Senior Capstone Design Class-Academic Year 2003-2004

Four design projects were available to the incoming senior class this academic year. The projects were selected to allow the students to explore contemporary issues.

**LEO RESCUE VEHICLE** The Columbia disaster and subsequent investigation have raised many serious issues concerning International Space Station (ISS) and Space Shuttle operation safety. Current NASA planning includes an intermediate launch/recovery system to back-up/replace the Space Shuttle. This new vehicle will utilize existing technology and boosters, and will be operational by 2007. The need for a rescue vehicle for these and other LEO manned missions is critical.

**LEO Rescue Vehicle – Project Statement**

Design an LEO rescue vehicle which is compatible with ISS operations (including the vehicles which support same) and other LEO manned missions. The vehicle will be designed with current technology and be operational by 2007 thru the expected life of ISS.

**SPORT AIRCRAFT** The FAA has issued a Notice of Proposed Rulemaking to create a new certified aircraft category between ultra-lights and normal category airplanes. This new category is called the Sport Aircraft category and shows promise to bring many new people into aviation by providing them with more affordable aircraft which will have improved safety standards.

**Sport Aircraft Design – Project Statement**

Design an aircraft to meet the new FAA (proposed) Sport Aircraft standards. The aircraft design criteria will be based on a market analysis of existing information. The project will include building a wind tunnel model to verify performance, stability and control.

**SAE AERO DESIGN RC MODEL COMPETITION**

SAE International supports a design competition which challenges engineering students to design, fabricate and test a heavy-lift RC airplane.

**SAE Aero Design West RC Model Competition – Project Statement**

Prepare the design and build an RC aircraft to meet the 2004 SAE Aero Design Competition rules. The students involved in this project will participate in all aspects of the SAE competition including timely submitted written reports, drawings, analysis and presentations. A wind tunnel model and testing is required.

**HIGH ALTITUDE SURVEILLANCE AIRCRAFT**

Space based platforms have demonstrated the value of monitoring Earth resources and providing global communications. These space based platforms are very expensive. NASA is investigating using robotic high-altitude solar-powered aircraft to reduce cost. Emerging technologies show promise to make these vehicles much smaller and therefore potentially less expensive.

**HASA – Project Statement**

Design a high-altitude aircraft which is capable of keeping an Earth surveillance or communications payload aloft for very long periods; the aircraft will be powered by an in-flight generated power-source. The aircraft design will be based on market and cost analysis. A wind tunnel model will be built and tested to verify performance, stability and control.

Students wrote job application letters to apply of their team and work discipline of choice. Each team was lead by a Project Manager and Systems/Weights Integrator. The aircraft design teams had the following working disciplines: Aerodynamics (Perf/Stab/Control) & TPS Systems, Flight Control Systems, Structures and Propulsion. The spacecraft design team had the following working disciplines: ReEntry Aerodynamics (Cross Range, Perf/Stab/Control), Thermal Analysis & Thermal Protection Systems, Landing Aerodynamics (Perf/Stab/Control), Flight Control Systems, Structures and Propulsion.

Students were expected to become familiar with all aspects of their design project, conduct necessary research and trade studies, define detailed design requirements, run their meetings in a professional manner, do all the design work, and present their design results in written reports and oral presentations. The instructor and teaching assistants acted as facilitators to give the students direction, listen to their presentations and critique their design. Students used SolidWorks to define their vehicle. The Conceptual Design Review (CDR) used Power Point with facing page text; it was moved up to week 10 of the semester in the hope model construction projects could begin before the end of fall semester, providing more time for testing at the end of spring semester.

www.aem.umn.edu

(Continued on next page)
Students were organized into the following Project Groups during spring semester during which they designed, built and tested their models. LEO Rescue Vehicle: Full-Size Mock-Up and Detailed Orbital Maneuvering Simulation. SAE Aero Design West: Wind Tunnel Testing, Wing & Landing Gear Structural Test and Radio Controlled Model. Sport Aircraft: Wind Tunnel Testing and Radio Controlled Model. HASA: Wind Tunnel Testing, Primary Structure Analysis & Test and Radio Controlled Model. Each Project Group prepared a proposal for the work they intended to accomplish during the semester. The proposal included a description of the Project Group's goals and means by which these goals will be achieved. It included a budget (all expenses including AEM Aero Shop time) and Gantt Chart (with at least four measurable milestones). Each Project Group was given a budget (including Aero Shop time) based on their proposal. The Project Groups meet with the instructor and teaching assistants on a regular basis during the semester. The meetings were conducted by the students and included summary of work accomplished, identification and detailed discussion of critical issues, evaluation of work planned vs. work accomplished, a review and updated budget and schedule, and work planned for the next week. Professional people are expected to return some of the benefits afforded by their training and status back to their communities. To this end, students were required to talk to elementary, middle or high school students about Aerospace as a part of the class activities.

Two field trips were available to students during the academic year. The first trip took us to Cirrus Design in Duluth Minnesota. Cirrus manufactures the all composite SR-20 and SR-22 single engine airplanes. The airplanes are unique in that they have an all-airplane parachute recovery system. During the visit former student Pat Bergin showed us how they are ramping-up production from two airplanes per day to up to four airplanes per day by redesigning key parts of the airplane; their production rate has now surpassed Cessna. We also visited Whiplinger in South St Paul, the world's largest producer of floats and many after market STC’s. Former student Charlie Whiplinger gave us the tour and showed us how they upgrade production agriculture spray airplanes with turbine engines and floats to make them into forest-fire fighters.

James Chiles, author of the book Inviting Disaster - Lessons from the Edge of Technology (Harper Business) and presenter on the History Channel Inviting Disaster series talked to the students about selected ethical topics from his book. The book was also used as a source for student discussions about ethical issues.

Two former students also made presentations to the class. Terry Johnson / PemStar talked about ISO 9000. Eric Kaduce talked about preliminary wing design at Boeing.

I have been teaching the senior design class starting in 1983. During this time I have been able to share some of the exciting experiences I have had as a professional Aerospace Engineer. It has been a wonderful experience to work with students and take them on trips to the Moon, Mars, Comet Temple 1, and look for life on Europa. We have designed RLV's, LEO rescue vehicles and a variety of airplanes from modifications of a BD-5 to aero-cars, business airplanes, amateur built racers, sport airplanes and HASA's. I need to thank Dr. Garrard and Dr. Leo for their strong support during these years. I also need to thank you, the alumni, for your support of the Akerman fund. Forty two years ago I graduated from the department. My adventure started with the NASA Flight Research Center at Edwards CA working on the worlds most advanced and exotic aircraft: X-15s, Lifting Bodies and the YF-12. We must all thank our AEM department for the wonderful career opportunities it has made possible for all of us; it deserves our continued support. I retired from teaching at the end of this academic year and will be spending much of my time at Bellanca / Alexandria Aircraft LLC in Alexandria MN. My aerospace adventure continues.

Andrew Vano
Akerman Professor of Design (Retired)