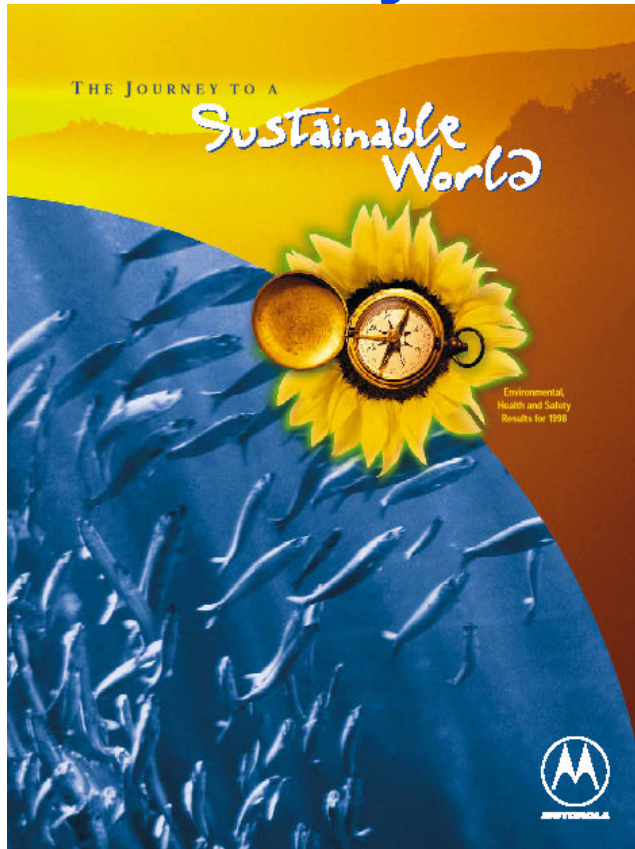


Journey to a Sustainable World



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Schaumburg, IL

R.C.Pfahl
December 15, 2001
Slide 1

Outline

- **Environmental Drivers**
- **Environmentally Preferred Product Attributes**
- **Motorola's Pb Replacement R&D**
- **Motorola's Design Tools**
 - **The Green Design Advisor**
 - **Life Cycle Assessment**
- **Case Study**
- **Conclusions**

Environmental Drivers for Industry

- **Societal Concerns**
 - Sustainability
 - Global Warming
 - Pollution
 - Energy
- **Societal Responses**
 - Public Policy

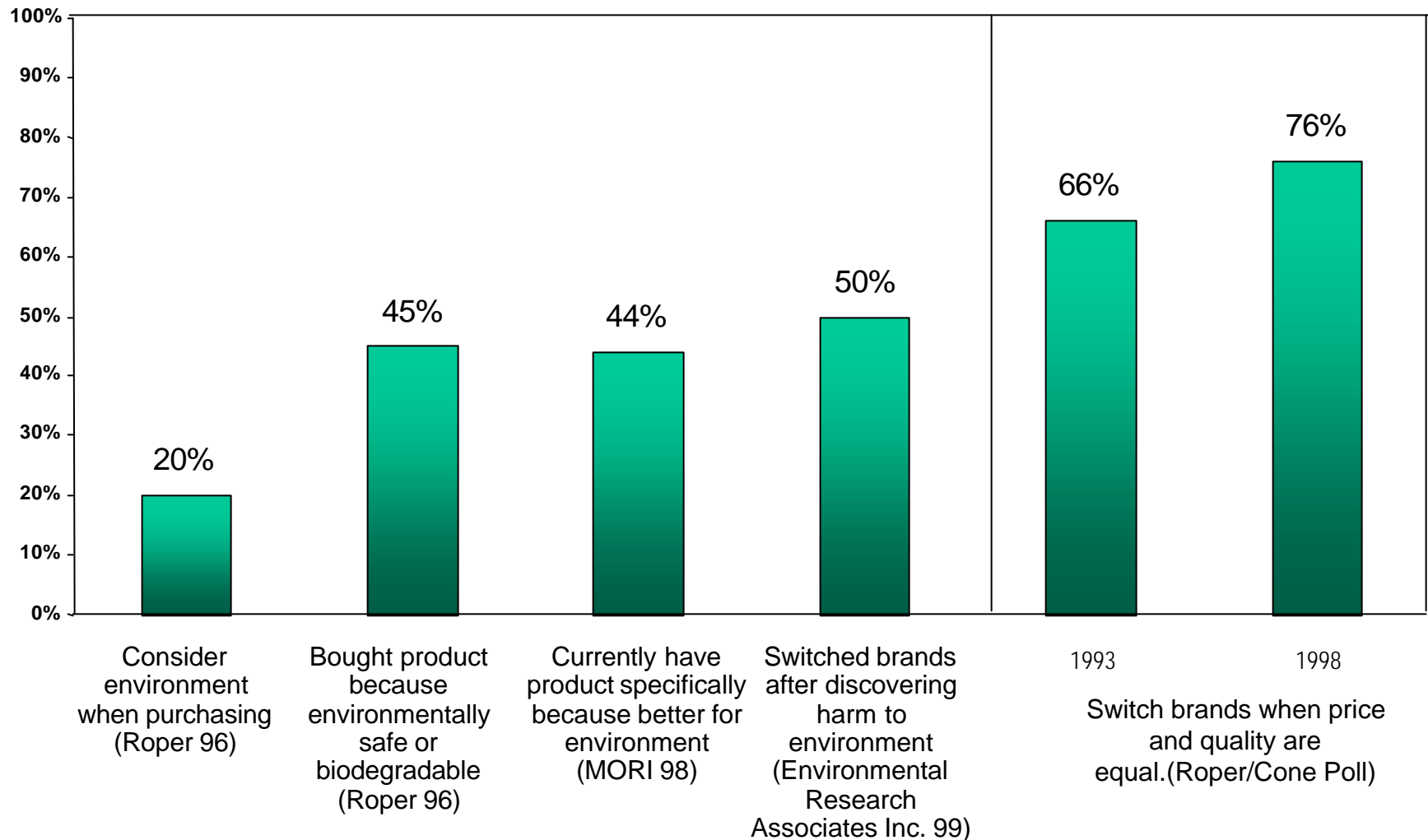
Examples of Public Policy

- **Geneva, Rio, and Kyoto Conventions**
- **United States Clean Air Act**
- **Japanese Home Electronics Recycling Law**
- **Proposed European Waste Electrical and Electronic Equipment (WEEE) Directive**
- **Revision of U.S. Toxic Release Inventory (report 100 lbs of Pb)**
- **Proposed New England Hg Take-back legislation**

Environmental Drivers

- **Societal Concerns**
 - Sustainability
 - Global Warming
 - Pollution
- **Societal Responses**
 - Public Policy
 - Consumer Action

Consumer Behavior and the Environment



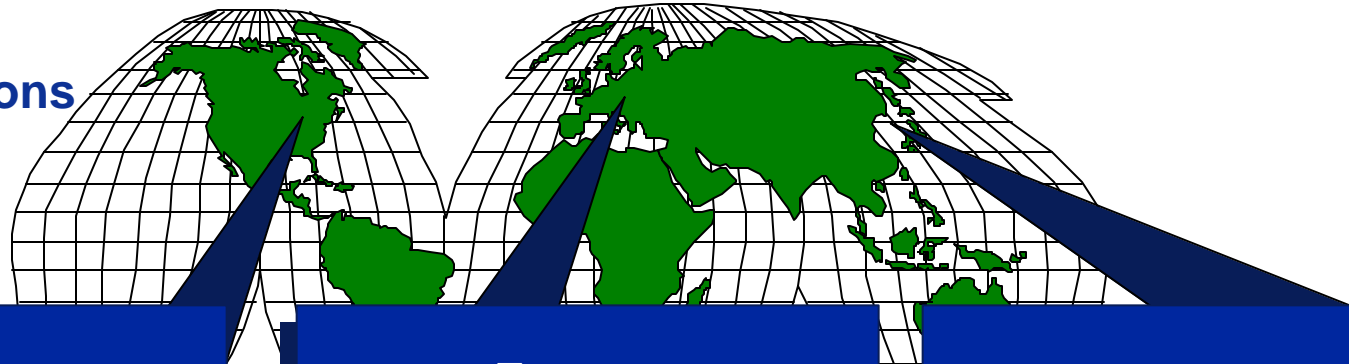
Environmental Performance Drivers

- **Societal Concerns**
 - Sustainability
 - Global Warming
 - Pollution
- **Societal Responses**
 - Public Policy
 - Consumer Action
- **Regional Differences**

Regional Differences

Regional Drivers

Global Solutions



United States

- Regulation Driven
- Factory Focus
- R&D: Manufacturing Focused
 - CFC Elimination
 - VOC Reduction

Europe

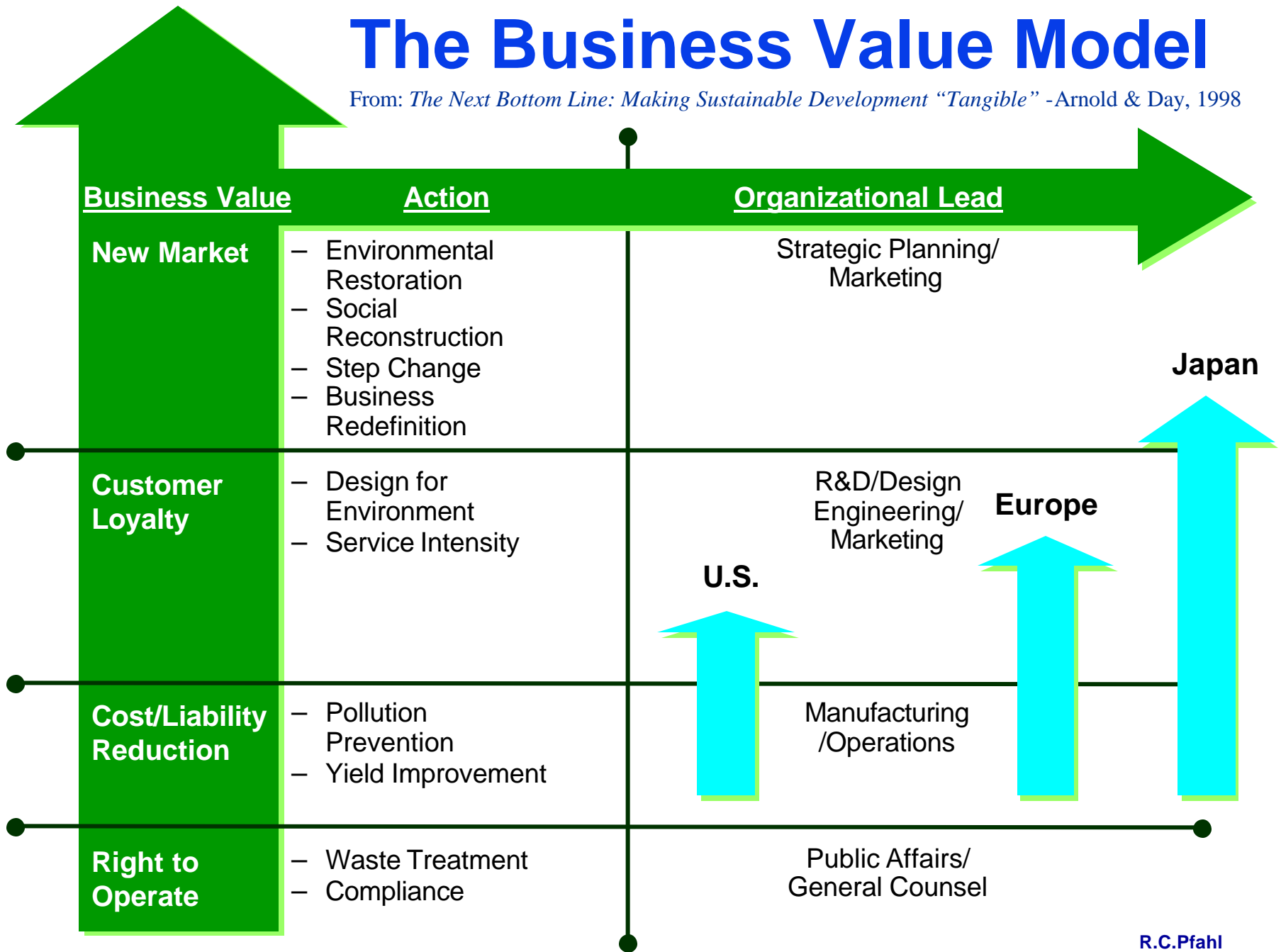
- Customer & Regulation Driven
- Academic Focus
- R&D: Model Focused
 - Life Cycle Analysis
 - Material Flow Analysis

Japan

- Government/Industry Driven
- Market Focus
- R&D: Product Focused
 - Hybrid Engines
 - Halogen Free Plastics
 - Pb-Free Products

The Business Value Model

From: *The Next Bottom Line: Making Sustainable Development "Tangible"* -Arnold & Day, 1998



Environmentally Preferred Product Attributes

- Use Non-Hazardous Materials
- Minimize Use of Energy
- Are Highly Recyclable
- Minimize Use of Matter



1983
First Portable
Cellular Phone
DynaTAC



1996
First Wearable
Cellular Phone
StarTAC®

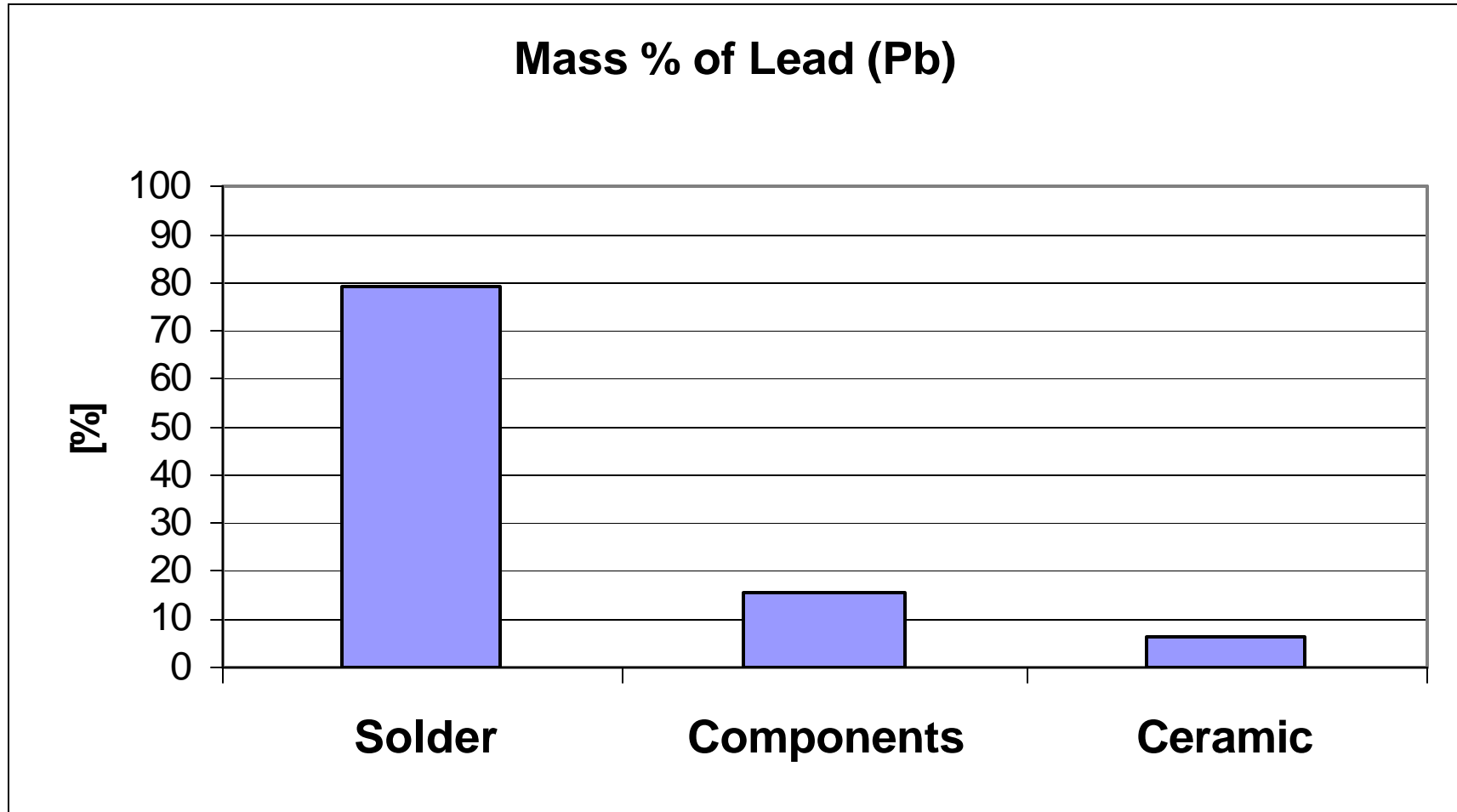


1999

Summary of Drivers by Attribute:

Attributes Measured by Motorola	Consumer	Government Regulation	Business To Business
Improve Recyclability		Japan	●
Increase Recycled Contents	●		●
Minimize Packaging		EU	●
Label Plastics/Metals			●
Reduce Hazardous Materials	◐ →	◐	●
Reduce Energy	●	●	●

Motorola's Pb Replacement R&D: Distribution of Pb in Motorola Products



Motorola's Pb Replacement R&D

- No Pb-free drop-in replacement for Pb-bearing solders for all applications
- There are optimal Pb-free alloys for given applications
 - Sn-0.7Cu for Wave Soldering and for Flip Chip
 - Sn-3.9Ag-0.6Cu for Surface Mount Reflow Soldering
 - Sn-Sb for Die Attach
 - Variety of alloys (Ni-Au, Ni-Pd, Sn, organic preservatives, Sn-Bi) for Surface Finish

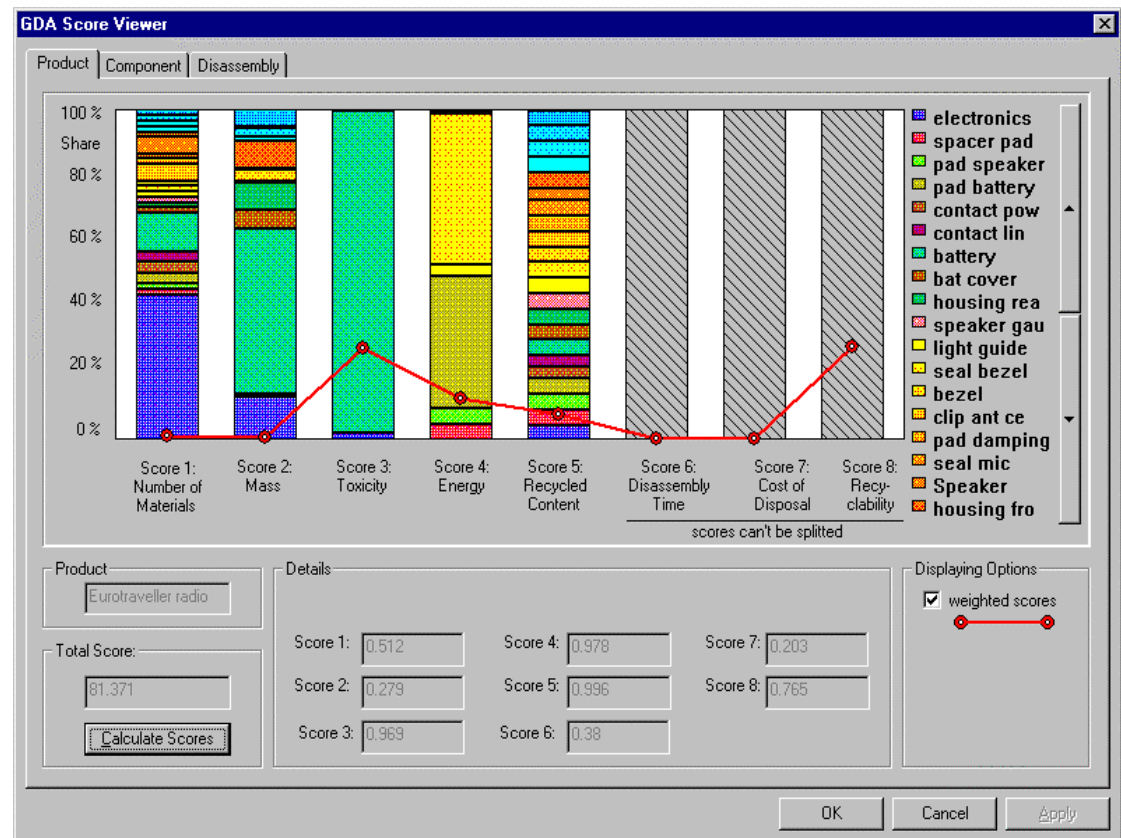
Motorola's Environmental Design Tools

- **DfE – The Green Design Advisor**
- **LCA Studies**
 - **With Customers and Suppliers**
 - Creates Understanding, cooperation, and profit between Businesses
 - **LCA of Services**
 - Could create alternative environmentally positive solutions

Motorola's DfE Tool: The Green Design Advisor (GDA)

Output from Green Design Advisor Analysis: Measurement of Eight Environmental Criteria

- Number of Materials
- Mass
- Toxicity
- Energy
- Recycled Content
- Disassembly Time
- Cost of Disposal
- Recyclability



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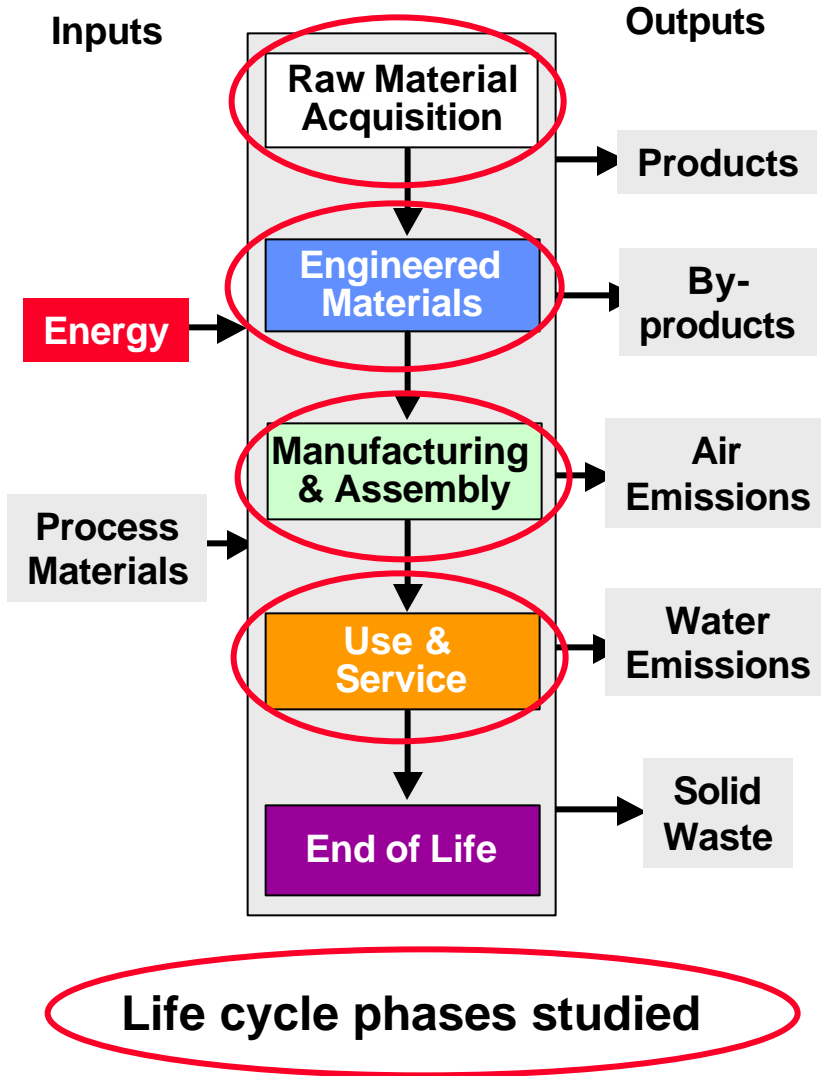
Motorola's Environmental Design Tools

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Joint Motorola - Service Provider LCA Project

Life Cycle of a Product

Focus of the Study



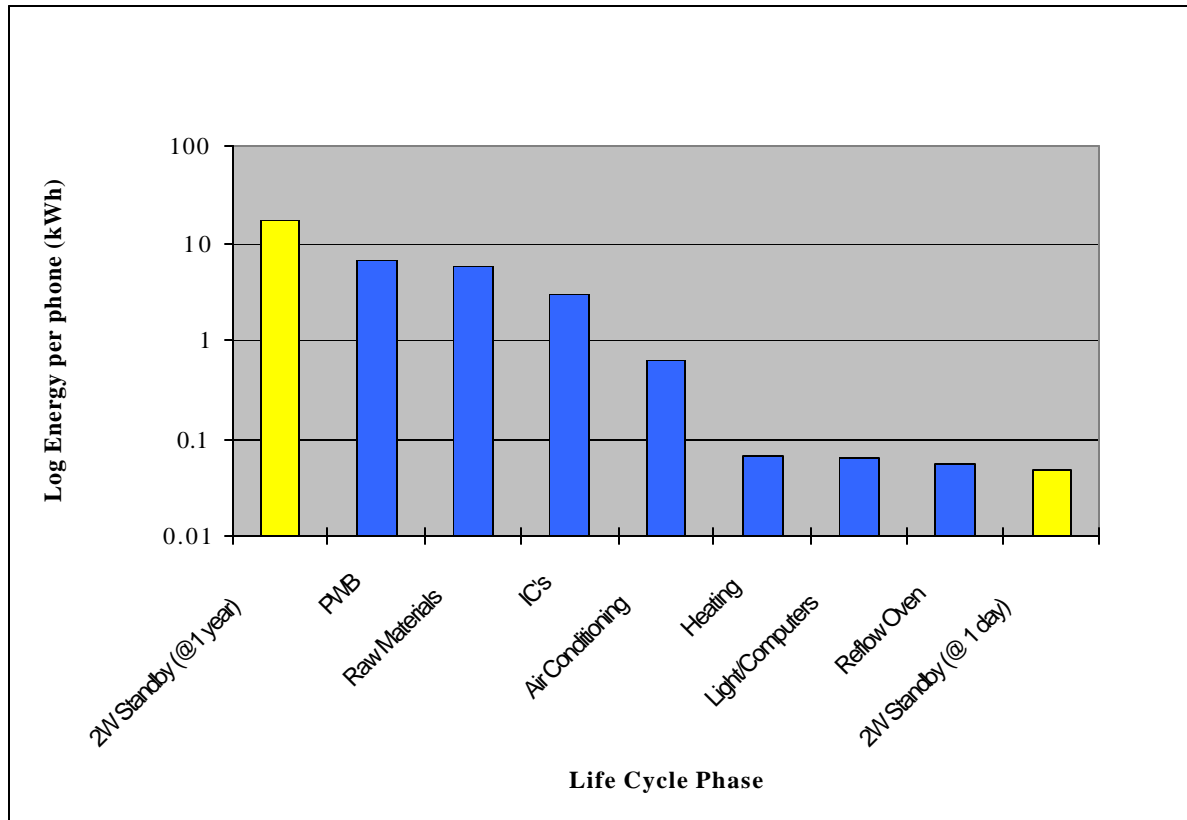
Hazardous Materials:

- Material's inherent toxicity
- Determined by the Motorola Toxicity Index

Energy Use:

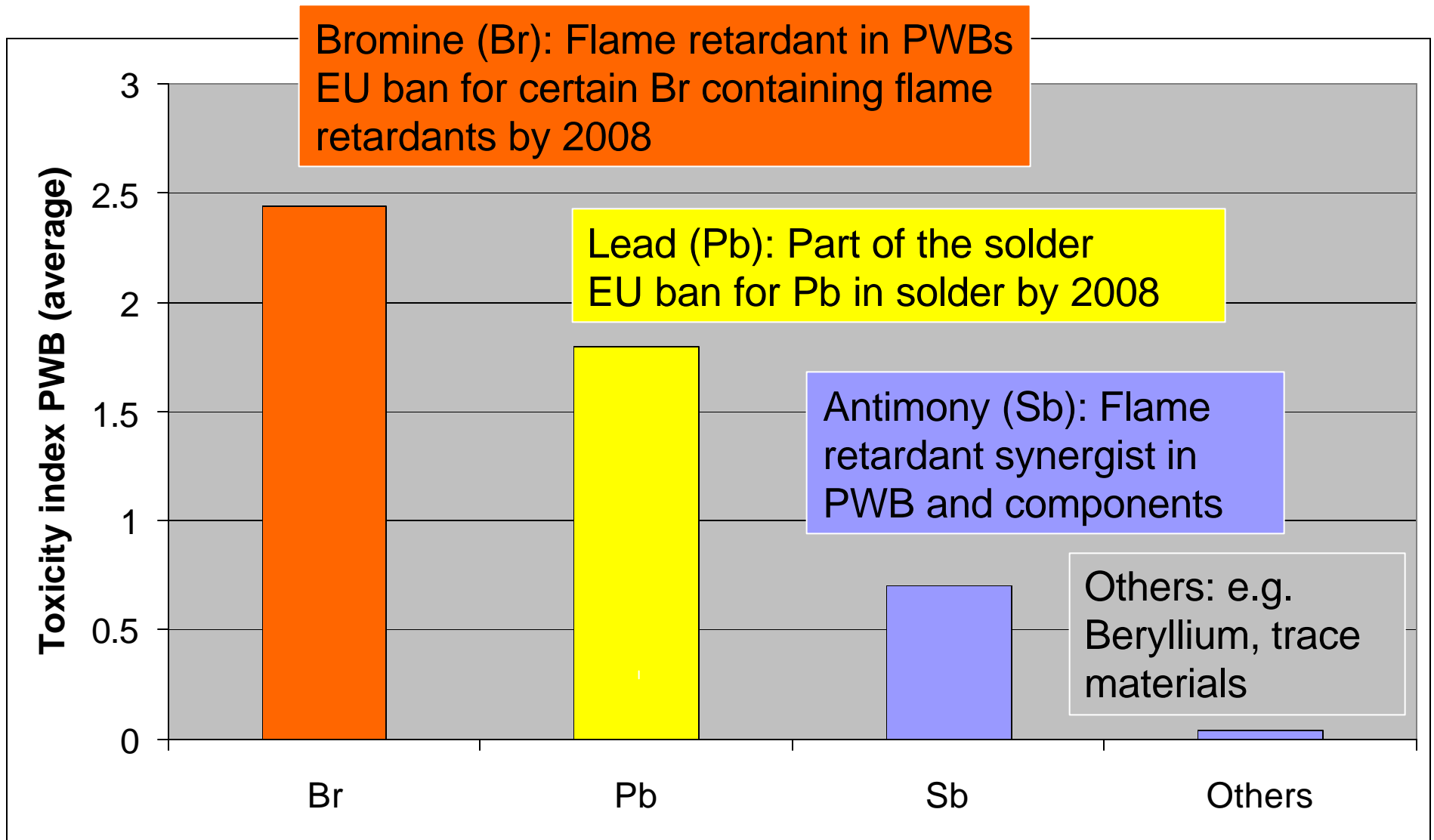
- Energy used for materials
- Energy used for manufacturing of components and product
- Energy used during use phase (charging, standby charger)

Life Cycle Assessment Result: Energy



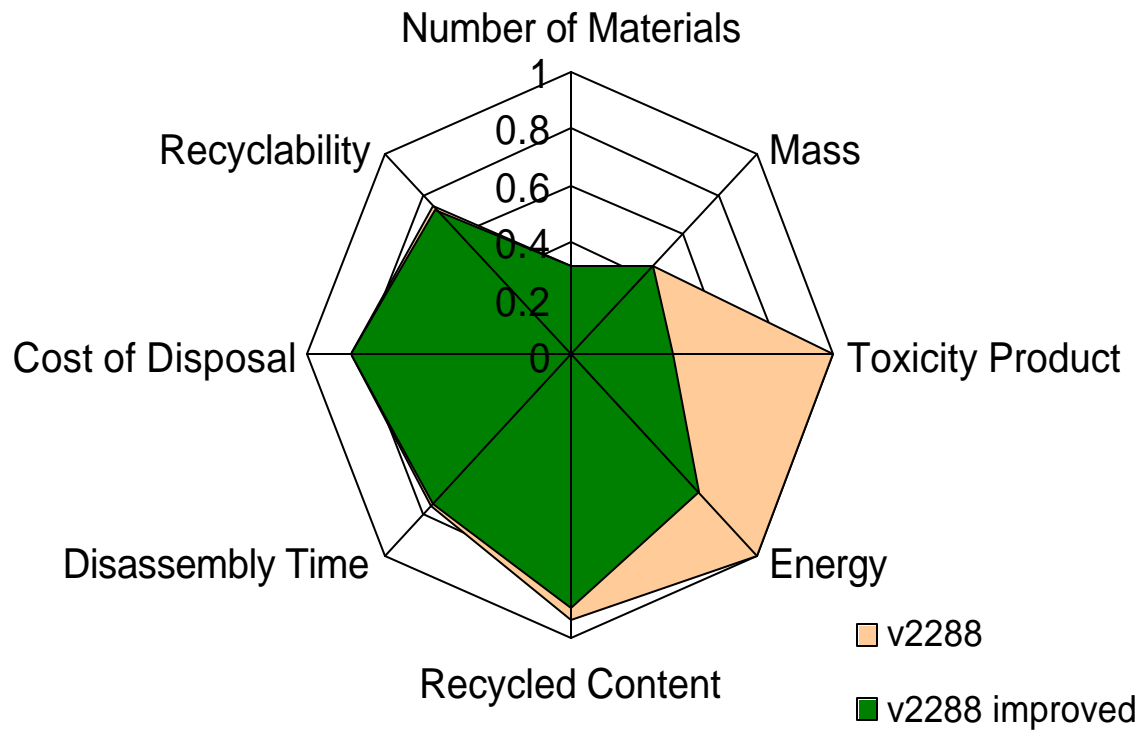
- High energy use for raw materials
- High energy use for purchased components
- Use phase dominates due to:
 - Standby of the charger
 - Losses of the charger

Life Cycle Assessment Result: Material Toxicity (PWB)

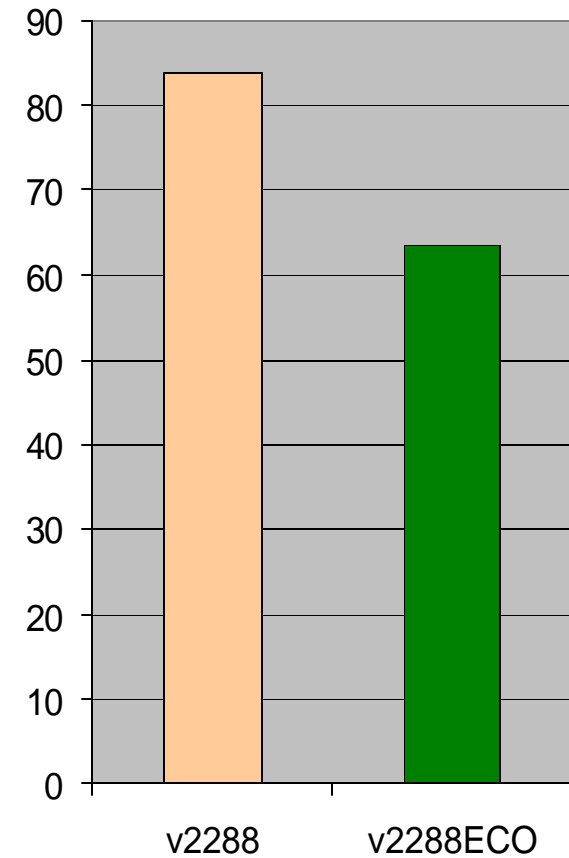


Case Study of the v.2288: Analyzed by the Green Design Advisor

Normalized Scores

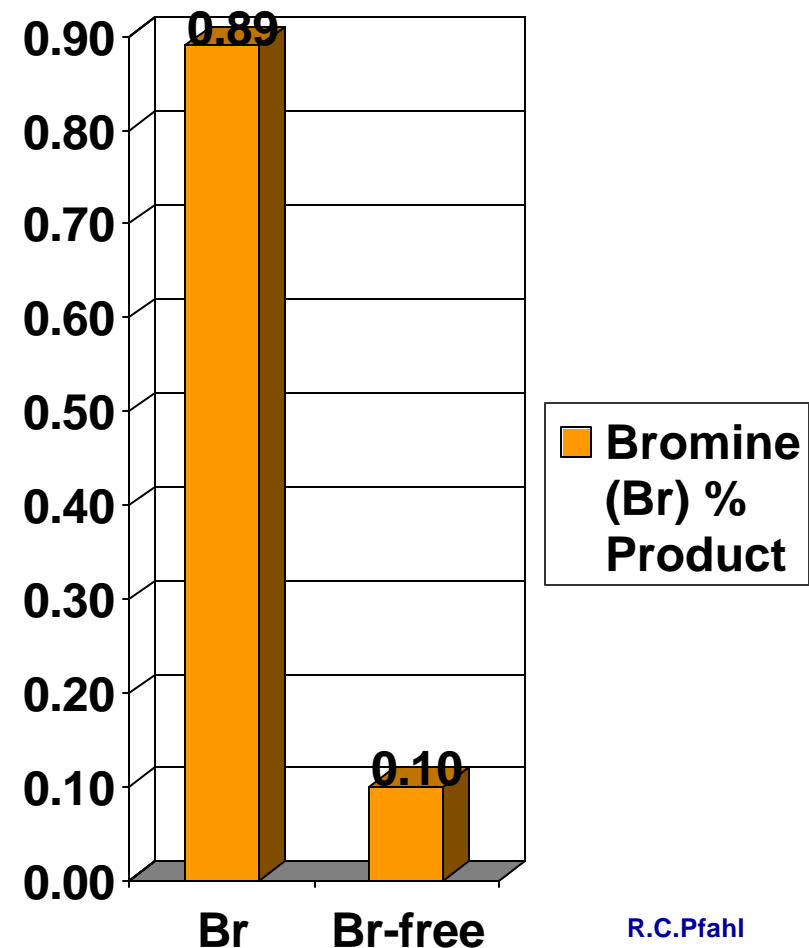


Total Score



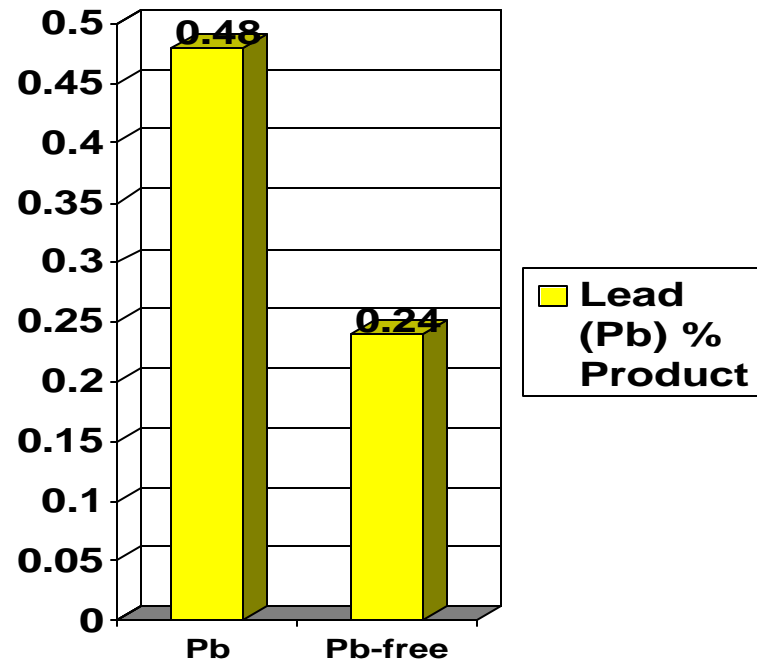
Bromine (Br) Reduction v.2288

- A Bromine (Br) and Antimony (Sb) free PWB was used
- ↓ The Bromine content of the Entire Product was reduced 89%
- ↓ The board to board reduction of Bromine (Br) for the populated PWB was 89%



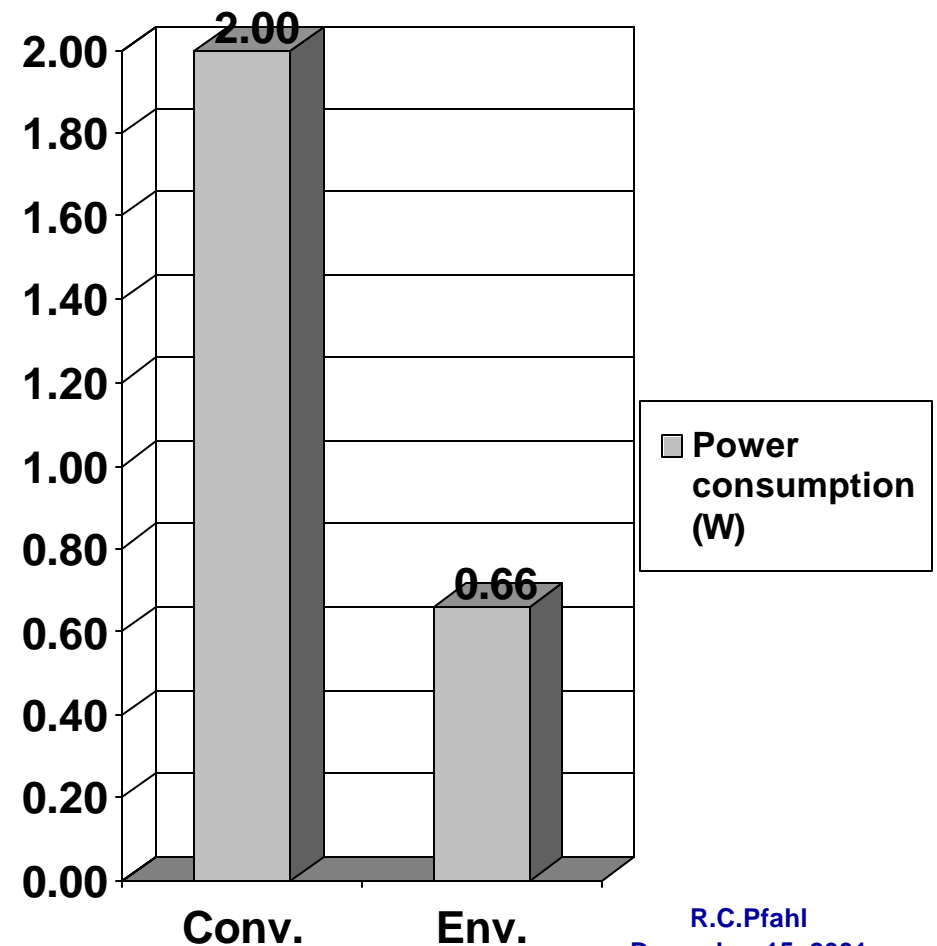
Lead (Pb) Reduction v.2288

- Lead-Free solder was used on the PWB
- No attempt was made to obtain lead free components
- ↓ The Lead content of the Entire Product was reduced 51%
- ↓ The board to board reduction of lead for the populated PWB was 52%

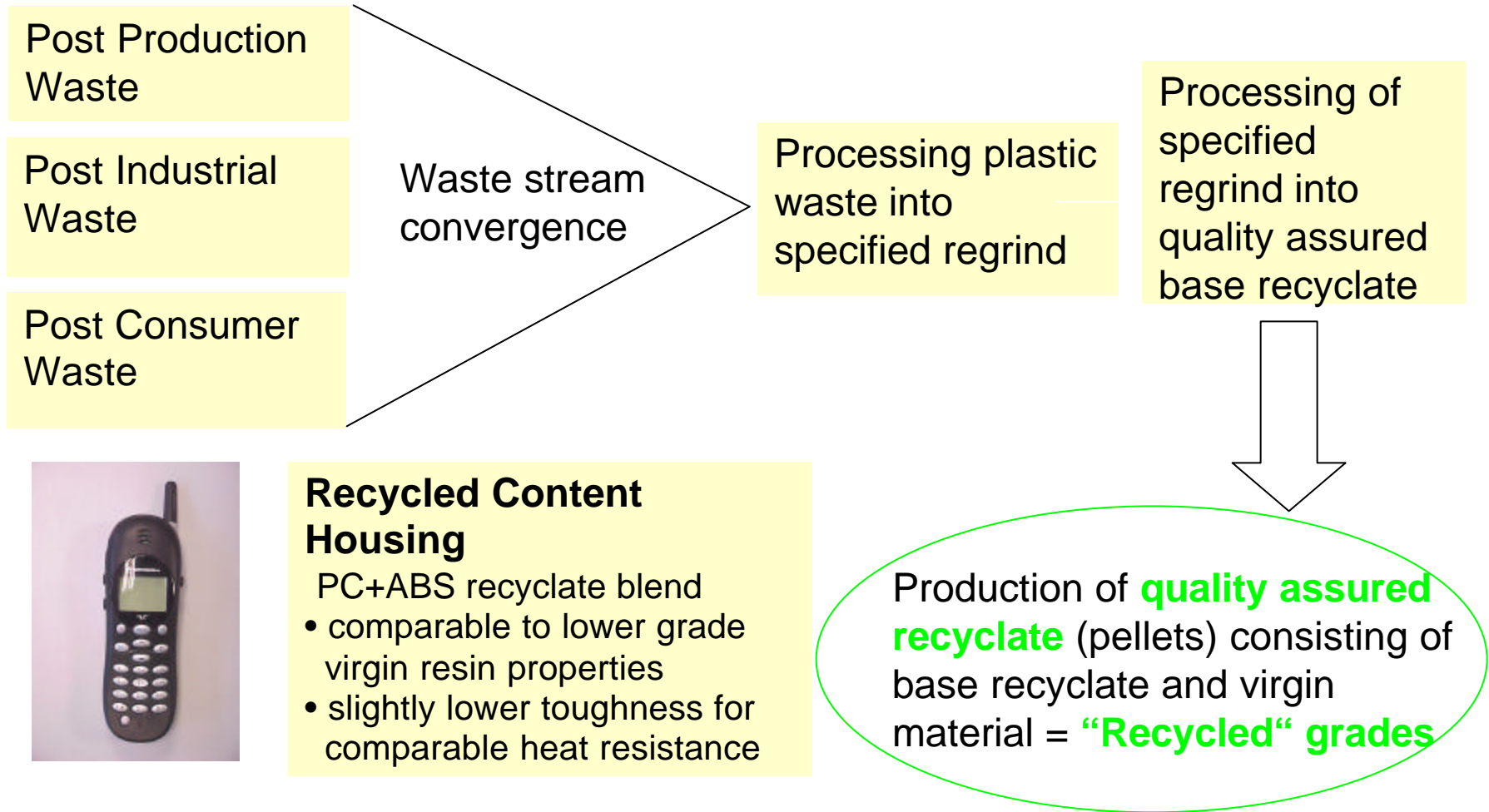


Energy Efficient Charger v.2288

- New energy efficient charger reduces no-load energy loss (stand-by)
- Charger meets EU voluntary agreement of 2002
- ↓ The no-load energy loss was reduced from 2 W to 0.66 W => 66%reduction



Environmentally Improved Mobile Phone Prototype: Recycled Plastic Housing



Design Sense Awards 2001

- Sponsored by the Design Museum, London England
- Over 80 submissions for the Award
- Motorola Labs submitted the v.2288 Environmental Limited Edition: **lead-free solder, bromine-free wiring board, housing of recycled plastic, energy-efficient charger**
- Motorola v.2288 one of 12 finalist
- Only finalist with an electronic product
- Judges critique
'A big company has taken a sustainable initiative - I hope to see this experiment lead to mainstream products in the near future. It would be wonderful if this phone could represent a turning point in the sustainable design of mass-produced products such as mobile phones.'



Motorola iDEN® i85s

General Features Digital Cellular Phone Service

- Speakerphone
- Java™ 2 Micro Edition Capable
- Voice Activation
- Multi-Language Support
- SIM Card Operation
- Voice Recorder
- Voice Activated Dialing
- VibraCall® Alert

Digital Two-Way Radio / Message Service

- One-touch Private & Group Call
- Built-in Speaker
- Voice & Message Mail Indicators

Data Capable

- Software Download Capability
- Internet Access Services
- T9 Text Input for fast entry



Performance Specifications

- Dimensions: 131mm x 50mm x 30mm with High Performance Battery
- Weight: 132g with Slim Battery
- Power: 600mW (typical)
- Frequency Range: Tx 806 - 825 Mhz/Rx 851-870 Mhz
- Channel Spacing: 25 kHz
- Channel Access: TDMA

- **Halogen Reduced, Bromine Free, Interconnect Technology.**

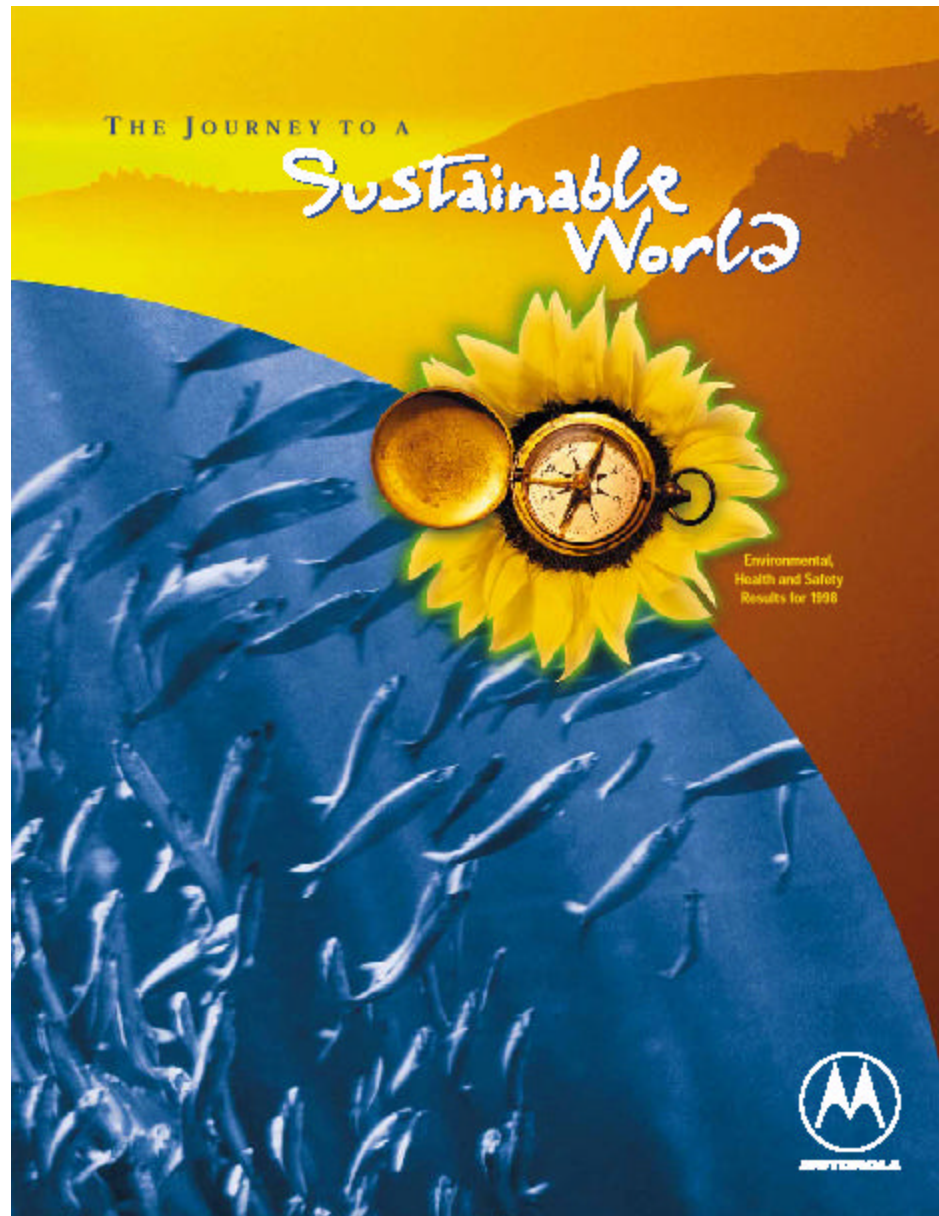
- **Lead Free Solder Assembly Technology.**

Summary

- **Summarized Environmental Drivers and Attributes of Environmentally Preferred Products**
- **Described current proactive activities at Motorola**

Conclusion

“The Journey to a Sustainable World ” has just begun



<http://www.mot.com/EHS/>

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December 15, 2001
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