2007
PROBLEM STATEMENTS

These Problem Statements are the preliminary problem statements for the 2007 TEAMS competition. Actual problems may be edited and expanded upon in the actual TEAMS exam; however the overall thrust of the problems will remain. The order of the problems may change as well.

Students are encouraged to research the general problem topics and terms they are unfamiliar with in preparation for the competition. Check the JETS website frequently for additional information about the problems that may become available.

Problem Statement: **GPS engineers help aircraft pilots fly under any weather conditions by providing them with critical guidance information during flights.**

Air transportation of passengers and cargo constitutes an important part of the infrastructure of a developed nation. Schedules must be kept regardless of weather conditions. A variety of aircraft instruments and radio navigation systems have been developed over the past century to provide aircraft and pilots with guidance information continuously throughout a flight. Over the past ten to fifteen years, the United States satellite-based navigation system known as the Global Positioning System (GPS) has come into common use.

Problem Statement: **Transportation engineers design the extremely important travel signs of the Interstate Highways.**

Roadway signing is needed to help drivers get to their destination. It provides them with vital information that they need before they have to take an action while driving. Information needs to be visible from large distances on the Interstates because of the high speeds traveled. Large signs are needed for the letters and symbols large enough for these signs. Interstate signs can reach sizes in excess of 15 feet in length and 10 feet in height. The length and height of guide signs depends on the Speed Limit of the road and the amount of letters in the name of the destination.

Problem Statement: **Automotive engineers help consumers determine whether their next car should be a hybrid-electric or not.**

You are ready to buy a new car and are concerned about the high gas prices and the environmental impact of most automobiles. You have heard about different kinds of hybrid vehicles and are trying to decide if one of them is right for you. You asked an engineering firm to provide input to you. It is your engineering group's task to provide information from which the consumer can make an intelligent decision.

Problem Statement: **Mining engineers protect the lives of coal-miners by designing safety equipment**

Since coal is the most abundant fossil fuel energy source in the United States, mining engineers are important for the continued success in providing the necessary energy for society. Mining engineers are responsible for the development and operation of a typical coal mine. They determine safe ways to extract and prepare the coal for use by industries. Mining engineers are responsible for the safe removal of the coal, as well as economical and environmental issues involved. Electrical and mechanical engineers work on the design of equipment used in mining and develop safety equipment and procedures to protect the miners. Mining engineers also extract other minerals from the earth and process the ore prior to shipment.

Problem Statement: **Paper mill engineers help save energy during the production of recycled paper**

Paper making is an energy intensive process. A paper mill making a product made from 100% recycled fiber is given two options for reducing its energy use (1) modify the pressing operation so that the solids content of the paper entering the drying operation is increased from 45% to 50% (2) use a newly developed additive which will increase the sheet strength and allow the same product to be made using 10% less fiber. The total costs for both options are equivalent. You are asked to decide which option will provide the greatest energy savings.

Problem Statement: **Bioengineers discover ways to produce human insulin to treat diabetes**

Bioengineers are responsible for developing processes such the recombinant DNA process described here. They also develop artificial joints and human organs and medical tools to support surgeons. Chemical engineers are involved with sizing the process equipment and developing the flow path through the process. Electrical and mechanical engineers build the support systems such as the instrumentation and distilled water supply.

To meet this year's increase in global demand, your team is to design a manufacturing facility capable of producing 1800 kg/yr of human insulin. You will be using a recombinant DNA process by growing E. coli bacteria that contain Trp-LE'-Met-proinsulin. You will need to provide the proper growth media, air, heat and agitation. After a batch has matured, you must homogenize the material then separate the product using centrifuges, diafilters and chromatography in a series of steps with specific conditions as you extract and purify the product. Finally, the insulin crystals must be freeze-dried into crystals for final distribution.

Problem Statement: **Construction engineers evaluate and manage the risk involved with the impact of extreme weather conditions on the operation of Hospitals in areas vulnerable to hurricanes.**

Your engineering team has two tasks:

TASK ONE: you must ***characterize the impact of hurricanes*** on the campus of a major hospital located in a coastal location vulnerable to hurricanes, in order to make decisions regarding the design of a new *central oxygen supply facility* (hereinafter "the facility") to replace an existing older facility that has reached its maximum capability.

TASK TWO: based on the characterization of hurricane impact you must ***establish design criteria*** to build the facility and reduce the potential for damage to it from the impact of future hurricanes.

Problem Statement: **Nuclear engineers discover techniques to diagnose and treat illnesses such as cancer.**

Nuclear principles are used in many applications for society's benefit. In medicine nuclear imaging is use to diagnose illness, to treat cancer, etc. Another major application area is energy generation. Nuclear applications for weapons have been an issue for many years. Your group has been asked to investigate some selected nuclear applications.