DESIGN AND PERFORMANCE OF A PAPER AIRPLANE

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SYNOPSIS

There is a problem existing in most engineering curricula in the Philippines at present. The problem is the lack of an engineering subject, which will allow first engineering students to understand what engineering is all about. To solve this problem Engineering 121 was introduced in all engineering curricula in the College of Engineering of Central Philippine University. One of the important components of the curricula is a design contest for all first year students enrolled in this subject. The design component is simple what is important are the students learning what is needed in the undertaking the design process. This paper explains what was done during the design competition in the making of a paper airplane

▸ INTRODUCTION

Engineering 121 is also known as Freshmen Project Design, which is its course title; Central Philippine University offers it to first year engineering students. It constitutes one academic unit. This subject is a laboratory subject and meets three hours a week. This course covers a design contest, what engineering proposals should include, how to make oral presentations, how to make projects, how to write final reports, and on identifying the audience. It is learning how to write a report, make the objective of the report, and present the report. The Freshmen Project Design Program is managed by a Course Coordinator who is responsible for organizing the course, presenting lectures, insuring that design teams are formed and are aware of course requirements and sets the deadlines.

The goal in offering Engineering 121 is to orient all first year engineering students what engineering is all about and is needed. The objectives of the subject are to: provide students with an experience and background on their chosen field of study, look for solutions for problems in our daily lives through designing and assembling, prepare the students for more advance courses in their fields of study, and teach students what goes on in the entire design process including Proposal and Final Report making.

One of the most important components in the subject is the design competition for all students. It seeks to teach students what to do in competing with others when undertaking a design project. The design selected for this competition was the design of a paper airplane, which will fly the longest distance, the longest time and perform the best aerobatics.

Paper airplanes are simple and inexpensive toys made by children of all ages. Although this can be made by almost anyone considering its practicality and simplicity, the designs involved in making paper planes varies. The structure itself includes many properties to consider like gliding flight, ascent, aerodynamics, etc. The reason for the contest is to motivate design teams to brainstorm and create innovative designs for a paper airplane. This will help them exercise their analysis, judgment and teamwork. After the contest, this will enable teams to reflect and evaluate their design and its efficiency. This may also help them answer what went wrong, what made it successful or what should be done to make the design better.

Upon completion of this design project, each student in the team will be able to demonstrate creativity in designing paper airplanes by:

1. Creating and testing designs to compete in the areas of longest flight duration, longest distance traveled and aerobatics.
2. Creating designs that have predictable performance characteristics in terms of longest flight duration and longest distance traveled.

Preliminary Work

Working in teams of 5-6 students, each design team is required to construct paper airplanes to compete in the categories of longest distance traveled, longest duration of flight and aerobatics. Teams must submit a maximum of three different airplanes, one for each category in the competition. Hybrid designs are acceptable too, and in fact, encouraged. (Note: a hybrid design would be the case where a single airplane design becomes appropriate for competing in two or more categories). Other rules of the competition are as follows:

1. All planes must be constructed using no more than three ANSI-B size sheets (17inch X 11 inch) or three ISO-A3 (420mm X 297mm) size sheets.
2. All planes should be constructed of paper, tape,

thread, glue, and weatherproof coating. Paper clips may be used as ballast weights. No other materials/items are allowed.

a. All paper aircraft must be hand launched. No rubber bands, catapults, rocket engines, linear accelerator or the like will be allowed.

b. All planes must be heavier than air. No hydrogen, helium, or hot air is allowed.

c. Each team should compete in all the three categories of distance, duration and aerobatics defined as follows:

   i. Distance- is determined as the greatest distance from the point thrown to the point of impact with any solid object.

   ii. Duration- is determined as the greatest flying time from point of release to the point of impact with any solid object.

   iii. Aerobatics- is defined as the art of precision flying where pre-set patterns (called maneuvers) are drawn in the sky by the airplane to form a sequence or schedule. Loops, rolls, vertical flight, level flight and inverted flight are the typical elements involved. Each of which has corresponding points. The one with the highest point is considered the winner

A total of around 500 students enrolled in the first year classes joined the competition. Participants include only those who are bona fide students of Central Philippine University taking up Engineering 121. They work in teams of 5-6 members. The technical advisor is responsible in seeing to it how each group will design their project.

▸ PLANNING AND DESIGN

A team of 6 members joined the contest. They review the rules and brainstorm ideas. They decided to research properties of paper airplanes that are vital in the competition. They learned that aerodynamics plays a big role in the efficiency of paper airplanes. The discussion about aerodynamics includes the understanding of gliding flight, throw, ascent, dihedral, anhedral and folding time. They also discuss certain factors like weather that might affect the condition of the paper plane during the contest and brainstorm ideas how these can be handled. After understanding the properties of a good paper airplane, the team decided to look for existing paper airplane models that can be innovated to meet the demands of the contest. The best and the most common source the team used is the Internet. It has a wide coverage of existing paper airplane designs. Some designs already won an award, so it's good to know the properties that made it successful.

After data has been collected, the team decided to test the paper airplane models in the Sports Complex in Iloilo. They chose three best paper airplanes from the test to compete in the three categories. They focus on those models and brainstorm how they can make it more efficient. The design that they will use to compete in aerobatics was patterned to the propeller of an electric fan. The rule states that the winner in this category is determined by the most number of points. Points are based upon the number of tricks performed by the plane. For example, a roll has a corresponding 6 points, if the paper airplane rolled three times it will have a score of 18 points. Knowing that the propeller is really designed to spin fast, the wings of the plane are shaped like it. Paper clips were also added on the plane's bumper to add weight on that part and cause it to spin radically. The performance of this paper airplane met the design team's intention to let it spin or roll fast.

▸ INITIAL DESIGN COMPETITION

All students in each section had a preliminary contest first, with the supervision of their technical advisor. Design teams of the same section will compete in the three categories. Winners in the preliminary contest will compete for the final. Each section must have a maximum of three different design teams to compete for the final contest. Design teams who won in the preliminary contest will represent their section in the category they have won. Appointed contest officials will supervise the final contest.

▸ FINAL CONTEST

Design teams assemble at En200 for final briefing about the final contest. Rules were reviewed. Only those teams who won in the preliminary contest where allowed to join the final. Php 500 will be given to the winners of each category. Only one team may be declared as winner in each category. The contest proper started right after the final briefing. The contest was held in front of Rose Memorial Auditorium. A total of 15 teams representing one section each prepared their paper airplanes. Contest was divided by categories. In each category, teams are given three trials to fly their airplanes. The best result in the three trials will be considered. Previous rules were followed in determining the winner of each category.

▸ RESULTS

Two design teams won the contest. One team won in the longest distance category. It was estimated that the total distance traveled by the airplane was around 80 meters and this bested the other 15 teams. The team was given the price of P 500. The other team won the longest flight category and recorded a time of flight of almost 25 seconds. The same team that won the logest flight category won the third contest, which was airobotics. They therefore won a total amount of P 1000.

▸ CONCLUSION

The members of the team who won in the longest flight and aerobatics category were very happy because they can use the amount to fund their upcoming proposal. Resourcefulness and being innovative really made a bi deal in the team's success. They found a world record paper plane for the longest flight in the Internet. They used it and as a result that plane proved its world record capabilities. The plane that was used in aerobatics was just a simple dragon plane. It was only modified. Its wings were pattered to the propeller of an electric fan. As a result the plane spinned radically like a drilling machine. The judges didn't even count the rolls because it was too fast to be counted. What was used to determine the winner was the visual analysis of the no of turns each airplane made.

The team learned the value of planning and brainstorming. A good design usually comes from a good plan if not always. It is good to have a background first of what you are doing before getting involved with the real thing. Research work is a big help in gathering resources and information. A good background is needed in a good procedure and a good procedure is needed in a good result. Therefore, the quality of the finished design depends on the quality of planning and procedure.

There are several important concepts we learned from the competition. The first was presenting a design proposal. We found what was needed and what did we do was important in the presentation process. The second important trait we learned from the competition was understanding what the design process consisted of. The final important trait we leaned was understanding what is engineering generally all about based in the undertaking of the design project. This understanding will now make us realize what engineering is all about. This in essence is what we did in undertaking a paper design contest which was part of the first year design project.