- Helps identify *trade-offs* among alternatives
- Identifies opportunities for *improvement*
- Supports environmental decision making
- Provides the environmental pillar of Sustainability
ISO 14040 SERIES

Life cycle assessment framework

Goal and Scope Definition

Inventory Analysis

Impact Assessment

Interpretation
THE ISO LCA STANDARD

- Defines Life Cycle Assessment
- Gives the approach legitimacy
- Outlines the basic principles
- Does not provide step-by-step instructions on how to conduct an LCA
- “Flexible standard”
- Allows for a lot of interpretation
- Variability in the tool may not be obvious
THINGS TO CONSIDER WHEN EVALUATING AN LCA

1. Are the goal and functional unit clearly defined?
2. How are inputs & releases allocated among co-products?
3. Was credit given for “avoided burden?”
4. Was a Consequential LCA approach applied?
5. Are the inventory data accessible and transparent?
6. Is the uncertainty of the data provided?
7. Life Cycle Impact Assessment is not Risk Assessment
8. Report qualitative as well as quantitative information
9. LCA does not always (Usually) declare a “Winner”
10. LCA is an iterative process, increasing in detail
Goal Statement: Why is the study being done?

Evolution of the LCA Framework
Functional Unit is a unique feature of LCA

The *functional unit* is a quantified description of the service provided by the product system. It is shaped by the study goal to answer the question (concern) at hand. Especially important for comparative studies.

For example: Covering 20 m² of wall A with 98% opacity and 5 year durability.

A *reference flow* is a quantified amount of manufactured product necessary for a product system to deliver the performance described by the functional unit.

For example: 2.3 liters of paint A
Company Product Energy Usage from Life Cycle Perspective

Life Cycle Phase

Energy (GJ)

Product Type

Diaper
Bathroom Tissue
Laundry
Liquid Fabric Softener
Feminine Pad
Paper Towel
Liquid Dishwash
Shampoo

FROM “SUSTAINABLE INNOVATION PRODUCTS”
LEN SAUERS, PHD
VP, GLOBAL SUSTAINABILITY, PROCTER & GAMBLE
P&G initially focused on manufacturing (cradle to gate), and compared surfactants from “natural” palm oil to crude oil.

They found that a total substitution is not recommended:

- The wide range in consumer needs (wash conditions) would be more difficult to meet with oleochemical surfactants alone.
- Data from biodegradation, removal by sewage treatment, toxicity and other assessments support that petrochemical and oleochemical surfactants are of comparable environmental quality.
- Replacement of petrochemical by oleochemical surfactants would not lead to any significant reductions in water or air emissions

The results make it clear that neither surfactant can be supported as environmentally superior. Rather, there are trade-offs: lower environmental resource requirements are offset by higher emissions.

Broadening the boundaries to include a cradle-to-grave perspective revealed 80% of the overall energy consumption is associated with the use of the product by the consumer when heating the water and running the washing machine. According to their calculations, if every U.S. household used cold water for laundry, the energy savings would be 70 to 90 billion kilowatt hours per year, which is 3% of the nation’s total household energy consumption. These savings would translate into 34 million tons of carbon dioxide per year not released into the environment.

Tide Coldwater was introduced by P & G in 2005, and marketed to consumers as a way to reduce their energy bills.
2. How are inputs & releases allocated among co-products?

Allocation can be based on mass, energy, market value, etc.
**EXAMPLE ALLOCATION**

- **Materials**: 1300 kg
- **Industrial Process**
  - **Air Emissions**: 2 kg
  - **Co-Product A**: 850 kg (@ $2.00/kg)
    - Allocated air emissions: 1.33 kg or 1.86 kg
  - **Co-Product B**: 430 kg (@ $0.30/kg)
    - Allocated air emissions: 0.67 kg or 0.14 kg
  - **Effluents**: 8 kg
  - **Solid Waste**: 10 kg
**WHAT IF A WASTE IS A MARKETABLE PRODUCT?**

- **Inputs**
  - Corn stover → EtOH feedstock

- **Process**

- **Co-Products**

- **Effluents**

- **Waste**

- **Emissions**

- **Coal ash → roadbed material**
### WAS CREDIT GIVEN FOR “AVOIED BURDEN?”

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<tr>
<th>Output weight basis:</th>
<th>Ethanol Coproducts</th>
<th>Energy use without coproduct credit</th>
<th>Energy use with coproduct credit</th>
<th>NEV with coproducts</th>
<th>Energy ratio</th>
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<tr>
<td>Wet mill</td>
<td>48</td>
<td>79,503</td>
<td>39,987</td>
<td>44,974</td>
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<td>Dry mill</td>
<td>49</td>
<td>74,447</td>
<td>37,289</td>
<td>46,672</td>
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<tr>
<td>Weighted average</td>
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<td>77,228</td>
<td>37,895</td>
<td>46,066</td>
<td>2.22</td>
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4. WAS A CONSEQUENTIAL LCA APPROACH APPLIED?

- **Attributional LCA** - accounts for the inputs and outputs of a defined system, in a static material balance.
- **Consequential LCA** - predicts potential consequences of implementing actions within a system.

For example*, a 20% decrease in GhGs was calculated in an attributional analysis of US corn ethanol. A consequential analysis predicted a 47% increase in emissions due to land use changes from additional demand.

5. ARE THE INVENTORY DATA ACCESSIBLE AND TRANSPARENT?

Commonly used databases:

- EcoInvent database
  www.ecoinvent.org
- European Commission’s International Reference Life Cycle Data System (ILCD) Data Network
- US LCI database (through USDA)
  https://www.lcacommons.gov/nrel/search

Makes it easier to “plug and chug” without understanding how the data were modeled.
7. LIFE CYCLE IMPACT ASSESSMENT IS NOT RISK ASSESSMENT

Life Cycle Impact Assessment (LCIA) characterizes emissions over a product's life cycle; it reports emissions at an aggregated level and for a chosen functional unit basis.

Risk Assessment (RA) characterizes the nature and magnitude of health risks to humans and the environment from potential chemical contaminants and other stressors at the site-specific level.
The ISO developers defined:

- Analysis: Limited to quantified information
- Assessment: Includes qualitative information

This is why the term Life Cycle Assessment was chosen - the original intent was to allow for reporting both types of information.
EXAMPLE OF QUALITATIVE INFORMATION: POTENTIAL TOXICITY OF NANOCOMPONENTS

Environmental Interventions (Inventory)

- SOx
- NO2
- TCDD
- CO2
- HCFCs
- Noise Emission
- NMVOC
- Total P
- Total N
- Land use
- Copper
- Oil
- Waste

Midpoint Categories

- Human Toxicity
- Accidents
- Noise
- Oxidant creation
- Ozone Depletion
- Climate Change
- Acidification
- Nutrification
- Ecotoxicity
- Land Use and Habitat Losses
- Species and organism dispersal
- Natural Resources Consumption
- Waste

Endpoint Categories

- Cancer
- Respiratory Disease
- Acute Injury
- Skin Cancer
- Thermal Stress
- Infectious diseases
- Starvation
- Natural Disaster
- Forestry
- Crops
- Land Loss
- Fishery
- User Cost

Areas of Protection

- Human health
- Biotic & abiotic natural environment
- Biotic & abiotic man made environment
- Biotic & abiotic natural resources

Nano

Water use??
9. LCA DOES NOT ALWAYS (USUALLY) DECLARE A “WINNER”

The desire to come up with a single “score” can lead to a meaningless result...

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<tr>
<td>Founded</td>
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<td>Elevation</td>
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GAS IS "BETTER" IN 4 IMPACT CATEGORIES, "WORSE" IN 2
10. LCA IS AN ITERATIVE PROCESS, INCREASING IN DETAIL

Figure 1. Social LCA iterative process

Life cycle assessment framework

- Goal and Scope Definition
- Inventory Analysis
- Impact Assessment

Social LCA iterative process

Social Hotspots Assessment
Site-Specific Assessment
Combination of both assessment results

Catherine Benoit Norris 2012
AN EFFECTIVE LIFE CYCLE ASSESSMENT

- Examines *system-wide* effects (cradle-to-grave)
- Analyzes *multi-media* (air, water, waste, etc.)
- Analyzes *multi-attributes* (all impacts)
- Helps identify *trade-offs* among alternatives
- Identifies opportunities for *improvement*
- Supports environmental decision making
- Provides the cornerstone of Sustainability
LCA HAS BECOME A POPULAR TERM BUT IS OFTEN VIEWED USING TUNNEL VISION

http://foraneyes.blogspot.com/2011/05/tunnel-vision.html
SELECTIVE LIFE CYCLE MANAGEMENT

- Simplifies data needs
- Uses available expertise
- Addresses issues perceived as most important.

BUT IT MISSES THE VALUE OF LCA IN IDENTIFYING POTENTIAL TRADE-OFFS!
EPA’s Chemical Alternatives Assessment:

- Determine critical exposure points in the life cycle
  - Chemical, product, use, disposal
- In DfE CAAs, most focus has been on:
  - Use phase – exposure of consumer or occupational worker
  - Disposal phase
    - “Down the drain” - exposure to organisms in effluent receiving waters
    - “Direct release” - release to environment without sewage treatment
LIFE CYCLE: CHEMICAL RISK
LIFE CYCLE: CLIMATE CHANGE

Renewable Fuels Standard (RFS) calls for “LCA” of GHGs

EPA 2010
LIFE CYCLE GHG ANALYSIS

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- Waste

Areas of Protection
- Human health
- Biotic & abiotic natural environment
- Biotic & abiotic man made environment
- Biotic & abiotic natural resources
Reduce GHGs/fossil fuel use but impact water & soil quality in the agricultural stage.
LIFE CYCLE: MATERIAL MANAGEMENT

- End-of-Life (EOL) Management (recycling, landfill, incineration)
- Material Flow Assessment/Analysis (MFA)
LIFE CYCLE ASSESSMENT HANDBOOK: A Guide to Environmentally Sustainable Products

MARY ANN CURRAN, Editor

The first book of its kind, the LCA Handbook will become an invaluable resource for environmentally progressive manufacturers and suppliers, product and process designers, executives and managers, and government officials who want to learn about this essential component of environmental sustainability.

www.scrivenerpublishing.com/cart/title.php?id=154
Closing Comments

Dan Lambert, VLS Chair
Thank you Mary Ann!

- Thank you for speaking tonight
- As our way of saying thanks, we have shipped you a coffee cup
Thank everyone for attending

- Thank you!!
- VLS meeting next month
  - It's Time to Change How We Promote the Profession
    - Dr. John Anderson
    - Thursday, December 20, 2012 VLS