HP's Search for Green Replacements for Restricted Substances in Electronics

Helen Holder
Corporate Material Selection Manager
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ROHS

The Law That Changed Everything

EU Directive 2002/95/EC on the Restriction of the Use of certain Hazardous Substances in Electrical and Electronic Equipment

Logo from companion regulation Waste Electrical and Electronic Equipment (WEEE) Directive

Companies Implement RoHS Restrictions

Material selection:

- Cost
- Function
- Reliability
- Manufacturability

All unregulated substitutes equally acceptable

1 July 2006

More Regulations Coming

Substance restrictions have become a major class of regulation for finished electronic products

- More substances
- More jurisdictions
- More reporting

Choosing Better Materials

Replacing materials is expensive

- Select alternatives that won't be restricted
- White lists

Want to avoid unintended consequences

- MTBE

Methods and Tools for Identifying Safer Chemicals

What's green?

Many tools

Lots of information

Some Tools and Methods

- Restricted substance list (RSL) screening, esp JIG list for electronics
- LCA
- Risk assessment
- Green Screen/DfE AA
- TURI P2OaSYS
- EPA hazard portion of TRACI
- Dutch QuickScan
- MSDS screening
- R-phrase screening
- Column
- Review of complete dossiers or summary data for each potential chemical
- EPA EPISuite, Oncologic, PBT profiler, etc.
- OSPAR CHARM
- German Evaluation Matrix
- Proprietary
  - SciVera lens
  - MBDC
  - SC Johnson GreenList
  - Johnson&Johnson Product Scorecard

Life Cycle Analysis (LCA)

- Comprehensive “cradle-to-grave”
- Resource and time intensive, especially to get all data
- Availability of data determines the accuracy of the final results
- Works for simple alternatives assessments (plastic vs metal chassis)

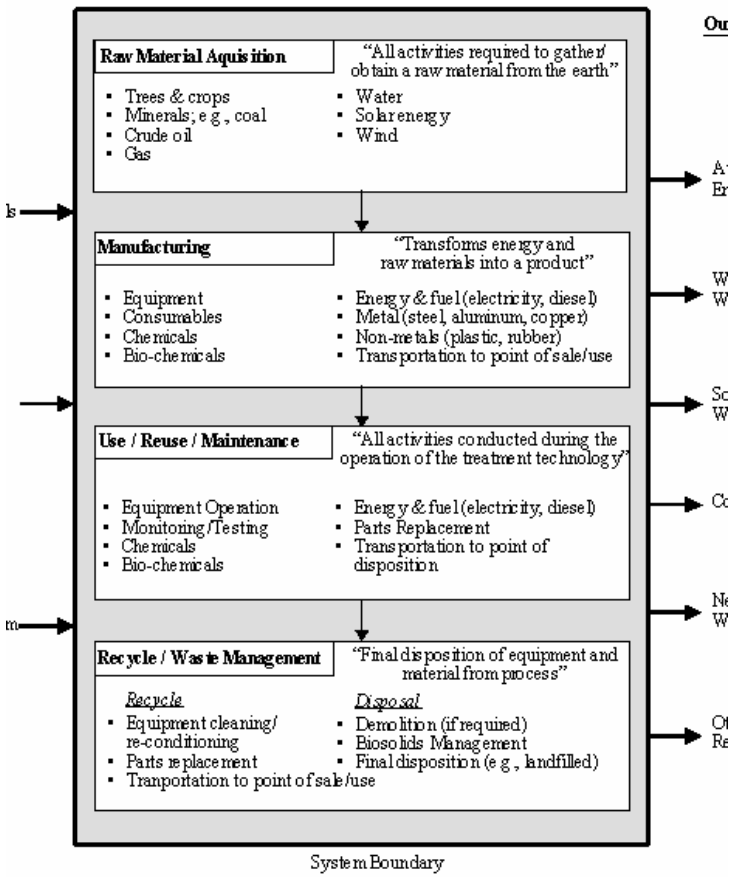


Exhibit 2-1. Sample Life Cycle Stages for a Treatment Project

Not the Right Tool for Assessing Replacements for Restricted Substances in Electronics

- Hundreds of compounds across thousands of components in electronics products = very complex, impractical for many decisions
- For complex systems, existing tools and inventories are not precise enough
  - Similar materials not well differentiated (e.g. beryllium copper vs phosphor bronze)
  - Expected to improve over time
- Not acceptable to introduce high chemical hazard for other life cycle benefits

Risk Assessment

Objective

Evaluation of the risk to human health and the environment by the actual or potential presence of pollutants

Features

- Structured, well-defined, established
- Much more detailed consideration of a particular substance than LCA
- Considers:
  - Source of the chemical
  - Fate and transport mechanisms
  - Exposure scenarios
  - Dose and thresholds

Good and Important Tool

- Needed for development and implementation of effective environmental regulations
  - Hazard assessment is necessary, but not sufficient, for regulatory decisions
  - Volume, exposure potential, etc. are important factors
- Critical for formulators
  - Industrial EH&S more challenging for raw chemicals than finished materials and products

Is it the right tool for comparing alternatives to restricted substances in electronics?

Example: Arsenic

Acute inhalation exposure of workers to high levels of arsenic dusts or fumes has resulted in gastrointestinal effects (nausea, diarrhea, abdominal pain), while acute exposure of workers to inorganic arsenic has also resulted in central and peripheral nervous system disorders. (1) Acute oral exposure to inorganic arsenic, at doses of approximately 600 micrograms per kilogram body weight per day (µg/kg/d) or higher in humans, has resulted in death. Oral exposure to lower levels of inorganic arsenic has resulted in effects on the gastrointestinal tract …

Overwhelming to most decision-makers

- Most decision-makers are procurement engineers
- Overwhelmed by information out of their field
- Can't effectively incorporate into existing procurement processes

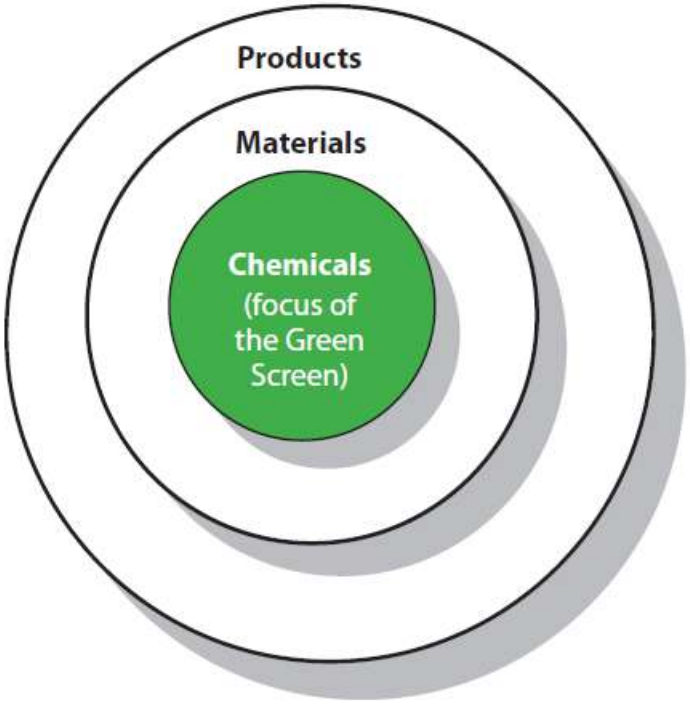
Not comparative

- Not in a useful format for comparative decisions
- Chemists consider function (solvent, surfactant, plasticizers, etc.) when designing formulations
- Alternatives must be shown in relation to other

Need Info in an Accessible, Comparative Form

Make a simplification

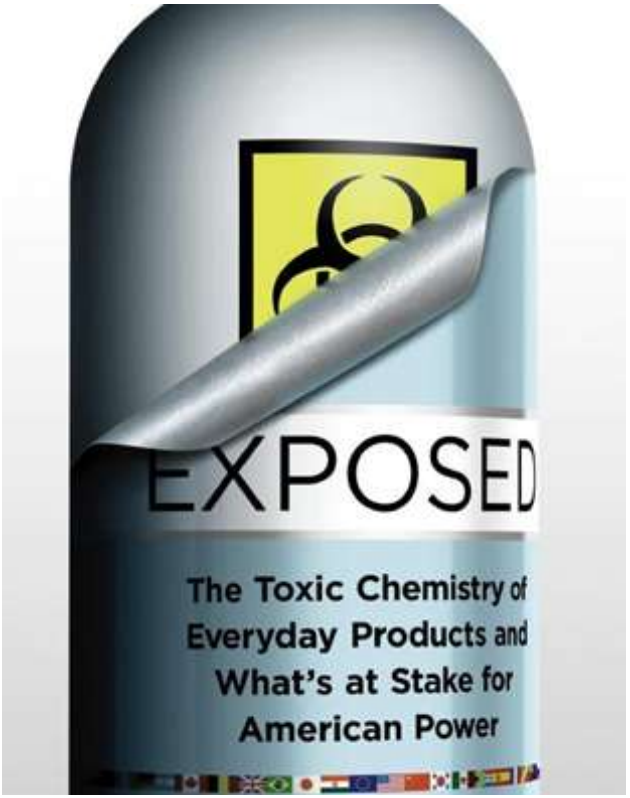
- Exposure reduction is not an option for most end users of materials (out of HP's control)
- Exposure potentials are roughly equal for the same application
- Therefore: hazard assessment becomes an effective proxy for risk for the same application



Source: M. Rossi, J. Tickner, K. Geiser 2006, *Alternatives Assessment Framework*, Lowell Center for Sustainable Production

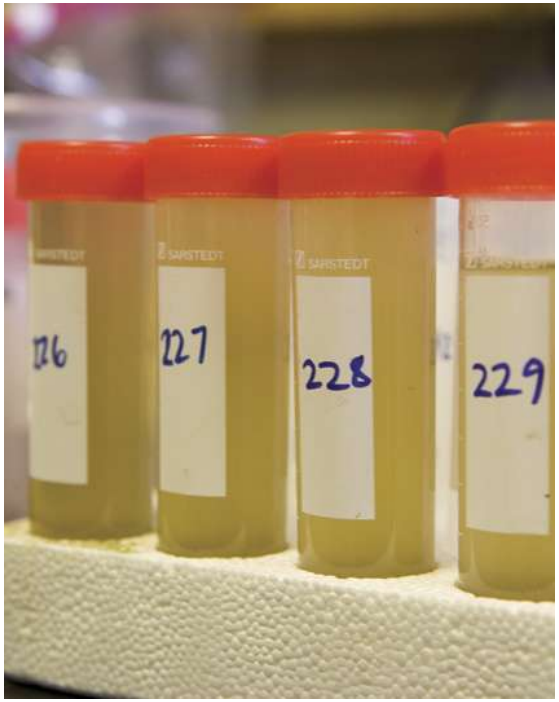
Shift to Hazard Reduction

- Reducing risk through hazard reduction is more effective and efficient than exposure reduction
- Better to use inherently safer chemicals rather than trying to make a hazardous substance "safe enough" by limiting exposure



To read more about the EU shift from risk to hazard, check out Mark Schapiro's book *Exposed*

Comparative Chemical Hazard Assessment



- Hazard assessments are faster, easier to complete than complete LCA or Risk
  - Narrower, endpoints are relatively well defined
  - Science-based, facilitates relatively quick chemical assessments
  - Can screen out hazardous options before investing time and money

- Regulatory bodies are increasingly using hazard as a screen for substances of concern, so useful an indicator of future restriction
  - Aligns business process with regulatory process

Green Screen for Safer Chemicals

- Comparative chemical hazard assessment
  - Developed by Clean Production Action
- Rates 17 hazard topics (High, Medium, Low)
  - Considers both environment and human health
  - Addresses constituents and breakdown products
- Decision logic looks at particular combinations of scores for a final four-point benchmark score
  - Uses the most conservative scoring guidelines of previous systems
  - Data driven, meaningful thresholds
- Compatible with risk assessment and other tools

More information available at http://www.cleanproduction.org

Green Screen for Assessing Replacements for Restricted Substances in Electronics

- Green Screen is the primary tool HP uses for alternatives assessment when replacing a restricted substance
- Enables identification of better materials, not just minimum acceptable
- Green Screen results are only part of decision, but initial hazard screening eliminates certain options early in assessment process
- HP continues to use Risk Assessment, LCA, and Carbon Footprint tools to complement

Green Screen Meets Business Needs

Helps us to select alternatives that won't be restricted in the future

Helps us articulate materials goals to suppliers and chemical formulators

Green Screen Assessments of Similar Function Chemical

Common Name	CAS #	Full Name	Benchmark
Preferred			
Design	none	Design material out, dematerialize	4
Substance 0	#####-##-#	Chemical name	4
Use but still opportunity for improvement			
Substance 1	#####-##-#	Chemical name	3
Substance 2	#####-##-#	Chemical name	3
Use but search for alternatives			
Substance 3	#####-##-#	Chemical name	2
Substance 4	#####-##-#	Chemical name	2
Substance 5	#####-##-#	Chemical name	2
Substance 6	#####-##-#	Chemical name	2
DO NOT USE			
Substance 7	#####-##-#	Chemical name	1
Substance 8	#####-##-#	Chemical name	1
Substance 9	#####-##-#	Chemical name	1
Substance 10	#####-##-#	Chemical name	1
Substance 11	#####-##-#	Chemical name	1
Substance 12	#####-##-#	Chemical name	1

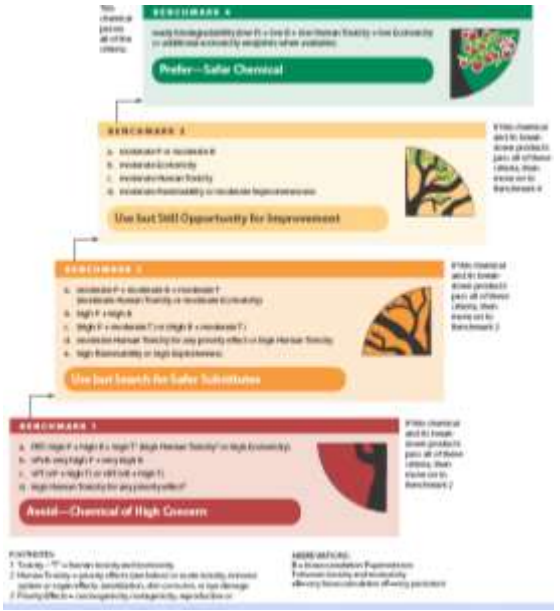
Pilot Programs

Green Screen 1.0 Early Trials

- Started with small program
  - Internal screening of 40 BFR and phthalate alternatives
- Green Screen most useful for organics, polymer additives by function (plasticizers, etc.)
- Less useful for inorganic
- Data gaps problematic

- **Successfully differentiated alternatives**

- **Simple integer score made results easy to use**

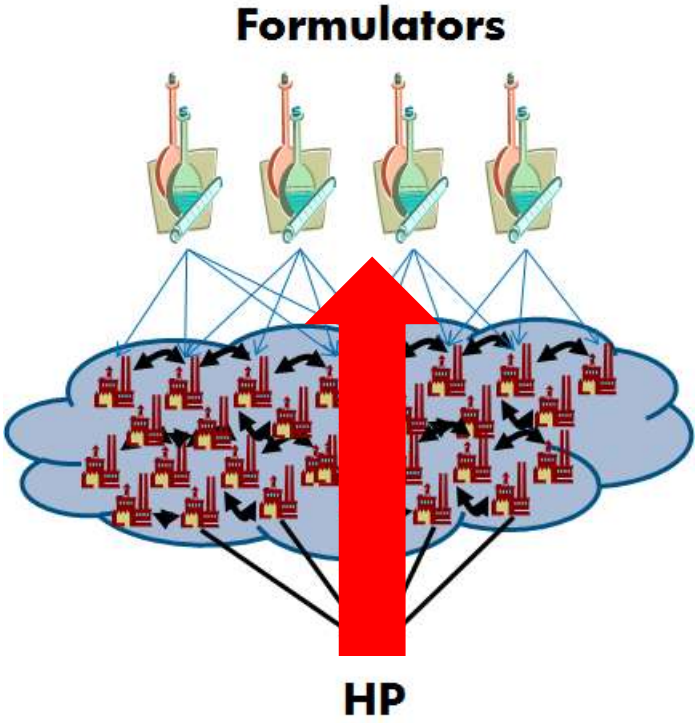


Pilot Program

Started as a small program to learn what works

Engaged directly with formulators

- Skipped complex parts of supply chain



PVC-Free Power Cord Green Screen Pilot

- Screening mandatory, in addition to all standard and regulatory requirements
- Full disclosure under CDA
- Over 29 materials screened
  - Several approved
- Material specification and approved material list being drafted

Lessons Learned & Next Steps

Lessons Learned

- Need to drive chemistry
  - Not as many alternatives as we want
- Use existing business processes for material selection
  - Articulate requirements and drive through procurement
- Public, multi-stakeholder AAs produce better results
- Core business case is in avoiding future regulation

Next Steps

- Bring Green Screen requirements to other types of materials
- Influence formulator culture to design better materials from start
- Promote Green Screen in electronics industry
- Third party repository for results
- Better harmonize comparative hazard with LCA and other tools

Questions