ENGLISH 1302: Advanced College Rhetoric: Writing in Engineering
Texas Tech University
Unit II: Describing a Problem

Example Problem Descriptions

The following examples are excerpted from students' final design reports in upper-division engineering courses.

Example 1

Description of Problem

The goal of this project is to provide an inexpensive, fully capable alternative to the current R/C planes available on the market. A quality R/C airplane can range anywhere from $100-$20,000. R/C products have a fairly large customer base in the military, law enforcement, search and rescue, commercial and hobbyist market segments.

Military and law enforcement use drones to do reconnaissance and surveillance, as well as provide aerial support to ground troops. In many situations it is safer to send a drone in before sending in soldiers. Law enforcement, as well as military can use drones for dangerous search and rescue missions as well, bomb disposal or scouting missions.

In the hobbyist and commercial segments, an R/C airplane is to show off one's skill in flying. Another use for an R/C airplane is to take unique pictures or videos of an event or landmark while flying over.

A major competitor for products produced by AA&A would be an entry-level model from Dragon Fly Innovations, such as the Dragonflyer X4, which costs $8,995. This model offers extended flight, weighs 1.5 lbs, and offers a payload of .5 lbs, typically used for video equipment. The Dragonflyer X4 offers flight times of up to 12 minutes. These specs were used as the benchmark. AA&A set goals of a 2 lb airframe weight, 2 lb payload, and a flight time of 45 minutes.

Manufacturing and materials are key to offering a competitive product at a more reasonable price. The Dragonflyer X4 employs expensive materials such as carbon fiber, glass filled nylon and stainless steels. By using less expensive materials, such as balsa wood and plastics, the cost can be greatly reduced. AA&A has successfully built and tested a prototype plane meeting the design goals set forth by the company at a fraction of the cost of the Dragonflyer X4.

Example 2

Description of Problem or Need

As of right now, there is very little known about the thermal properties of CEB's. It is thought to have similar properties to that of concrete. Using various energy simulation modeling software programs, a wide range of structures made of either CEB's or more common materials can be tested and compared. This would facilitate the development of a compressed earth block that is more efficient than concrete and conventional building materials. Also, this testing will provide a better understanding of the rate of heat transfer through the material. The data collected will be used to calculate the ideal dimensions that are necessary to produce an optimal block. This information will vary with climate and other variables. It is hypothesized that the CEB's collect heat during the day, so that by the time the outside temperature drops in the evening, the heat is being partially used to heat the interior of the building at night. Theoretically the cool temperatures of the night time hours will have the opposite effect, when by the morning the blocks will have lost enough heat to the interior and exterior.

The primary objective of this design project is to characterize the thermodynamic behavior of compressed earth block buildings. This will specifically be accomplished by experimentally acquiring physical and thermal properties of compressed earth blocks, and then using energy simulation software to compare modern buildings built with conventional materials to buildings constructed with CEB's. The key business goals are mainly to create valid thermal models of CEB buildings and building materials, as well as demonstrate and economically quantify the advantages of constructing with CEB materials. EarthCo Building Systems will use project's results to further improve their product.

Example 3

Description of Need:

After speaking with Larry Williamson, our funding sponsor, we managed to translate his requirements for an electric conversion of his Model T Pickup into a feasible set of specifications. Preliminary needs included some desires that were not viable, including a driving range of 80 to 100 miles per charge, a cost of fewer than 6000 dollars, and not removing any of the original parts. The goal of our project was to design, engineer, and fabricate a mechanical to electrical conversion of the provided vehicle. Realistically, the vehicle would have needed to be capable of operating at in-town velocities, providing ample acceleration, and have the capability to tow a light float in a parade. More realistic goals include a maximum speed of approximately 45 mph, a range around or more than 60 miles per charge, and acceleration to 30 in 15 seconds or less.

Because funding was short, we were not provided with the vehicle and instead will be using the desired vehicle specifications to provide a plan to convert the vehicle at a later date. Our plan will consist of a tentative parts list for the conversion; a Simulink model for speed, acceleration, and range (using the specs for some of the parts on the list); and a demonstration of the motor mount and connection.

Our motor will mount via a brace to the real differential using a connection we designed to emulate a standard driveshaft. The motor will be secured by a vertical plate in the front (rear of the motor) and a skid plate underneath. Testing was performed, both analytically via ANSYS and Inventor and physically using a scale workup of the mount. The skid plate, which was not part of our testing, will have a set of bushings to alleviate and dampen excessive vibration issues that may arise. The motor connected to the differential through a paired set of yoke and u-joints that will allow slack in alignment and provide a mechanical breaking point to avoid damage to more expensive parts such as the motor or rear end. The connection acts as a close simulacrum of a modern driveshaft, and analytical and physical model testing bears this out.

Example 4

Description of Problem or Need

Forest fires are often located in extremely dangerous and even unreachable locations, which makes it perilous for firefighters to physically extinguish these fires. This modern industrialized world currently poses greater risks than ever before, and therefore creates a need for even greater technological innovations. The most efficient solution for reaching these inaccessible places without placing a human being in danger is an Unmanned Aerial Vehicle, or UAV. These vehicles are remote controlled and are also less expensive than a life-size aircraft. However, the UAV is not only limited to firefighters. These aircraft can also be used by the military, law enforcement officers, park rangers, and hobbyists.

The specifications for the UAV are limited by the Student Professional Development Conference (SPDC) Competition requirements, designated by the American Society of Mechanical Engineers. The goal of the competition is to design a small UAV that maneuvers through the obstacle course, a 5 *m* by 7.75 *m* rectangular area made up of two gates. Each gate is 2 *m* wide by 3 *m* high, with a 1.5 *m* high opening, and the UAV is required to navigate through each of them. Next, the UAV must drop a payload in the designated "target area" and then proceed to return to the starting point. In addition, extra points are awarded for flying back through each of the gates on the return journey.

The competition requirements are the following ("Student design competition"):

1. Must fit through a 28 *in* diameter hoop.
2. Must be powered by batteries.
3. Must be controlled through a wireless transmitter/receiver radio link.
4. All devices must have a readily accessible and clearly labeled master shut-off switch.

The final tetra-copter design will meet the competition specifications stated above, and will simultaneously be well suited for commercial use.

Example 5

Description of Problem or Need

This project entails the development of a fuel economy process to preheat hydrocarbon fuel so that it may be supplied to an internal combustion engine in a form that will allow more complete combustion to occur, thereby improving overall engine efficiency. In order to accomplish this task, a heat exchanger must be designed to preheat gasoline safely and effectively before the fuel enters the combustion chamber. The goal of this project is to design a prototype for the heat exchanger and conduct an experiment to determine the final temperature of the gasoline and the amount of vapor fuel produced.

The gasoline is required to be heated between 150°F-250°F with an error of ±5°F. Therefore, the heat exchanger must be designed with a fluid used in a combustion engine that is capable of heating the gasoline to the desired range. There is no constraint on the amount of vapor fuel produced. The amount of vapor produced is merely for future reference to related projects that will involve designing a control system for the heated liquid fuel and the vapor fuel to the combustion chamber of an engine. Safety is the most important factor in the design, because gasoline is highly flammable and combustible. However, since the flashpoint for gasoline is 456°F, there is no concern for spontaneous combustion at the desired operating temperatures. Open flames, sparks, and static electricity pose the greatest threat to igniting the fuel. In order to ensure a safe experiment, all pipelines should be evacuated of oxygen and the experiment should be conducted outside, away from any open flames.

This project requires Mat Lab simulations, detailed drawings and schematics, a heat exchanger prototype, and experimental data. Mat Lab simulations are used to estimate the final temperature of the gasoline during operating conditions when heated by the exhaust gas, estimated with carbon dioxide thermal properties, and when heated by the engine coolant, estimated with water thermal properties. These simulations also provide size requirements for the heat exchanger and time required to reach steady state conditions. Detailed drawings of the heat exchanger are developed from the Mat Lab simulations, which are used in the construction of the prototype. Schematics of the experiment are used for the setup and provided a layout of all of the materials needed. The data obtained from the experiment is used to verify the accuracy of the Mat Lab simulations for use in the final design.

Example 6

Problem Description:

Surgeons use staple guns instead of sutures for many procedures. While titanium staples give a distinct advantage to sutures there are still issues with them. Although there is less skill involved with the use of a staple gun, the metal staple could still leak like a suture. Some metal staples also interfered with the MRI machines and all require an extra surgery for removal. This was why the push came for bio-degradable staples. There are current models that use bio-degradable staples. However, none had been developed that are small enough to be used effectively in laparoscopic surgeries.

This design team inherited a staple design from a previous semester around which to build a release and folding mechanism. This staple was comprised of a two piece polymer that was to be melted together to form a bond and seal the tissue together. This staple would then bio-degrade in two years time, meaning that it required no follow up surgery for removal of the staples. The polymer staple would not interfere with MRI machines either since there was no metal in the design. The design for these mechanisms was based off of the current model used for laparoscopic surgeries so that they would be immediately implemented and would require minimal training to use. This was done not only so that the doctors would require less training, but also because of the ease of use the current model had.

The staple design the previous design group invented gave distinct advantages over the titanium staples. The biggest was that it leaked less than the metal staples. This was due to the bigger surface area that the plastic staple had versus the metal staple. It also created a tighter seal to further decrease the leakage that was present; both of these claims were proven by the previous design group. This method would decrease infections which was better for the overall health of the individual. The tremendous advantages that this staple has over the current titanium staples are the reason that this project was initiated.

Example 7

Description of Need

Contemporary mountain board trucks can take a physical toll on the rider. As they go off jumps, their bodies absorb the impact instead of the board. This repetitive action could lead to serious injury or joint problems. Many accidents have occurred because of the lack of proper support for the rider, which can be avoided by proper equipment. Figure 1 shows an example of a typical set of trucks that would be installed on a mountain board. There are no springs or dampers to cushion the blow for the rider.

Figure 1: Current Mountain Board Truck Design

Mountain boarding has not changed, component wise, since it was invented. Therefore, riders are bound to certain riding styles and techniques. Our business is changing that completely. Our trucks will allow the rider much more freedom in their riding style. Skilled riders will find it easier to manipulate the board to their liking.