"I just want to say one word to you... just one word...

Plastics"

-the graduate
extra lab time! Tuesday 4–6 and 7–9 PM
Blah-gistics!™

design consultations!

pickup sketch models 2–3:30 PM Wednesday

go straight to your team’s consultation room

be ready to start at 3:45
Rooms!

3-370  1-273  1-375  1-371  1-132  1-246  5-217  5-232

10 minutes on, 10 minutes off, 5 minute break: 3X
Blah-gistics™ (continued!)

Playtesting! Friday 6:30–8:30
Quiz!

1. What is your name?

2. Which are polymers: wood, skin (dermis), Jell-O, DNA

3. Where does almost all plastic come from?

4. Which requires more energy to produce: paper or plastic bags?
What are Polymers?

greek for many parts

long chains of repeating molecules (monomers)

natural polymers:
proteins, starch, cellulose
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synthetic polymers...
What is Plastic?

- synthetically polymerized material... typically from hydrocarbons from crude oil
- 6-10 percent of U.S. oil consumption - approximately 2 million barrels a day

* lawrence livermore, 2004; metabolix 2007
Thermoplastics vs. Thermosets

THERMO (heat) PLASTIC (deform)

THERMO (heat) SET (permanent)
Thermosets

permanent, chemical reaction

Usually two-part exothermic, or heat treated

Used in for high temp, high tolerance, or joining

Not recyclable
Thermoplastics

most common with toys

easy to (re)shape with different processes. chains relax

mostly recyclable

8 common thermoplastics

- Acrylonitrile Butadiene Styrene (ABS)
- PolyVinyl Chloride (PVC)
- PolyPropylene (PP)
- PolyEthylene (PE)
- PolyStyrene (PS)
- PolyMethylMethAcrylate (PMMA) (Acrylic)
- PolyCarbonate (PC)
- PolyEsters (PET, PETE)
Thermoplastics

common toy plastics

ABS  PVC  PP  PE

common clear plastics

PS  PMMA  PC  PET

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Thermoplastics

Physical Properties:
feel, look, smell
density, stiffness, opacity, surface finish

Manufacturing Properties:
What are the processes used with this plastic?
thickness, detail, size?

Design Considerations:
Which types of products use this plastic? What is the cost of these products?

common toy plastics
ABS   PVC   PP   PE

common clear plastics
PS   PMMA   PC   PET
PolyVinyl Chloride (PVC)

- inexpensive, heavy, rigid, durable but not tough without plasticizers
- outdoor/water products
- characteristic smell
- environment concerns
PolyEthylene (PE)

most common plastic

HDPE, LDPE

cheap, very flexible, less dense than water

waxy feel, milky, smooth

highly resistant to food, water, salt, chemicals
PolyPropylene (PP)

VERY similar to PE but...

- a bit more rigid
- doesn’t fatigue: hinges, snaps
- shinier surface with better color acceptance
- harder to scratch
Compare ABS, PVC, PP, PE

ABS
- Hard
- Colorful
- Strong

PVC
- Dense
- Flexible*
- Unique Shapes

PP
- No Fatigue
- Tough
- Shiny Surface

PE
- Flexible
- Food/Chemical Safe
- Waxy

Stiff
- High $
- Nicest Finish

Flexible
- Low $
- Worst Finish
Polystyrene (PS)

clear, hard, cheap, brittle, tinny sound

typically foamed into Styrofoam

good for lightweight insulation

cracks easily
Crazing

strain whitening

network of small voids or cracks
PolyMethylMethAcrylate

Acrylic, Plexiglass, Lucite

transparent like glass, hard, brittle, but stronger than PS

great for laser cutting

can weld with superglue
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PMMA particles suspended in water?
Polycarbonate (PC)

an “engineering” plastic

expensive, extremely tough and rigid...

and optically very clear

bullet proof
Polyesters (PET)

- cheap, transparent, easy to mold
- food products, barrier to moisture
- tough, able to withstand high pressures
- easy to recycle, requires less energy than glass bottles
Compare PC, PET, PMMA, PS

PC
“bullet-proof” tough
High $  

PET
low-permeability tough

Acrylic
glass like brittle strong

PS
tin sound brittle light weight

Tough
Brittle

High $
Low $
Thermo-Plastic Forming

Extrusion
Injection Molding
Thermoforming
Blow Molding
Rotational Molding
Extrusion

like a pasta extruder

countant profile extrusion (rods, straws, etc)

high volume

dies are expensive (sort of)
Injection Molding

for thin, constant thickness parts

gate, parting lines, ejector pins

mass production, molds are expensive
Thermoforming

for thin sheets, simple one sided forms

glass transition, relaxing the chains
Blow Molding

for open thin walled
hollow parts

milk jugs, most bottles

pinched look on bottom
Rotational Molding

for simple closed hollow shapes

good for inexpensive large, durable parts
Team Quiz

1. What is your team name?

2. Identify the purpose of each component and the type of plastic it is made of.

Bonus: How do you think the part was made? Why?
PolyStyrene (PS)
PolyPropylene (PP)
PolyPropylene (PP)
PolyPropylene (PP)
PET - Plastic Bottle Preform
PET - Plastic Bottle Preform
PolyEthylene
PolyEthylene

Plastic granules

Plastic wrap is made by an extrusion process. Granules of plastic are melted and forced through a die to form a bubble. The bubble is then collapsed between metal rollers to form a thin film.

The plastic film is unrolled, cut, and rerolled onto cardboard tubes.

The tubes are packaged in boxes with serrated edges.
PolyEthylene
PolyEthylene
PVC (poly vinyl chloride)
ABS (acrylonitrile butadine styrene)
Polyethylene  (low density)
Polystyrene  (two ways!)
PLA (poly-lactic acid) lower melting temperature than ABS
Plastic Recycling

not everything gets recycled (even if it’s recyclable)

sorting, shredding, cleaning processing

30% of PET bottles recycled

2.5 million water bottles are discarded per hour, in the US alone!

8% of all plastics are recycled

* 2010 Environment Agency report
Energy In Plastic

5 lbs of plastic ~ gallon of gasoline
Paper vs. Plastic

2 plastic bags use 13% less energy to make than one paper bag

and produce 72% less pollutants than one paper bag

but do not degrade and come from a non renewable resource

* institute for lifecycle environmental assessment
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ONLY 3 Weeks after this week!

PLAYsentations are Tuesday May 10th, 7:30pm
Room 10-250
Questions