Due dates (no extensions)

- One copy of a two-page essay describing the requirements of your design and your design concept due at 2:00pm in lecture on Tues., Feb. 9 (to allow technical feedback; if feedback is positive you can paste the content into your final report)
- Two copies of final Technical Report 1 due at 2:00 pm in lecture on Tues., Feb. 16, 2010.
- Any pertinent software (in a single compressed file) e-mailed to both the course instructor (ematkins@umich.edu) pertinent software, and no software is required for this project.

Problem Statement (also discussed in lecture Feb. 2, 2010)

Your team has been contracted by a growing company, Unmanned Unlimited, to propose a preliminary design for an Unmanned Aircraft System (UAS) that will operate over moderate durations (15+ minutes) in urban canyon environments. Vertical takeoff and landing (VTOL) capability is desirable so the vehicle can be launched/retrieved on rooftops. The UAS must carry a small video camera capable of transmitting its data back to the launch point, and it must be safe (bring no harm to people or property in its environment). The UAS must navigate through urban canyons autonomously, requiring an autopilot. Ideally, the UAS would also be built to be “frangible” (fragile + expendable): low-cost if lost and with at least a “shell” built from components that themselves either shatter or compress (e.g., as a nerf ball/dart) to minimize chance of harm to the environment on impact.

As a precursor to your design, Unmanned Unlimited has requested that your team provide a preliminary (2-page) description of your design requirements and concept to allow early feedback. This information can then be part of your final design memo, which must include the requirements and concept from your preliminary essay, details of your design (the primary content), and a brief (less than a page) overview of a flight test plan to certify the UAS for flight operations.

As you’re beginning to learn, an aircraft has many subsystems that must efficiently work together to achieve flight. Each member of the 5-member teams (with one exception) should therefore take responsibility for designing/documenting a required subsystem, in parallel working as a group to ensure subsystem designs are consistent and integrable into a common flight vehicle.

Subsystems to be designed include:

1. **Propulsion design:** Select an energy source (electric, fuel) and motor(s) from available specifications (online hobby shops have components – finding spec sheets may take a bit more search but you’ll find some force numbers). Specify desired operating range (RPM range) and associated thrust given your choice of propellers (based on online data – look but feel free to ask if you can’t find anything!) Estimate power consumption for different phases of flight (climb, cruise, hover, descend).

2. **Aerodynamic design:** Design lifting bodies (wing, tail) cross sections and dimensions to generate sufficient lift and balance moments. Specify control surface locations and designs. For designs with helicopters, work with the propulsion designer to establish appropriate forward and hover speeds.
3. **Materials and structure:** Propose a frangible construction method (materials, structural layout) for the aircraft that also will withstand normal flight operations without being overly flexible and with sufficient strength.

4. **Power & payload:** Based on propulsion and avionics requirements, establish range and endurance estimates for your vehicle. Select a wireless video system that meets platform mass/weight requirements and sketch an “urban canyon coverage” flight profile feasible given range/endurance and video transmission constraints.

5. **Avionics:** Propose an onboard instrumentation package and computing architecture. If you custom-design your autopilot electronics, that can be your emphasis. If you select an off-the-shelf miniature autopilot system, focus on how you would program it to achieve the baseline urban canyon mission and how it might need to be augmented to provide a sufficient level of safety for low-altitude flight through Manhattan.

You are free to consult any source of information on the web or in the library; please cite your sources of information in your final report. It is fine to draw inspiration from an existing design, but please try to be both creative and careful in your decisions and back them to the extent possible with “back-of-the-envelope” calculations and performance characteristics (power, propulsion, aerodynamic, materials) you find on the web or textbooks. Certainly your design will be “preliminary”, but please take care to perform and document any quantitative information and computations you are able to make.

**Report Format**

Please write your report in the memo format. We will review this format in the TC sections. Place a company logo at the top of the first page and the heading (To, From, Subject, Date, (Dist. (Distribution), Att. (Attachment)). Write a Foreword and Summary and place both items on the first page. On the second page, place the first-level header “Details” and provide a short introduction to your report.

Use sub-headers for all sections of your report and include a brief Conclusion. Use single spacing within and double spacing between paragraphs. Use 11-point or 12-point Times New Roman font and provide 1-inch margins. Left-justify your text and provide page numbers on all pages, except page 1 (but include page 1 in your page count).

Include drawings, images, tables and other illustration in your report as you see fit. Number your tables and figures and provide proper titles for all illustrations. Provide additional, less important data in an appendix. If you are writing programs, include the code in an appendix. If you reference material by other authors, please provide a “Works Cited” page.

**Grading**

The technical report will be graded on the basis of its technical merit and its merit as a technical document. It should be thorough, persuasive, technically sound, and clear. All team members will receive identical grades on the technical report.

The main body of the report should be no more than 10 appropriately formatted pages and the entire report, including appendices, should not exceed 16 pages.