Lesson Plan Discussion

Introduction to Research Projects

Lesson 1: Crisis? What Crisis?
Students watch the film An Inconvenient Truth and answer questions during the presentation on a worksheet or graphic organizer. Small group discussions and presentations, including alternative points of view, serve to deepen understanding and provide motivation for the rest of the unit. After viewing the film, students will gather in small groups and share the answers to the questions with the class. The group will come to a consensus and construct a presentation for the class. Students then produce an individual written product to demonstrate their understanding of the topic.

Lesson 2: Alternative Fuels
Students perform experiments where they perform a biocube research activity, where they perform a web-based/engineer/hunter online activity concerning an assigned biofuel. Students are then the experts in their respective fuel and present their findings to the class. Students realize that the ultimate source of the energy is the sun, and that plants concentrate this energy and make biofuels that are renewable. We then do some hands-on experiments with a web site that is a valuable resource.

Lesson 3: Light 'Em Up, Dirty Burn
Students perform experiments in the combustion of various biofuels through two experiments: Light 'Em Up and Dirty Burn. In Light 'Em Up, the students will burn measured amounts of readily available fuels (diesel, kerosene, gasoline, engine oil, and RIC nitronite) in a controlled environment. The students will measure the rate in temperature of a known quantity of water to gauge the amount of heat each fuel released. Performed simultaneously, in Dirty Burn students will add the products of combustion in a fly apparatus and measure the amount of particulate matter that each fuel produces. The students will then evaluate which fuel has the least amount of particulate matter, which will lead to a discussion of other waste combustion products that may be more difficult to remove and require expensive catalytic reactors.

Lesson 4: Transparent Engine, Animated Engine
In this lesson, research group, or individual student lesson, the students will analyze and diagram the various kinds of engines that are used in transportation. High-speed video of the operation of an alcohol fueled internal combustion engine and computer simulations (animatedengine.com) of different engines provide insight into how the internal combustion process works in engines used for transportation. Students will also investigate the applications of fuel properties in the design of engines and fuel systems. The teacher will provide a method (Graphing Organizer) for task notes during the demonstration.

Lesson 5: Engine Characterization Spreadsheet
In a Virtual Laboratory environment, students will use an engine characterization spreadsheet to adjust engine parameters to model and optimize the characteristics of an internal combustion engine. Changing the compression ratio will cause a corresponding efficiency until friction losses begin to dominate. Changes in the intake pressure and the Equivalence Ratio also impact the efficiency, but also have an impact on emissions. Changes in engine speed can produce an increase in power, but efficiency is lost as some point to friction and airflow.

Lesson 6: Advanced Internal Combustion Engine (AICE)
Data from the Advanced Energy Research Building (AERB) and from the Advanced Internal Combustion Engine (AICE) labs will be used to generate ACT style questions where the students will analyze several graphs and tables of data to see how changes in one parameter can influence others. Data will address fuel efficiency, different fuel mixes (AERB), combustion simulation (AICE), and efficiency (AICE).

Lesson 7: So You Want to be an Engineer?
In this lesson, the students will work on a problem where they must use their scientific knowledge to make the world a better place.

Conclusions
The research experience at Michigan Technological University has been instrumental in the development of the students. It was quickly realized that the equipment and instrumentation that was used in the Advanced Engine Research Building (AERB) and the Advanced Internal Combustion Engine (AICE) lab was beyond the budget of the school district, but the fundamental concepts were well within the abilities of high school students to grasp. The data from the experiments to be used for our high school students to evaluate and draw their own conclusions.

Our procedure was to observe the initiation of the experiment, and ask questions of the graduate students as the experiment was running. During the diesel tests, where the accumulation of data would take 10 to 15 hours, we would obtain the initial data (as the grad student running the test did not have this luxury), then return to the testing environment and ask more probing questions to get at the heart of the conduction of the experiment. We were able to determine the independent and dependent variables, the conditions of the experiment and why the experiment is conducted, the ways it is done, the industry requirements that must be satisfied, and real-world conditions that they are modeling.

Surrogate fuels are used in the Advanced Engine Research Building (AERB) for their tests and characterizations. Surrogate fuels are simple blends of fuels that are easier to control and model than the complex blend of components that exist in fossil and alternative fuels. When compared with the alternatives of modifying a factory diesel engine, or building a transparent engine, or a continuous pressure apparatus, the benefits of the Combustion Vessel (CV) approach become more apparent. The more pressure, more design. Fuel type, pressure, type, and other parameters can be easily modified, and the results on liquid temperature, vaporization, and combustion measured. High School students interpret the data to gather meaning.

This experience emphasizes automotive engineering, but opens up the opportunity to discuss the field of engineering in general, and that engineers are creative problem solvers.

References Cited
An Inconvenient Truth: http://www.climatemelt.net/ (by no means the only site, but a good one and favored at the end of the film)
Numerous sites listed in the accompanying lesson plan document.
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