AE528/628 Design Project Summary

Wichita State University holds an annual engineering competition known as Bronze Propeller. During this time WSU undergraduates, high school students, and professionals compete in their respective categories to win cash prizes. This year's competition had a mission of flying five laps with a payload of tennis balls set to drop autonomously after the second lap. In addition to this, the aircraft must be able to be stored in a 11x7x36-inch storage box and be assembled in a five-minute time frame. Many competitors may find this challenge especially difficult with all these rules and potential failing criteria. But a plan must be made and executed thoroughly to beat the competition.

MAROSHELITE is a team comprised of five engineering seniors who each have their own specialty in airplane design. Starting off we have Tenzin Sherpa our aerodynamics lead, Nick Livingston the propulsion lead, Jun Chung Teoh the team coordinator, Deepansh Arora the structures lead, and finally Robert Mabrey the stability and control lead. By using each individual's unique talents and knowledge, this mission could be accomplished within the limited design time. The phases of design that all senior design students were subjected to could be briefly summarized as a proposal, concept selection report, conceptual design report, preliminary design report, and a detailed design report. Unfortunately, due to the unforeseen pandemic, all teams were unable to compete or even construct and test their aircraft.

Before starting on designing an aircraft all students must submit a proposal entailing their members, meeting times, strategy and competition analysis, and schedule for submitting deliverables. Next, was the concept selection report (CSR), in this report, every member was required to virtually sketch an aircraft they thought would be suitable for the mission. Then all the sketched aircraft would be subjected to a thorough weighted evaluation to determine all pros and cons. The screening criteria MAROSHELITE deemed as most important were, the weight of empty aircraft, lift at takeoff, the complexity of the design, payload clearance, maneuverability, ground clearance during landing, and number of components during assembly. With all aircraft evaluated, the decision was made to continue with a generic high-wing aircraft, because it provided simplicity and an excellent take-off and landing properties.

Finishing off the first semester was the conceptual design report (CDR). In the CDR, MAROSHELITE took the first crucial steps in designing their chosen aircraft. The contents of this report included airfoil screening and selection, wing dimensions, wing displacements and loads, control surface sizing, propeller selection, and motor specifications. Before diving into this project, three pillars of the design were established by all members to ensure that all selected parts were in accordance to MAROSHELITE's standards. The pillars are listed as reliability, durability, and above all simplicity. The airfoil selected was an SD7062. This airfoil was chosen because during the screening criteria it scored consistently higher than all other conventional airfoils. The size of the final wing was 54in span and 7in chord, by having such a large wing the team will be able to lift a larger payload of 8 balls max. But a disadvantage to having a large wing is the ability to fit it inside the necessary box. This was when MAROSHELITE implemented its interconnected wing technology, allowing for a precise spar slot system attached by pins. The stabilizers were sized according to the main wing to achieve a stable and balanced aircraft by designing the initial static margin to a specified number of about 12.4% of the chord length.

Entering into the second semester, MAROSHELITE was tasked with finishing preliminary and detailed design. This entailed progressing upon the conceptual design report and submitting strong validated numbers along with detailed CAD drawings that depict the construction process and layout of every component. Unfortunately, due to the recent outbreak of COVID-19, many students were left out of construction and testing. However, looking back at MAROSHELITE's progress and deliverables, we believe that the team did a good job of coming up with ways to combat the negative situation they were in and did what we could to further the progress on the plane.

One of the problems our team had during the PDR was trying to accommodate the 54" wingspan our team had selected. The issue the wing gave us was primarily with the mission required box size. To have a wing that long, a horizontal stabilizer of a proper size and moment arm away from the wing are needed to

maintain a stable aircraft. Because of this, several new designs had to be made. One of these new additions to the plane's design was having a larger detachable horizontal tail which allowed enough room to get the 3 segments of the wing into the storage box. By increasing the span of the horizontal stabilizer, MAROSHELITE could ensure stability was met in both loaded and unloaded configurations.

Another issue MAROSHELITE faced was trying to come up with a simple, durable, and reliable dropping mechanism. Many ideas were disregarded such as having a sheet cover the opening where the balls roll out from. Then when it was time to release the balls, the sheet would roll-up. The issue with this design was it would require a rather big servo to pull the sheet open against the force of 6 balls binding the sheet closed. Another idea was to use some form of spring mechanism to contain, then launch the balls out of the plane, the issue here was the complexity of the design and uncertainties associated with where the balls would land. Finally, MAROSHELITE decided the best way to do it was to design a trap door with a ramp that would swing open using a servo. The issue here was trying to design a pull system to open the door, this was accomplished using a string that was wound onto a shaft attached to the servo, raising the hinged door upward.

A final problem resolved in the PDR was the issue of a poor weight build up spreadsheet. The team discovered this issue after the initial preliminary design report and began doing a full analysis and reconstruction of the C.G and weight build-up. It was discovered that the weights and positions of components were not properly input, thus giving us faulty values. These were corrected and then validated through VSPaero.

During the detailed construction of the aircraft in CATIA, MAROSHELITE encountered very few problems and had many good engineering decisions made. One instance of this occurred when figuring out how to properly connect the stabilizers to the body of the aircraft. A decision was made to create slits and holes that first connected the two stabilizers and then could be inserted into the rear of the fuselage. Secondly, it would be the ingenious design of the bulkheads account for our internal payload ramp. Our engineers ensured the payloads clearance when being released.

After resolving these design issues all of the big issues were completed and our team felt as if most of the foreseeable surprises were found and we had a safe and competitive plane, next construction and testing would have been done however the teams did not have the option to follow through.