Session 2651

Environmental Engineering in a High School Classroom.

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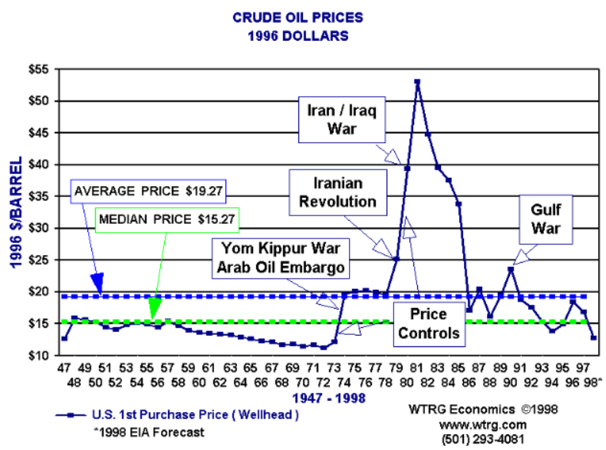
Abstract

Used oil, filters and retail containers have a direct effect on major environmental legislative initiatives like the Safe Water Drinking Act. Any quantity of improperly disposed oil harms or kills plants and wildlife on contact. Because of its adverse impact on human health and the environment, it is important to properly dispense and recycle oil.



WTRG Economics Crude Oil prices and events associated with price changes.
Source: wtrg.com

I. Introduction

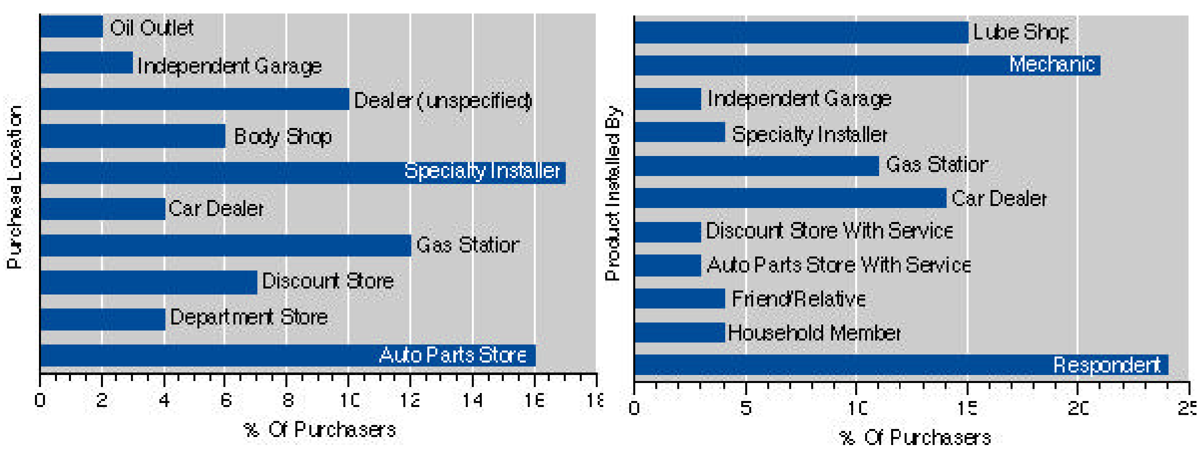
Motor oil and filters have been changed by do-it-yourselfers for decades. Many family members change their oil on their own for a fraction of what it costs to get it done at the local garage or quick lube. Though cost effective for families, some home mechanics overlook the details and hazards created when changing their own oil.

Approximately 400 million oil filters are manufactured annually in the United States. Current research shows 90% of all used oil filters are currently dispensed into the landfills. If these filters were recycled, an estimated l6l, 500 tons of steel and l7.8 million gallons of oil would be recovered. Used oil filters are a hidden source of used oil. An un-drained oil filter can contain from one-half pint (8 oz.) to a full quart (64 oz.) of used oil.[1]

High Density Polyethylene (HDPE) is the plastic that is used to mold the containers that lubricating oil is shipped in. HDPE that is contaminated with oil or other water insoluble material poses a special problem for recyclers. Quart-sized motor oil bottles and bottles which previously contained other automotive materials or additives are the most common source of this type of waste. Many curbside-recycling programs still cannot accept emptied motor oil bottles for recycling. Currently, very few plastic recyclers can handle this type of material.

The primary problem companies face when recycling these materials is the washing process and the accompanying wastewater discharge. Some compounding processes can use limited amounts of oil contaminated HDPE directly in a mix with non-contaminated plastics, but for most applications the material must be washed first.

The U.S. EPA estimates that 50% of Americans change their own oil and only 35% of that used oil is getting into the recycling stream.[2] In 1997 between 43 to 62 million gallons of used oil were collected and recycled by do-it-yourselfers. In the same year, local service stations and automotive service facilities recycled 194 million gallons of oil.[3]



The chart on the left reflects the purchase location of lubricating oil.
The chart on the right reflects who installs the product.

It is important that we understand that sometimes it is not used oil that is disposed of improperly. Unfortunately, within our classroom, we would have a hard time generating solutions to correct the laziness or bad habits of people who discard their *used* oil improperly. We can, however, focus on the containers that lubricating oil is shipped and dispensed in. Many do-it-yourselfers are simply impatient and careless with the containers that dispense the *clean* oil intended for their vehicles. This is where the engineering students at Madison West High School can focus their efforts through a case study.

II. Degree of severity

According to the US Department of Transportation and the Bureau of Transportation Statistics, the average mile driven per passenger vehicle in 1997 was 11,319 miles. [4] There are 215.5 million registered vehicles in the United States (1998). The United States environmental protection agency estimates that ½ of Americans change their own oil. Using these numbers we can derive the average number of oil changes completed by do-it-yourselfers. Based on this estimate, using the data from the DOT, 107,748,000 Americans change their own oil. The automotive industry recommends that a vehicle owner change their oil every 3,000 miles, and the average number of oil changes based on the average miles driven per year is 4. We have to allow for the people who push the limits of the recommendation, so reduce that number to 3 oil changes per year.

If, on average, an oil change for a passenger vehicle requires 5 quarts of oil, and there is 3ml(.101 oz.) left as residue in each of the 1 quart containers, there will be a total of .507 oz of oil left in containers per oil change. The number of oil changes per year is 3, so each person changing their oil will waste 1.521 oz per year. Multiplying that waste by ½ the number of registered vehicles (people that change their own oil), Americans waste 163,884,708 oz per year of unused oil. That converts to an amazing 1.099 million gallons of unused oil. Using that oil change we left out would push the waste to 1.467 million gallons per year. The data is similar for the years 1994-1998. Therefore, five years of waste would range from 5.495 million to 7.335 million gallons of oil that either inhibits the recycling of HDPE containers or ends up in our landfills.

III. Solving the problem

Students are required to work in groups of three to design a low cost system or alternative container to safely house automobile oil. This design should not allow any residue of oil to remain in the container when the installer has completed use of the container. The design can be made of any materials that are compatible, and it must follow prescribed restrictions.

The container capacity should remain at the industry standard capacity of 1 quart. Groups provide proof of the compatibility of construction materials, and those materials selected must be recyclable. The container should withstand regular wear and shipping environments and be able to be poured. Pouring or dispensing procedures should be investigated, as many spills are a result of poorly designed containers or a failure to use the container properly.

A system that fits to the existing container is acceptable as a solution for this case study. However, the cost of the system added to an existing container should not exceed $1.00 and have a use period of at least 100 applications. A new container's cost shall not exceed the cost of an average container on the market today (+ $0.10). Safety seals are to be in place to assure the customer of content integrity. Any new container must not weigh more than an existing container on the market (+ 4oz). Detailed CAD drawings of the prototype must be supplied with the specific scale to be determined by the design team. A full-scale model of the prototype will be supplied using materials that accurately depict the materials intended for the design. Instructions for the use of the system must be written in technical form and include illustrations and/or pictograms.

The teams are also responsible for completing a research report on the use and need for recycling HDPE oil containers. This includes pictures, graphs, as well as examples and expert testimony relevant to the project. An electronic presentation (PowerPoint) is also required. The presentation includes the entire process of designing the Prototype container(s), complete with CAD drawings, renderings, pictures, graphs, and all other relevant information to aid in the presentation.

IV. Implementing the case study.

Instructors should have relative ease implementing this case study in to a secondary or post secondary classroom. Some recommendation s for instructors is that they familiarize themselves with High Density Polyethylene (HDPE) and its characteristics as well as the recycling processes in their cities. There are many websites and companies that will send out sample products to your students, if they request them. IT is also preferable that students do the research and them substitute a material that they can manipulate if they are going to build a scale model. Make sure to pay specific attention to the rubric that you and your students create together for the case study as many solutions will fit into the criteria, while some may be only a slight tweak of an existing design. Make sure students have data, drawings, designs and research to support the major improvements or minor changes to existing packaging.

V. Engineering program description

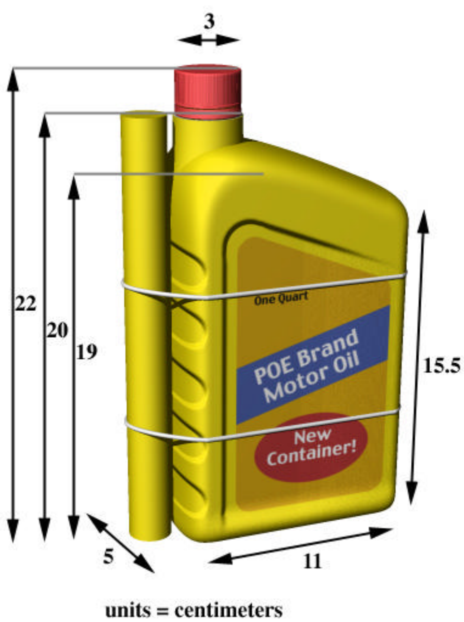
The course at Madison West High School, Principles of Engineering, is offered to sophomores, juniors, and seniors. We developed this course at the national level through a grant from the National Science Foundation, its origin based on the need for pre-college survey courses that stimulate interest in careers in engineering and technology. This course explores the relationship between math, science and technology. Students must know and learn to communicate these relationships if America is to remain competitive in the world markets.

In teaching the Principles of Engineering course for the past five years, I have found that learning to navigate the road to the solution is just as important, if not more important as finding the solution itself. We need to teach the learning process that students require in order to navigate that road. Although all students will not become engineers, they do need problem solving skills for life in the technologically complex 21st Century. Students complete fourteen to eighteen different case studies in a one-year class of Engineering. During this journey, all students are required to complete daily logs (lab reports) to document this process, just as any engineer or scientist would do.

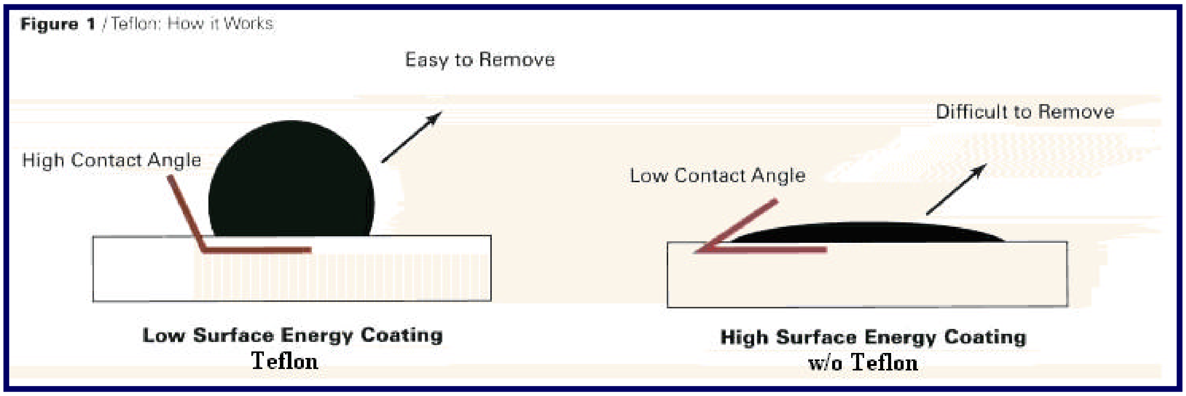
The course is organized around a set of concepts, skills, and attitudes necessary for an engineering career. Unfortunately, students in many other schools can still graduate having had no practical contact with engineering concepts or case studies. A major problem of secondary education is that schools teach science, technology, and mathematics only in the context of the specific disciplines. This course solves that problem. It shows students the important engineering concepts and has them work on real-world case studies resembling the problems they will be solving in an engineering career.

VI. Results-what results have we seen??

Solutions have varied from the most complex arrangements of systems to the simple addition of components such as the rendering below. The majority of students start on retrofitting the existing bottles and forget about the possibility of developing a entirely new design. Most students tend to understand the underlying culture issues that are the major contributors to the waste in the first place. These issues are that of time and convenience. How many times so just want to get finished with a project and don't have time to wait around until all the oil has drained out of the quart bottles. What used to take only ten to fifteen minutes now takes upwards of forty five or so, in order to save a few drops of oil, most people wont spare the time. Yet while they realize these issues with cultures, they focus in on the physical aspects of the case study in the container and the delivery system. It may take a few more times before they get into the culture issues and start addressing those as primary, but only time will tell.



Teflon research has dominated the case study as students know of its characteristics from their home applications. The Teflon® coating works by lowering surface tension between the surface (coating) and the oil. A drop of oil will bead up at a high contact angle on a Teflon-treated surface, and therefore be less likely to remain when poured. Teflon has so dominated the solutions that we have begun to present it in the orientation to the project as a viable solution, but one of little creativity. This is done to try and push the students to find alternative materials and systems and not quell their creativity.



VII. The future of K-12 Education

If everything we do is the same as we have done in the past and no evolution of programs takes place, our students will either find different venues to practice in or our programs will vanish. Engineering, combined with Materials Science, is what I believe to be the answer to what education will look like for the next 100 years. These programs must also recognize that other instructors in the math, science, and English departments play significant roles in an engineering program. Students work hard during their entire school day in other classes. The engineering program takes what they learn with other teachers, along with information teachers in our department provide, and applies it to solve problems. Suddenly, education looks more like it should, a cooperative effort to supply our students with the best experiences possible, utilizing every resource possible, including other teachers. This dream of an engineering program in every school district in the nation can become a reality. Visit the programs website at: www.imagine101.com

Bibliography
1. *URL: http://www.filterfuge.com* Filterfuge is a company that has developed a machine that is similar to a centrifuge, removing oil from used oil filters.

2. *URL: http://www.eq.state.ut.us* The state of Utah's Department of Environmental Quality's division of solid and hazardous waste.

3. *URL: http://www.recycleoil.org* The American Petroleum Institute's website on "used motor oil collection and recycling.

4. *URL: www.bts.gov/btsprod/nts* US Department of Transportation and the Bureau of transportation statistics.

5. Graphics source is through WTRG Economics. WTRG Economics provides data, analysis, planning and forecast services primarily for the energy and petrochemical industries. James L. Williams, WTRG Economics P.O. Box 250 London, Arkansas 72847 Phone: (501) 293-4081

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Alan Gregory Gomez is currently an Engineering and Technology Teacher Madison West High School in Madison, Wisconsin. He has taught one of the freshman engineering courses at the University of Wisconsin-Madison and taught graduate classes as an adjunct professor at the University of Wisconsin-Stout. He received his B.S. in Technology Education from the University of Wisconsin-Stout in 1995 and continues work on his M.S. in education. He has taught in several locations including Fort Worth, TX, Minneapolis, MN and Madison, WI. Alan frequently holds state and national workshops to encourage and inform instructors and administrators about the benefits and necessity of engineering education in their school districts. Alan was a member of the technology education standards writing team for the state of Wisconsin and has written a national Foundations of Technology curriculum for ITEA's Center to Advance the Teaching of Technology & Science.