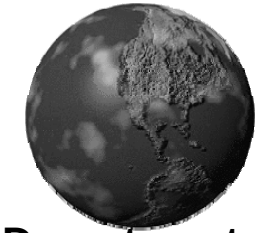
Industry Case Studies
Textiles
Computers

San Jose State University

Environmental Studies 152

San José State
UNIVERSITY

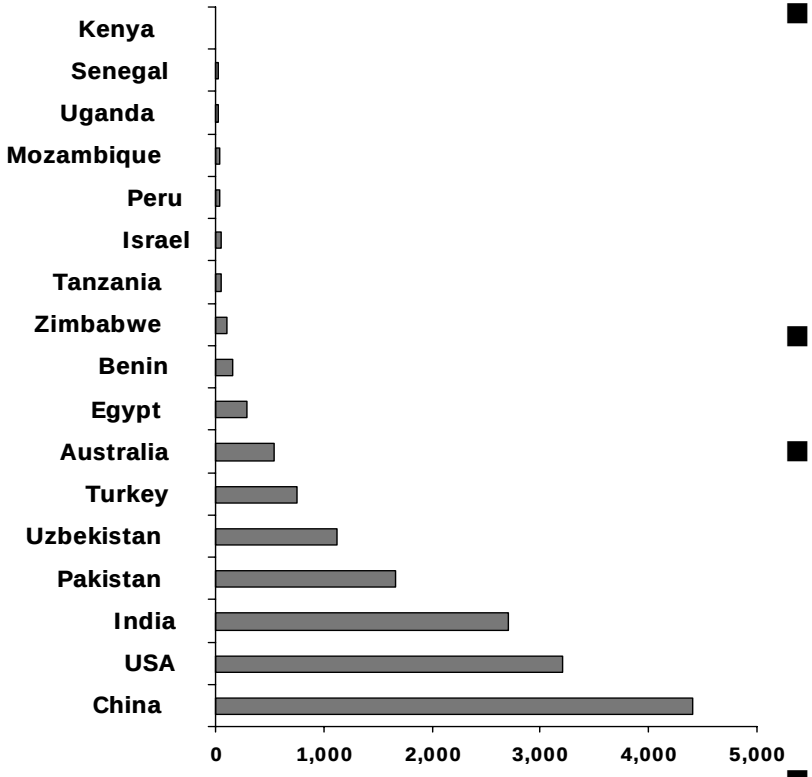


Department of
Environmental Studies

Agenda

- Textiles & Clothing
  - Fibers
  - Dyeing & Finishing
  - Clothing Design & Manufacturing
  - Product Maintenance
  - Waste Recycling
- Electronic & Electrical
  - Selection of materials
  - Energy & water efficiency
  - Design for Environment

Fibers: Natural – Cotton



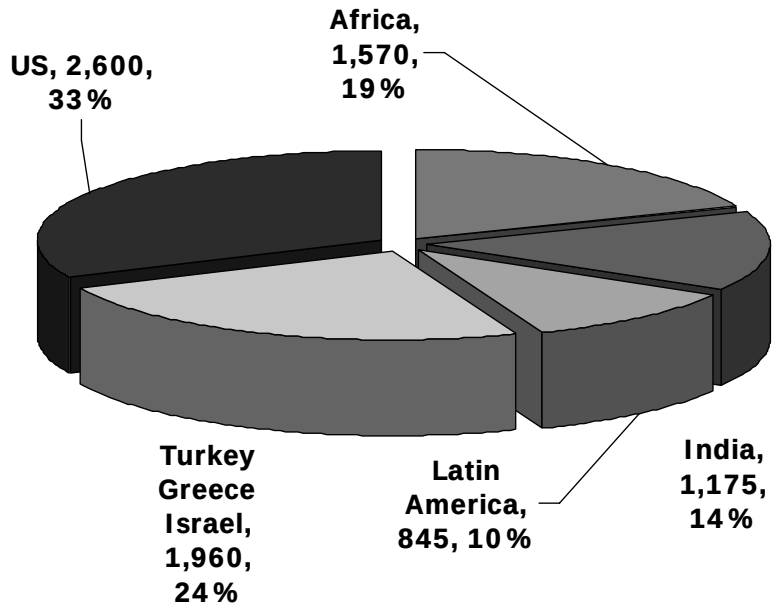
- 50% of global fiber production
  - History
    - 2,000 years of history (India, Nile Valley, Peru)
    - 1800's spurred the Industrial Revolution
      - Eli Whitney's Cotton Gin
  - 25% of the insecticide use in the world, 10% of the pesticides
  - United States:
    - 84M lbs of insecticides, herbicides, growth regulators, etc. used on US cotton…often dispersed in air
    - 2B lbs. of synthetic fertilizer
    - ~1/3 lb of chemicals per t-shirt
  - Increasing interest in "organic" cotton

Fibers: Natural – Cotton

- Problems:
  - Reduced soil fertility
  - Salinization
  - Loss of biodiversity
  - Water pollution
  - Adverse water balance
    - ~1M gal/acre/yr; 14.4M acres in US = 14.4T gal/yr
    - In the US 450B gal/day are used…almost 10% of all water used on cotton
  - Pesticide-resistance
  - Pesticide health problems
    - EPA considers 7 of top 15 pesticides used on cotton in as “possible,” “likely,” “probable,” or “known” human carcinogens (acephate, dichloropropene, diuron, fluometuron, pendimethalin, tribufos, and trifluralin).
    - organophosphates—cholinesterase inhibitors

Fibers: Natural – Cotton, Organic

- Certified Organic Cotton
  - Organic agriculture is an ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain and enhance ecological harmony.
  - 'Organic' is a labeling term that denotes products produced under the authority of the Organic Foods Production Act. The principal guidelines for organic production are to use materials and practices that enhance the ecological balance of natural systems and that integrate the parts of the farming system into an ecological whole.



Case Study: Patagonia

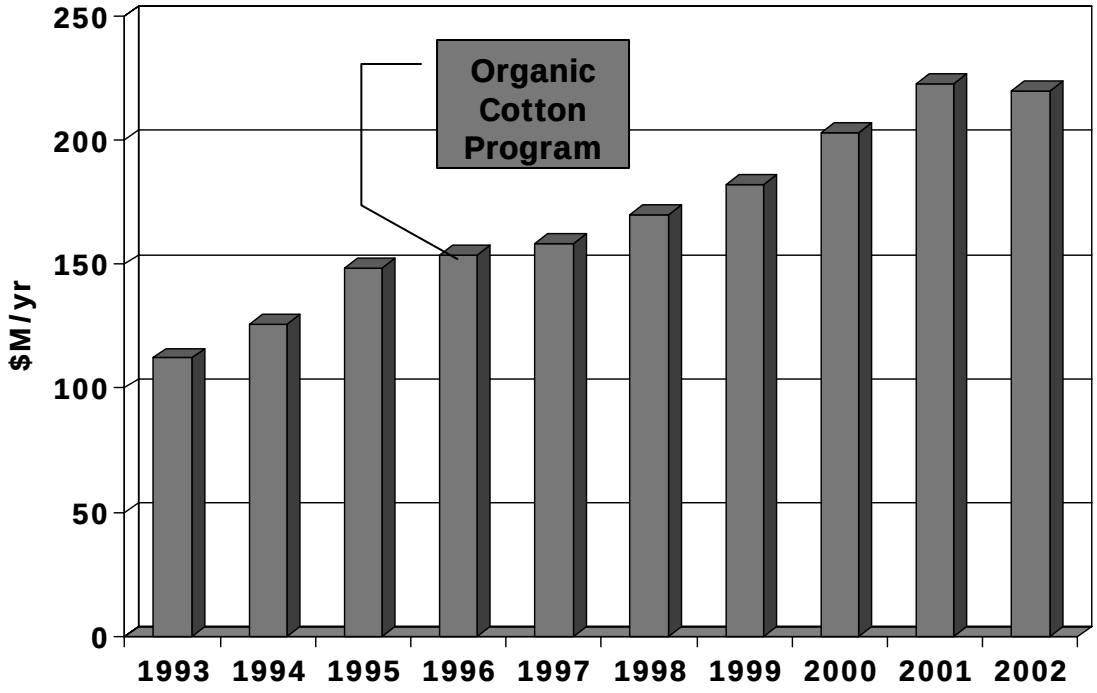
- “When we scrutinized fabric fibers to determine their environmental impact, we figured cotton was "pure" and "natural," made from a plant.
  - We were right about the plant.”

- “As it happens, very little is pure or natural about cotton when it is raised conventionally.”
- “...Their methods support biodiversity and healthy ecosystems, improve the quality of soil and often use less water. Growing organically takes more time, requires more knowledge and skill, and, for now, costs more. But it's worth it.”
- “In 1996, we converted our entire sportswear line to 100% organically grown cotton. We decided never to go back to conventional cotton, regardless of the outcome.”

http://www.patagonia.com/enviro/organic_cotton.shtml?seepromo=yes

Case Study: Patagonia

- Financials
  - Initially took a hit because of cost of organic cotton (+15-40%)
  - Reduced profit margin
  - Donates 1% of sales to environmental causes



Natural Fibers: Wool

- Sheep farming, Shearing, Scouring
  - Land degradation
  - Waste: 2/3 of weight of raw wool is grease, skin flakes, dirt & plant matter
  - Water, detergents, pesticides

Natural Fibers: Hemp & Ramie

- HEMP
  - Made from the stems of the Cannabis Sativa plant.
  - Hemp fabric DOES NOT contain tetrahydrocannibol (THC)
    - Marijuana is from the dried flowers and leaves of the plant
  - Stems are processed to separate the fibers which are then processed again and woven into yarns and fabric
  - The finest hemp for fabric is produced in Italy
  - Hemp fabric is like linen in both hand and appearance. Hemp fabric withstands water better than any other textile product
  - However, it wrinkles easily and should not be creased excessively to avoid wear and breakage of the fibers
- RAMIE
  - Also similar to linen
  - Natural white in color, has a high luster and an unusual resistance to bacteria and molds
  - Used in fabrics, and often mistaken for linen, it is extremely absorbent and dries quickly
  - Excellent abrasion resistance and has been tested to be 3-5 x stronger than cotton and 2 x as strong as flax
  - Inexpensive fiber from an East Asian plant and can be spun or woven into a fabric

Dyeing & Finishing

- Dyeing
  - Contaminated water
  - Energy for heating dye baths
  - Very dark shades requiring more rinsing & dye
  - Some are toxic (azo-dyes; heavy metal salts)
  - Cold-pad batch dyeing...least impact
    - 33% less energy, 45% less water, fewer chemicals

- Finishing
  - Resins for shrink-proofing, wrinkle-free
  - Fire retardants
    - Phosphonates or ammonium salts vs. brominated compounds
  - Antimicrobial agents (metal and organochloride compounds
  - Moth-proofing of wool (pyrethroids)
  - Aesthetic finishes: stone washing/weathering (energy and water)

Chemicals in Textile Processing

General Chemical Type	Difficulty of Treatment	Pollution Category
▪ Alkalis ▪ Mineral acids ▪ Natural salts ▪ Oxidizers	Relatively harmless inorganic pollutants	1
▪ Starches ▪ Vegetable oils, fats, waxes ▪ Biodegradable surfactants ▪ Organic acids	Readily biodegradable; moderate-to-high Biological Oxygen Demand (BOD)	2
▪ Dyes & fluorescent brighteners ▪ Synthetic polymer finishes ▪ Silicones	Dyes & Polymers difficult to biodegrade	3
▪ Wool grease ▪ Polyvinyl alcohol ▪ Mineral oil ▪ Surfactants	Difficult to biodegrade; moderate BOD	4
▪ Softeners ▪ Formaldehyde ▪ Chlorinated solvents ▪ Heavy metal salts	Unsuitable for conventional biological treatment; negligible BOD	5

Case Study: DesignTex

- Blend of New Zealand wool and organically grown ramie
- Originally used 4,500 pigments in dyes
- Reduced to 16 colors w/o use of carcinogens, biotoxins, or heavy metals
- Water in the plant comes in and goes out as drinking water quality.
- Fabric scrap is made into non-toxic, compostable felt which is used in gardens to insulate crops
  - Gradually the felt decomposes

Design & Manufacturing

- Most clothes don’t wear out...changing fashion and style...*design obsolescence*
- Component decisions
  - Fibers
  - Plastics
  - Manufacturing methods

Case Study: Esprit Ecollection

- Fabrics
  - Certified organic cotton, organic linen, Tencel® (from sustainably harvested wood)
- Dyes
  - Natural dyes (indigo-plant, cochineal-beetle)
- Finishes
  - Bio-deg. enzymes, chemical-free shrink prevention
- Components
  - Non-rusting metal alloys, environmentally friendly buttons (glass, recycled silver, Tagua nuts)
- Recycling
  - Scraps used to make paper for marketing materials

ESPRIT

Product Maintenance

- Consumer care accounts for about 70-80% of the environmental cost
- Washing
  - Water, detergent, energy
- Dry cleaning
  - Use of perchloroethylene (perc)
    - Toxic, air pollutant
    - 1.2M Americans exposed to perc in drinking water at levels > EPA's safety limit,
    - 75 to 90 percent of all dry cleaners have caused costly site contamination of groundwater,
    - Dry cleaning workers suffer higher death rates from several forms of cancer.
- Ironing
  - Man-made fibers can often be washed at low temps and drip-dried

Waste & Recycling

- Computerized patterning has reduced the generation of scrap (with cost savings)
  - Scrap should still be recycled
    - Rags, fiber use for insulation, etc.
- Reuse of clothing...charitable organizations Goodwill Industries International, Inc.
- Reuse/recycling of PET for clothing (EcoFleece®)
  - 1 sweater = 25 PET bottles; 150 sweaters saves 1 barrel of oil and 1.1 tons of air emissions

Electronic & Electrical Products (EEPs)

- Selecting low impact materials
  - Material declarations for:
    - Asbestos
    - Cadmium (plastics, packaging & inks, CRTs)
    - CFCs/HCFCs
    - Chloroparaffins (mechanical parts)
    - Lead
    - Mercury
    - PCBs/Polychlorinated triphenyls (PCTs)
    - Polybrominated biphenyls (PBBs)

Waste Electronic & Electric Equipment (WEEE) Directive

- large household appliances
- small household appliances
- IT & Telecommunication equipment
- consumer equipment
- lighting equipment
- electrical and electronic tools
- toys, leisure, and sports equipment
- medical devices (with the exception of large-scale stationary industrial tools)
- monitoring and control instruments
- automatic dispensers

WEEE Directive

- Product design: encourage design for disassembly and recovery
- Separate collection: household and other
- Treatment: treatment, recovery & recycling
- Recovery: targets of 50-80% depending upon type
- Financing: producers pay
- Information & Reporting: training of consumers and implementation reports
- EFFECTIVE: 15 August 2005

Electronics Case Study: XMH v. NiCd Batteries

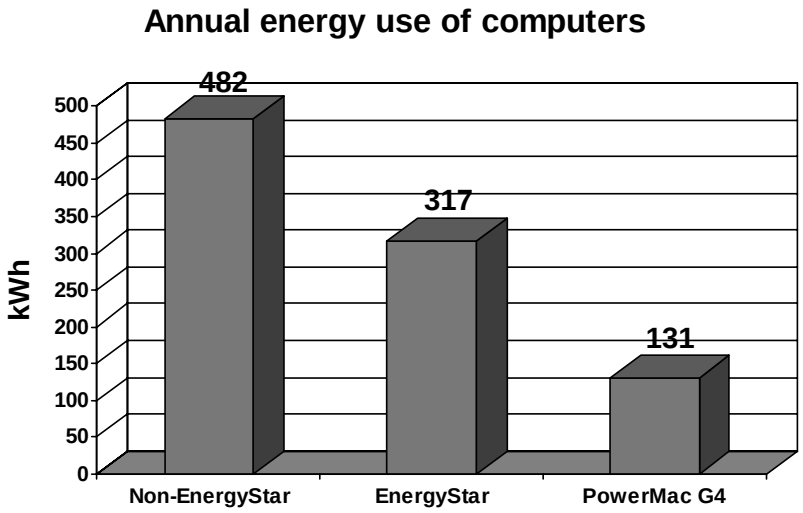
- NiCd batteries in use since the ’70s
- NiMH vs. NiCd:
  - Batteries = mobility; cell phones, laptops, etc.
  - Improved energy density (40% greater) = longer life or smaller battery sizes
  - Reduced issues associated with Cd toxicity
  - Better cycling...no “memory” problems
  - Does self-discharge at slightly higher rate
  - Similar operating temperatures
- Lithium ion batteries: even more lightweight
- Battery recycling programs
  - Rechargeable Battery Recycling Corporation http://www.rbrc.com
    - 300 manufacturers...20 million lbs. since 1994
- Future: Fuel cells
  - emit only water, carbon dioxide and heat when used
  - Last 10 times longer than typical rechargeables

Maximizing Resource Efficiency

- Energy is usually the biggest environmental impact...remember the LCA on the radio?
- Appliances: water heaters, heaters, cooking equipment, refrigerators, lights, AC, washing & drying machines = 95% of household energy usage
  - Example: Energy Star® washing machines (1997 DOE study)
    - Monitor energy & water consumption of 103 machines, 20K loads of laundry, 70 tons of washing over 3 months
    - Water: 41.5 g/load to 25.8 gal/load; 38% decrease
    - Energy: 58% decrease
    - Superior cleaning performance also

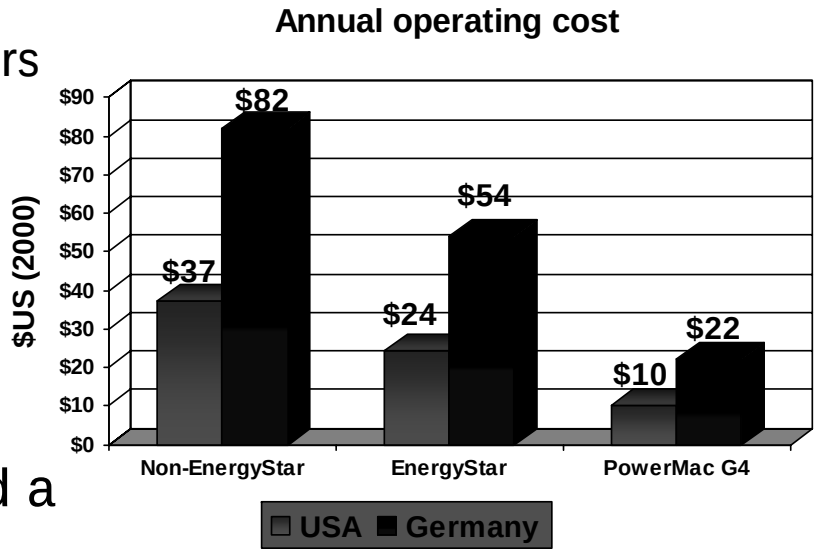
Case Study: Apple PowerMac

- Reduced Costs of Ownership
- Based on PowerPC G4 microprocessor
- Power requirements
  - Normal Operating Power = 45W
  - Sleep Mode = 5W (vs. USEPA EnergyStar® criteria of 30W)
    - Equivalent to a night-light
  - Off = 3W
  - 59% less energy usage than Energy Star ® and 73% less energy usage than non Energy Star®



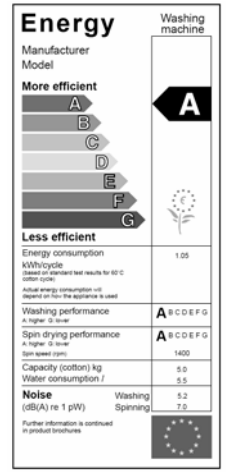
Case Study: Apple PowerMac

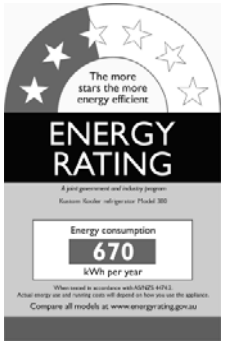
- Reduced energy cost may not have tremendous effect for a single computer (e.g., $10 v. $37)
- Multiply that by 10^4, 10^6, or 10^7 units
  - Significant impact; e.g., 10M computers all EnergyStar → 850MWh
- Additional energy: monitors
  - CRT = 240W v. FPD = 65 W
  - 73% reduction
- Calculation:
  - If a CRT is $200, what price would a FPD need to be to be economical based on the energy use in 1 year?
    - Assume electricity is at $0.13/kWh



Energy Labels

- US EPA Energy Star®
  - Heating & cooling appliances, lighting, TVs, VCRs, office equipment, windows, exit signs
  - Minimum standards set for each
- EU Energy Label
  - Refrigerators, freezers, washing machines, driers, lamps, electric ovens, ACs,
  - Mandatory for “White Goods,” grades from A to G
- Australian Energy Rating System
  - White goods, heating & cooling appliances, windows, houses
  - Actual energy consumption (e.g., kWh/yr); multiple stars based on energy efficiency





Design for Environment

- Miniaturization
  - Electronic components & devices continue to shrink
    - Portable music: Apple iPod = 10,000 songs (40 Gb)
      - Records = 12,026 cu in., 26’ tall + record player; weight = 90 lbs
      - iPod = 7.2 cu. in. (-99.94%), 4” tall (-98.7%); weight = 0.4 lb. (-99.6%)




Design for Environment

- Durability
  - Defect/wear-out
    - Issue of cost of goods; general trend is decrease...extremely so with electronics (e.g., VCR...$45 today vs. $1,000+ when introduced)
    - Service labor; general trend is increase...e.g., $100/hr vs. $35/hr for repair services
  - Obsolescence
    - Product lifetime of cell phones is 1-3 years

Design for Environment

- Remanufacturing
  - Original Equipment Manufacturers (OEMs)
    - Make & sell new an remanufactured versions
  - Independent remanufacturers
    - Purchase unserviceable components and remanufacture them
  - Contract remanufacturers
    - Done under contract to an OEM who retains ownership

Design for Environment

- Example: Kodak
  - Single use cameras: 70% remanufacturing rate
  - Shipped from photofinishers to 3 collection facilities...includes competitor products
  - Subcontractor facility disassembles, inspects, and replaces components as needed
  - Subassemblies shipped to Kodak manufacturing facilities into new cameras
  - Non-reusable components are recycled (plastic reground into flake for remolding)
  - By weight, 77-86% of the cameras can be reused or recycled...200 million have been done since 1990.