Term Project Discussion

- What have we learned in this class?
- What tools can you apply to the project?
- What *could* you do as part of your term project?

Caveats, to Start

- The goal of the final project is to give you a chance to use the tools and other content discussed in this class
- I do **not** expect anybody (any group) to do everything I'm listing here - prioritize on what you have already started and what is of greatest interest to you
- I understand that this "guidance" is coming too late in the term to really affect your work - more of a final "tweak"
- This is what you *could* do, not what you *should* do

Lecture 2 – Orbital Mechanics

- Select an orbital altitude and inclination for your station
  - Calculate deorbit Δv from orbit to entry
  - Consider possible launch sites and their effect on inclination

Lecture 3 – Rocket Performance

- Trade studies on rocket configuration
  - 150 mt vs. 200 mt for module launch
  - Single vs. different launch vehicle(s) for modules vs. humans/cargo
  - Single vs. different launch vehicle(s) for humans vs. cargo
  - Optimum payload size and mass
  - Number of stages
  - Choice of propellants
  - Expendable vs. reusable
- Calculation of resiliency for fleet

Lectures 4-6 – Entry

- Orbital decay for station in chosen orbit
  - Stationkeeping propellent
  - Trade study on orbital altitude
- Entry trajectory for Earth return vehicles
  - Trade study on lift vs. deceleration
  - Calculation of cross range
  - Calculation of number of entry opportunities per day
  - Choice of landing site and system

Lecture 7 – Cost Estimation

- Trade studies (Lecture 3) performed to minimize cost
  - Include nonrecurring and recurring costs including refurbishment and learning curve effects
- Trade study on effects of refurbishment rate on economic viability
- Total program costs including cost discounting with calculation of internal rate of return
- Cost spreading and real-year costs (in addition to constant-year costs)

Lecture 8 – Mass Estimating Relations

- Calculate launch vehicle component masses based on final configuration after Lecture 3 & 7 trade studies
- Revise cost estimates for Lecture 7 based on more detailed design
- CAD images of launch vehicle (external and internal) based on results

Lecture 9 – Propulsion Systems Design

- Preliminary design of primary rocket engines in launch vehicle (thrust, exhaust velocity, expansion ratio, nozzle exhaust diameter)
- Incorporate results into design decisions (e.g., number of engines) and incorporate into CAD
- Design RCS system for entry vehicle
  - Choice of propellants, pressurant, thrust, placement

Lectures 10-11 – Reliability

- Assume component reliabilities (e.g., engines, avionics) and calculate composite reliability of launch/entry vehicles
- Incorporate effects of intercorrelated failure modes for components with multiple units

Lecture 12 – Launch Abort/Escape Systems

- Design a launch abort system for any vehicle(s) carrying humans to orbit
  - Sufficient thrust/duration to escape from rocket at maximum acceleration and clear danger zone from explosion
  - Additional landing systems, if necessary

Lectures 16 and 17 – Aerothermodynamics

- Trade study of heat shield design using Newtonian analysis
- Calculation of entry heating rate and stagnation point temperature throughout entry trajectory (Lectures 4-6)
- Modification of chosen entry trajectory if necessary to moderate entry heating effects
- Calculation of heat profile through heat shield during entry (1D finite difference formulation)
- Detailed calculation of heat shield mass
- Entry vehicle CAD images

Lecture 18 – Ground Processing Systems

- Notional design of ground handling and processing for your launch vehicle
  - Horizontal vs. vertical integration
  - Fixed vs. mobile launch platforms
  - Refurbishment flow for reusable vehicles

Lecture 25-26 – Reusability

- Trade studies on types of reusability
  - Horizontal (wings, lifting bodies) vs. vertical (parachutes, rocket thrust)
  - Effect on payload and per-kg launch costs
  - Fleet size analysis

Additional Items - "Above and Beyond"

- Project/program names, logos, etc.
- Launch vehicle trajectories
- Trajectory optimization
- Rendered CAD images
- Animations
- Innovative concepts (supported by analysis!)