Cradle to Grave: The Life Cycle of Styrofoam®

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Introduction

- This presentation focuses on polystyrene, more widely known as Styrofoam.

- This presentation is designed for educational purposes as it takes us through the cradle to grave lifecycle of Styrofoam, paying particular attention to the social, environmental and public health impacts of the processes associated with Styrofoam.

Preview: Uses

- We will look at the many different uses of Styrofoam. This will cover:
  - Food and beverage containers.
  - Packaging products.
  - Building insulation and materials.
  - Craft project material.

Preview: Components

- In this section, we will look at the chemical components used to make Styrofoam.
  - Benzene
  - Styrene
  - Ethylene
  - Blowing Agents – CFCs and HCFCs

Preview: Workers' Health

- Here we will examine the health impacts on the workers of the Styrofoam manufacturing plants.
  - Benzene exposure.
  - Styrene exposure.
  - Ethylene exposure.

Preview: Consumer Health

- In this section we will look at possible health impacts we face from using Styrofoam beverage and food containers.
  - Chemical migration.
  - Styrene in fatty tissue and breast milk.

Preview: Distribution

- Here we will look at the concept of distribution.
  - Effects of transportation fuels and components on the environment and our health.

Preview: Waste

- In this section we will examine the different methods of dealing with used Styrofoam.
  - Reuse – pros and cons.
  - Recycle – pros and cons.
  - Incineration – pros and cons.
  - Land fill – cons.

Preview: Styrofoam Alternatives

- In this last section we will explore alternatives to using Styrofoam products.
  - Eco-foam.
  - Natural insulation.
  - Changing small habits for the better.

Styrofoam Uses: Food and Beverage Containers

Styrofoam, the Dow Chemical brand name for Polystyrene, is perhaps most widely known for its use as coffee cups, disposable plates and take-out containers.

The reasons for its popularity is that it has excellent insulating properties that keep hot products hot and cold products cold much longer than disposable paper cups and boxes.

Styrofoam Uses: Food and Beverage Containers

Here is a list of the different uses for polystyrene products related to our food.

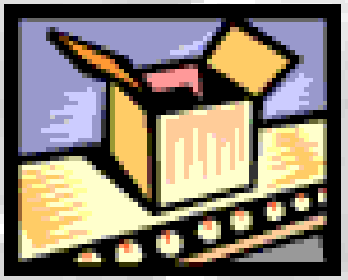
- **Cups.**
- **Plates.**
- **Utensils (un-blown polystyrene).**
- **Take-out boxes.**
- **Egg cartons.**
- **Clear plastic cups and boxes (un-blown polystyrene).**

Styrofoam Uses: Packaging Products

Using pre-molded Styrofoam or "peanuts" for packing delicate objects is probably the other most commonly known of use for this material.

For a long time, Styrofoam was the best packing material being light-weight and protective at the same time. However, in the past decade large, inflated air sacs have gained popularity as an even cheaper and effective packing material because it uses air and very few resources to create.

Styrofoam Uses: Packaging Products



Most Styrofoam packaging is either the little popcorn-like pieces referred to as “peanuts” or the large molded piece to fit a specific product.

If you ever come across packaging that looks like cut-up odd pieces of Styrofoam, it is re-used molded pieces that have been shredded down.

Styrofoam Uses: Building Insulation

This type of Styrofoam use is probably the highest consumer of Styrofoam altogether.

I say "probably" because there are so many different kinds of Styrofoam insulation and applications that they are too numerous to list, plus it is difficult to find reference resources that list the annual amount used of any of the types of Styrofoam insulation.

Styrofoam Uses: Building Insulation and Materials

Just to name a few uses…

- **Flexible Styrofoam pipe insulation.**
- **Sheeted wall insulation.**
- **Spray Styrofoam wall insulation.**
- **Ground Styrofoam flake attack insulation.**
- **Insulation in products such as refrigerators and freezers.**
- **Base sheeting for stucco treatments.**
- **Concrete molding frames.**

Styrofoam Uses: Craft Project Materials

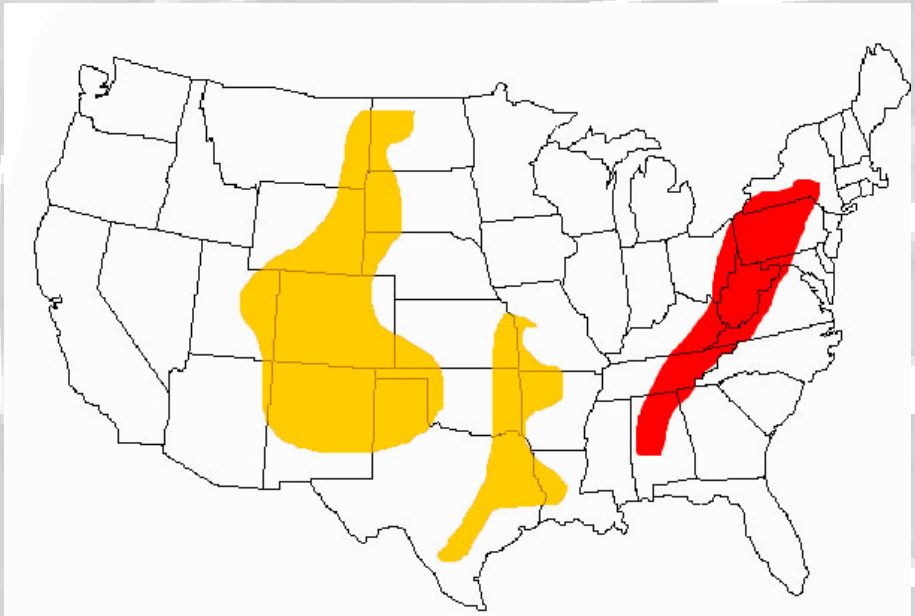
There is actually quite a large market for Styrofoam in the craft market.

Some such uses are various sized donut-like Styrofoam pieces that people use as a base for all kinds of wreaths.

There are many different shaped Styrofoam pieces for all sorts of projects, from arranging flowers to making architectural models. As with many craft materials, all you have to use is your imagination to figure out another use for this easily-molded substance.

Styrofoam Components: Benzene

Benzene is extracted from coal, but is also found in gasoline (2% present in U.S. gas and 5% present in gas from developing countries). Here is a map of the coal mines of the United States.



***The yellow areas are where scattered mines exist. The red area shows the greatest concentration of coal mines in the nation.**

Styrofoam Components: Benzene

The extraction of coal is very hard on the natural environment. The earth distributed around the mine from deep inside is virtually dead in that it cannot support plant life. This leads to erosion of the land even long after the mine has been closed for use.

Working in the coal mines has always been known of as a very hazardous job.

Styrofoam Components: Benzene

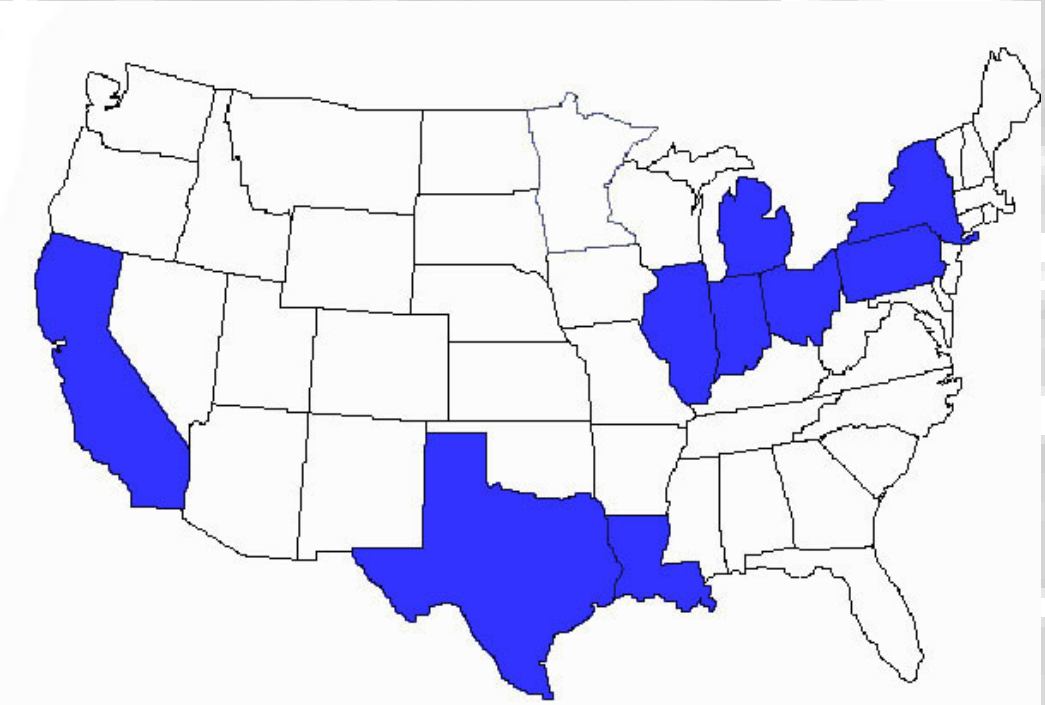
- Benzene is a clear, colorless liquid with a noted pleasant odor.
- Benzene is present naturally in certain foods (I could not find out what foods it's present in).
- Another common name for Benzene is Coal Tar.
- Nearly 75% of all extracted Benzene is used in Polystyrene production. It is used to transform Styrene into Polystyrene (brittle plastic).
- Other common exposures to Benzene are from cigarette smoke (it is one of the 4,000 chemicals present) and from the exhaust pipes of automobiles.

Styrofoam Components: Styrene

- Styrene Monomer is a clear, oily liquid with a slight odor.
- Styrene for manufacturing is “cracked” or extracted from petroleum.
- I could not find the exact way Polystyrene is made, but it is basically a combination of Styrene and Benzene
- Styrene is naturally present in most foods, such as: strawberries, beef, coffee, peanuts, beans, wheat and cinnamon. The article that stated this also noted that the technology needed to detect Styrene present in natural food products is only two decades old. So, this could mean that Styrene has gotten into our natural environment through the refining of petroleum, but we haven’t been able to test for it until recently.

Styrofoam Components: Styrene

- **Styrene extraction is a $20 billion a year industry in the United States, comprising over 5,000 industrial plants in the following states: CA, IL, IN, LA, MI, NY, PA, OH & TX.**



Styrofoam Components: Ethylene

- Ethylene is a colorless gas that becomes a liquid at very low temperatures.
- Ethylene is present in almost every plant and encourages plant growth.
- Generally used as a refrigerant, it is one of the main building blocks of the petrochemical industry.
- Ethylene has been used as one of the two new blowing agents in the production of Styrofoam.

Styrofoam Components: Blowing Agents

- Polystyrene is basically a hard, brittle plastic (just like disposable plastic cups) and it doesn't become Styrofoam until it gets injected with a "blowing agent" to make it 30 times lighter than its original weight.
- The name, Polystyrene, doesn't change once it becomes Styrofoam, because the chemical composition doesn't change.
- To make Styrofoam, certain gases are injected into the plastic, blowing tiny holes that become gas and air filled pockets once the plastic cools. The background of this PowerPoint are the cells of Styrofoam.

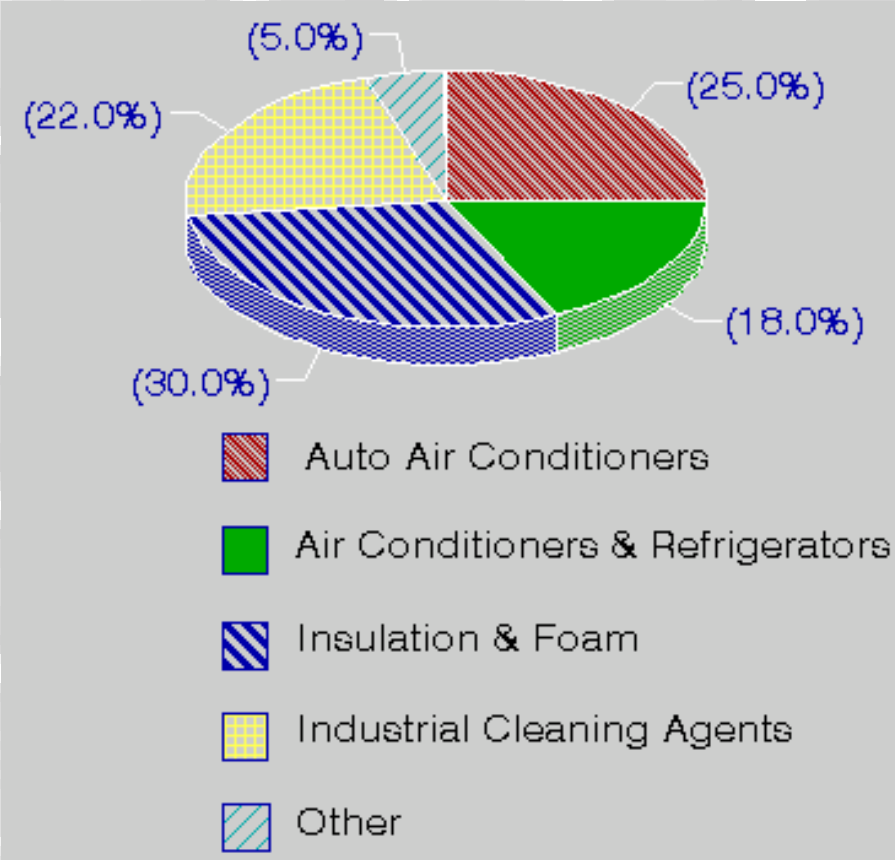
Styrofoam Components: CFCs

- **Up until the late 1970's CFCs, or Chlorofluorocarbons, were used as the blowing agents for Styrofoam production.**
- **The main CFC blowing agent was Isobutylene. This was phased out due to growing knowledge of the relationship between CFCs and global warming and replaced with HCFCs combined with Ethylene. Now before we move on to the controversy behind HCFCs, lets take a look at how the chemical companies and the EPA see the history of Styrofoam production differently.**

Chemical Corporations' Take on CFCs

The largest pro-Polystyrene website (sponsored by Dow Chemical, Chevron Phillips and NOVA Chemical Corp, as well as six other chemical companies) stated that, "…most polystyrene foam products never were made with CFCs. Those few that did use CFCs comprised a very small portion of the U.S. CFC use."

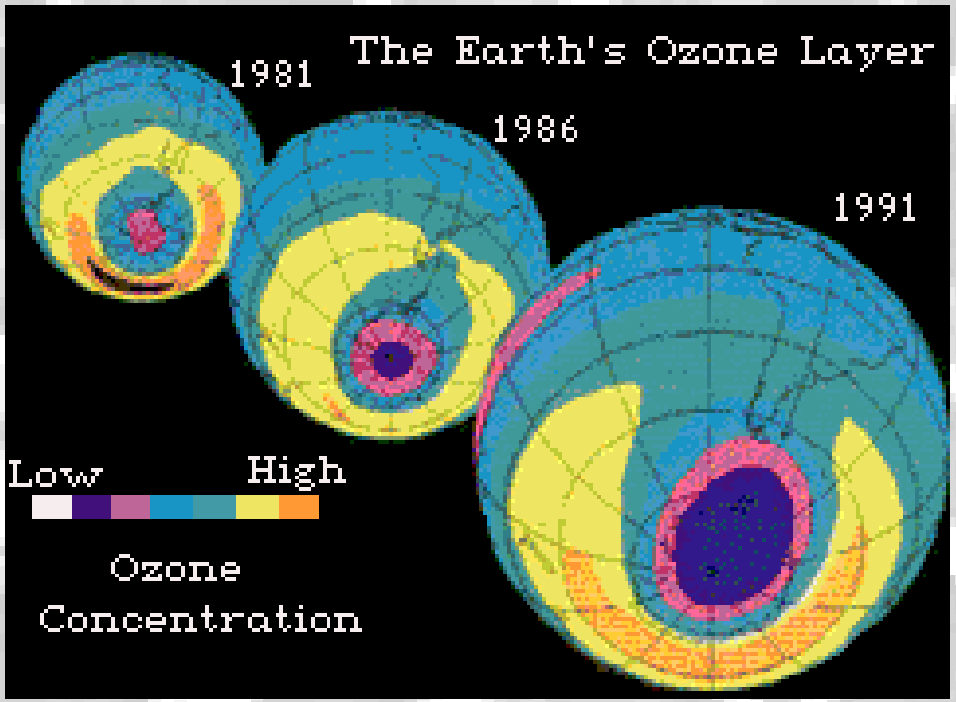
The EPA's Take on CFCs



The Environmental Protection Agency (EPA) had the opposite view of CFC use in Styrofoam production, and had a data chart to back up their statements. As you can see, insulation and foam make up 30% of the CFC use! I sure wouldn't consider that "a small portion of the U.S. CFC use."

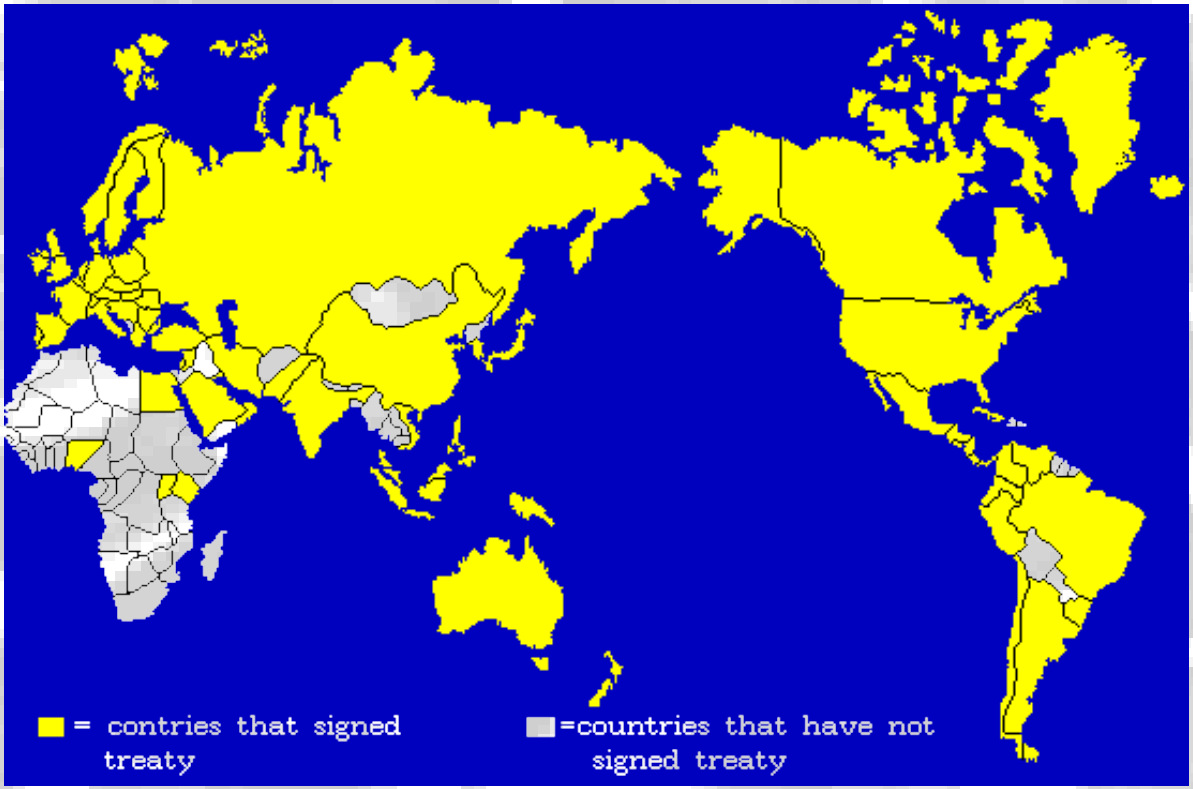
Global Warming

Another chart displayed on the EPA website is on the right. It shows how our Ozone Layer changed over only 10 years. The purple is an Ozone level of less than 2%. The Ozone Layer is the only protective barrier between us and harmful radiation from the Sun and outer space. This global threat is what lead to the Montreal Protocol.



Montreal Protocol

The Montreal Protocol on substances that Deplete the Ozone Layer was constructed in 1987 and signed by 35 countries to reduce the world's CFC production levels by 50% by 1998. This map shows the countries that signed (in yellow). However, in order to make this reduction of global warming truly effective, all countries needed to sign.



HCFCs

- **Hydrochloroflorocarbons are thought to be *less* harmful than regular old fashioned CFCs. In fact, HCFCs are supposed to be 90% less harmful than CFCs.**
- **For Styrofoam production, generally HCFC-22 is combined with Ethylene to create Ethylene Oxide (22% Ethylene).**
- **The fact that HCFC-22 is basically CFC-22 with a Hydrogen molecule attached (and CFC-22 was banned here in the late 1980's) many people are skeptical of the idea that HCFCs are much better for the environment.**

Workers' Health: Benzene Exposure

- **Benzene is the most toxic of all the chemical components of Styrofoam and enters the human body either through the skin or respiratory system**
- **Benzene is listed on the Hazardous Substances List because it is a known MUTAGEN, CARCINOGEN and is FLAMABLE. Many scientist believe there are no safe exposure levels for carcinogens (cancer-causing agents). However, the Occupational Health and Safety Administration (OSHA) defines safe worker limits at 1 ppm (parts per million) over 8 hours and exposure of 5 ppm to not exceed 10 minutes.**

Workers' Health: Benzene Exposure

- Effects of short-term levels of exposure have been known to cause: dizziness, lightheadedness, headaches, vomiting, convulsions, coma, and death from irregular heartbeat.
- Effects of long-term levels of exposure have been known to cause: skin scaling, leukemia, plastic anemia, and death.

Workers' Health: Styrene Exposure

- Styrene is also very toxic in high levels, and is in the fatty tissue of every single one of us right now.
- Styrene is listed on the Hazardous Substances List as a MUTAGEN, FLAMABLE and REACTIVE. A mutagen alters one's chromosomal make-up. Styrene is also considered a neurotoxin.
- OSHA defines safe levels as 50 ppm over 8 hours and 100 ppm to not exceed 15 minutes.

Workers' Health: Styrene Exposure

- Exposure to Styrene at low levels for a short time can cause: eye, nose and throat irritation.
- Exposure to Styrene at higher levels for a short time can cause: dizziness, lightheadedness, loss of consciousness, trouble concentrating, memory problems, poor learning ability, brain damage, and death.
- Exposure to Styrene over months and years can cause: trouble balancing, learning impairments, fetal damage, decreased fertility in females, lung cancer, and shortened lifespan.

Workers' Health: Styrene Exposure Case Studies

- In several studies of human fat cells, 100% of the samples contained anywhere from 8 to 350 ng/g (nanograms per gram) of Styrene. 350 ng/g of Styrene is 1/3 the amount needed to cause neurological problems.
- In 12 breast milk samples, 75% were contaminated with Styrene.
- In Russia, Female workers exposed to vapors reported various menstruation problems, including excessive bleeding.
- In 1986, a worker exposed to Styrene vapors for five years complained of a burning sensation in his feet. Doctors found he had near total demyelination of the nerves in his feet (myelin is the protective sheathing allowing nerve signals to travel properly). The authors stated, "…Styrene affects the nervous system to a greater degree than formerly thought."

Workers' Health: Ethylene Exposure

- Ethylene has not been found to be toxic.
- Ethylene is, however, on the Hazardous Substances List because in large quantities it can be FLAMABLE.
- High levels exposure can cause frostbite with direct contact and, like with many gases, can cause unconsciousness.
- As long as workers are properly trained and work at a properly regulated plant there should be little risk of explosion.

Consumer Health: Chemical Migration

Benzene exposure from automobile exhaust, gasoline vapors and cigarette smoke are more worrisome for us as documented thus far than from Styrofoam itself.

The dangers for non-workers are for those living in close proximity to the Styrofoam production plants and Petroleum refineries. The largest risks are with locally contaminated water from these plants (which is almost inevitable) and from vapors and soil contamination. I could not find any documents on any areas with contamination, nor contamination levels, but there was information stating the health risks of living near such an industrial plant.

It is very difficult to find any sort of actual harmful health effects from Styrofoam itself. There was evidence to suggest the *possible* migration of Styrene from Styrofoam food containers and cups into the food or drink it contains, but that many other resources suggesting nothing of the sort. So officially, the dangers of using Styrofoam in relation to food is inconclusive.

Consumer Health: Styrene Exposure

As mentioned earlier, Styrene is present in many foods, in our fatty tissue (documented 1972, 1976, 1982 & 1986), and present at high percentages in samples of breast milk. However, I found no documentation to *how* this chemical wound up inside us. The question still remains is this chemical *naturally* present in food, or has it originated there after years of petroleum-based pesticides and pollution? There needs to be similar studies done of those who live ecologically sound lifestyles far from developed areas might be a good indicator of whether this is a natural migration or an effect of petroleum-related product use.

Distribution: Fuel, Oil, and Break Pads

- Freight trucks run on diesel fuel that has over 40 toxic chemicals in its exhaust.
- Diesel fuel comes from crude oil and is extracted at petroleum plants. Diesel, like gasoline, contains Benzene.
- Break pad dust is now being linked to escalating asthma rates in children, and elevated cancer risks to those living near sections of freeways that experience high levels of traffic congestion.

Distribution: Fuel, Oil, and Break Pads

Now, a study of the pollution rates from freight trucks in relation to Styrofoam distribution is an entire study in itself. For this analysis, we need to realize that out of our 50 states, there are only a handful that have plants that manufacture Styrofoam. So approximately 80% of our nation gets its Styrofoam from over 500 miles away. That leaves us with a large amount of exhaust pollution, oil-to-groundwater seepage pollution, and break pad dust that escapes into our environment. All that so we can drink out of a Styrofoam cup for 20 minutes?

Styrofoam Waste Facts

- **Here are the basic facts of Styrofoam waste:**
  - **Although Styrofoam breaks into pieces easily, it will take 500 years for one cup to dissolve. My unanswered question is: dissolve into what?**
  - **Our nation averages 547,945 tons of garbage per day and Styrofoam products make up 0.25% of this weight. It sounds a little more impressive when that comes out to 1,369 tons. Don't forget, this stuff is pretty light weight. So, by volume Styrofoam waste takes up 25-30% of our nation's land fill space.**
  - **There are over 25 million Styrofoam cups thrown away each year.**

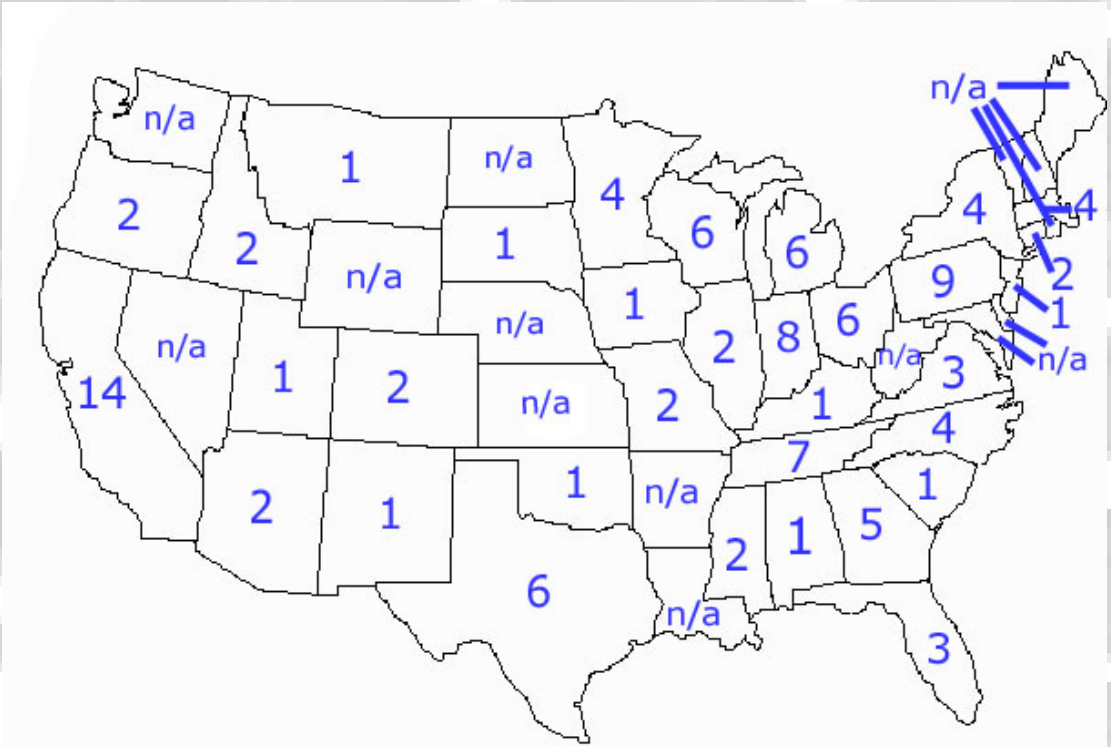
Styrofoam Reuse

- Foam insulation can be ground up and made into bean-bag chairs.
- Styrofoam sheeting insulation and molded Styrofoam can also be shredded to be used for packaging fillers.
- It would not be worthwhile to try and re-use a Styrofoam food or beverage container for its purpose for more than 2-3 times, because the material is flimsy and begins to break up. Cups can be re-used for plant seedlings, but then again there is the underlying issue of whether or not Styrene transfers to the plant itself.

Styrofoam Recycling

- **Recycling centers are limited in number.**

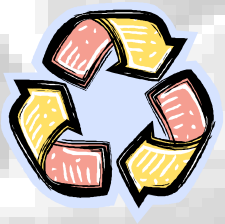
Here's a map of all the recycling centers I could find in the United States (number of centers in each state).



Styrofoam Recycling

When Styrofoam is recycled it's generally made into some other product that also has a low level of recycling patrons. Styrofoam is recycled into products like: cafeteria trays, video and audio tape bodies and cases, rules, desk top accessories, hangers, and horticultural plant trays. When was the last time you heard of many people actually recycling these products when their use is up? I would imagine not very often.

Styrofoam Recycling



- **Out of the other alternatives we will look at for dealing with *waste*, recycling is the best option.**
- **What we need are more strict government regulations toward pro-Styrofoam recycling, such as curb-side pick up along with other recyclables.**

Styrofoam Incineration

- Burning Styrofoam gives of over 90 different hazardous chemicals, including Styrene vapors and dioxins.
- If incinerated in extremely specialized plants, these vapors can be controlled, more often then not incineration facilities do not have the huge amount of financial resources to keep their plant operating at these extremely controlled levels. Thus, people living near these plants face a greater risk of developing health problems. And, normally these risk falls upon the poor who cannot afford to move as far from the incineration plants as the wealthy and middle class.

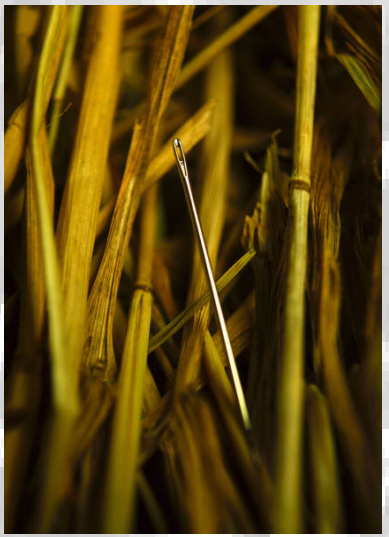
Styrofoam in Landfills

- Can make up to 30% of the garbage volume in landfills.
- Takes half a millennia to dissolve.
- Because of the landfill strategy of compacting the garbage and then packing dirt on top, practically nothing breaks down as it should, and that methodology winds up giving paper the same decomposition time as Styrofoam.
- Styrofoam captures water from seeping into the soil and therefore allows water to soak garbage until it's almost a soup-like mixture. When heavy rains come, this soup escapes the Styrofoam barrier onto the landfill lining (if there is one) or more likely off into our soil and groundwater.

Styrofoam Alternatives: Eco-Foam®

- Made from corn (starch).
- Creates no static-electricity (as does Styrofoam) and is much better for protecting very delicate electronics, like microchips.
- You can put it in your backyard compost, i.e . it's 100% biodegradable (as long as it's not packed down in a landfill).
- Comes in nearly everything from packaging "peanuts" to molded Eco-foam and insulation, plates, cups, and utensils (they make biodegradable trash bags, too).

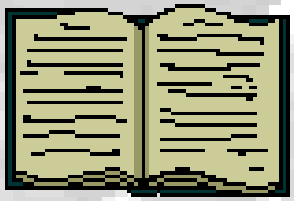
Styrofoam Alternatives: Natural Insulation



- M.I.T. developed straw insulation that costs half as much as Styrofoam insulation, is non-toxic and is biodegradable.
- Made with an easily renewable, natural resource.
- Straw plus a sticky adhesive agent and compression = eco-friendly insulation.
- Predicted to be great for building in developing countries because of low cost and very easy to manufacture.

Styrofoam Alternatives: Changing Habits

- Use reuseable cups such as ceramic mugs, plastic cups, or plastic-lined stainless steal containers.
- If you *must* have disposable dinnerware, try the Eco-foam plates, cups and utensils.
- Buy your eggs in recycled paper cartons instead of Styrofoam.
- Buy meat that is packaged in plastic bags (like a whole chicken) instead of Styrofoam containers (its cheaper, too).
- Sit down to eat at a restaurant instead of ordering take-out (chances are it will be a healthier meal than take-out also).



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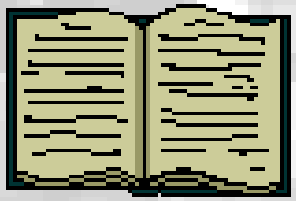

- Plastic Loosefill Council (for a recycler near you). 1(800)828-2214.
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Thank You