Term Project 1 and ENAE 484 Planning

- Lecture #12 – October 5, 2022
- Selecting project and specialty assignments for ENAE 484
- Team assignments for Team Project 1
- Overview of Team Project 1

Selecting Teams and Specialties for ENAE 484

- Setting up ENAE 484 is a highly over-constrained optimization problem, matching each of ~85 people to their choice of
  - Project
  - Specialty group
  - Section (class meeting time matching Spring '25 class schedules)
- Projects are set by NASA design competitions and teaming arrangements
- Base assignments on individual preferences to the extent possible while keeping all projects and specialties fully staffed

Sustained Lunar Evolution

- For Foundational Exploration (FE) segment of Artemis - 33-day surface stays with up to 4 crew
- Design/develop/demonstrate scalable lunar infrastructure and services architecture that leverages space logistics; in-space servicing, assembly, and manufacturing (ISAM); and in-situ resource utilization (ISRU)
- Availability of basic infrastructure at lunar south pole
- Demand for tens of (metric) tons of regolith/year for regolith extraction, metal production, and propellant production

Sustained Lunar Evolution – Discussion

- NASA is asking these teams to design the next phase of human lunar exploration after Artemis, with an emphasis on taking advantage of water and other polar resources
- Mining ice from deep craters at a minimum – other options for using indigenous materials? (e.g., 3D printed habitats?)
- How much needs to be brought from Earth? Cost of transport?
- Ideally, make scenario fit in expected NASA funding limits
- Not much opportunity for experiment, but will need scale models for RASC-AL poster competition

Science/Technology Demos for Human-Mars

- Develop mission concepts for innovative science missions or technology demonstrators, focusing on reducing risks to future crewed Mars missions (e.g., geological studies, environmental monitoring, habitability investigations)
- Perform detailed design of the hardware for the mission payload, but include launch and transport systems to send payload to Mars
- Identify key technology areas critical for human Mars exploration that would be validated by your mission concept

Human-Mars Science/Tech Demos – Discussion

- Long pole for humans on Mars is heavy entry/descent/landing (EDL) – NASA will definitely want to see details!
- Could be done as a precursor mission, e.g., send a pressurized rover, set up water or propellant extraction, build greenhouse?
- Find and explore a lava tube for radiation protection?
- Great opportunity for innovative mission concept(s)
- Also a cost-constrained program
- No experimental opportunities? RASC-AL competition models

Small Lunar Servicing and Maintenance Robot

- Develop a concept for a robot that can accomplish ISAM tasks on the lunar surface
- Capable of manipulating and transporting small payloads, attaching power/data/fluid umbilicals, inspecting and repairing surface systems, monitoring the environment
- Capable of operating autonomously or teleoperated, either locally or remotely from Earth
- Build, test, and demonstrate an Earth prototype (<500 kg)

Small Lunar Servicing Robot – Discussion

- Strongly hardware-oriented
- Leverage experience, equipment (and spare parts) of SSL
- Will need electronics and software, not just hardware
- Involves both a mobility base and one or more dexterous manipulators – leverage existing SSL systems within rules? Can we use existing robot arm?
- Highly cost constrained – may need to ask department, dean for funding

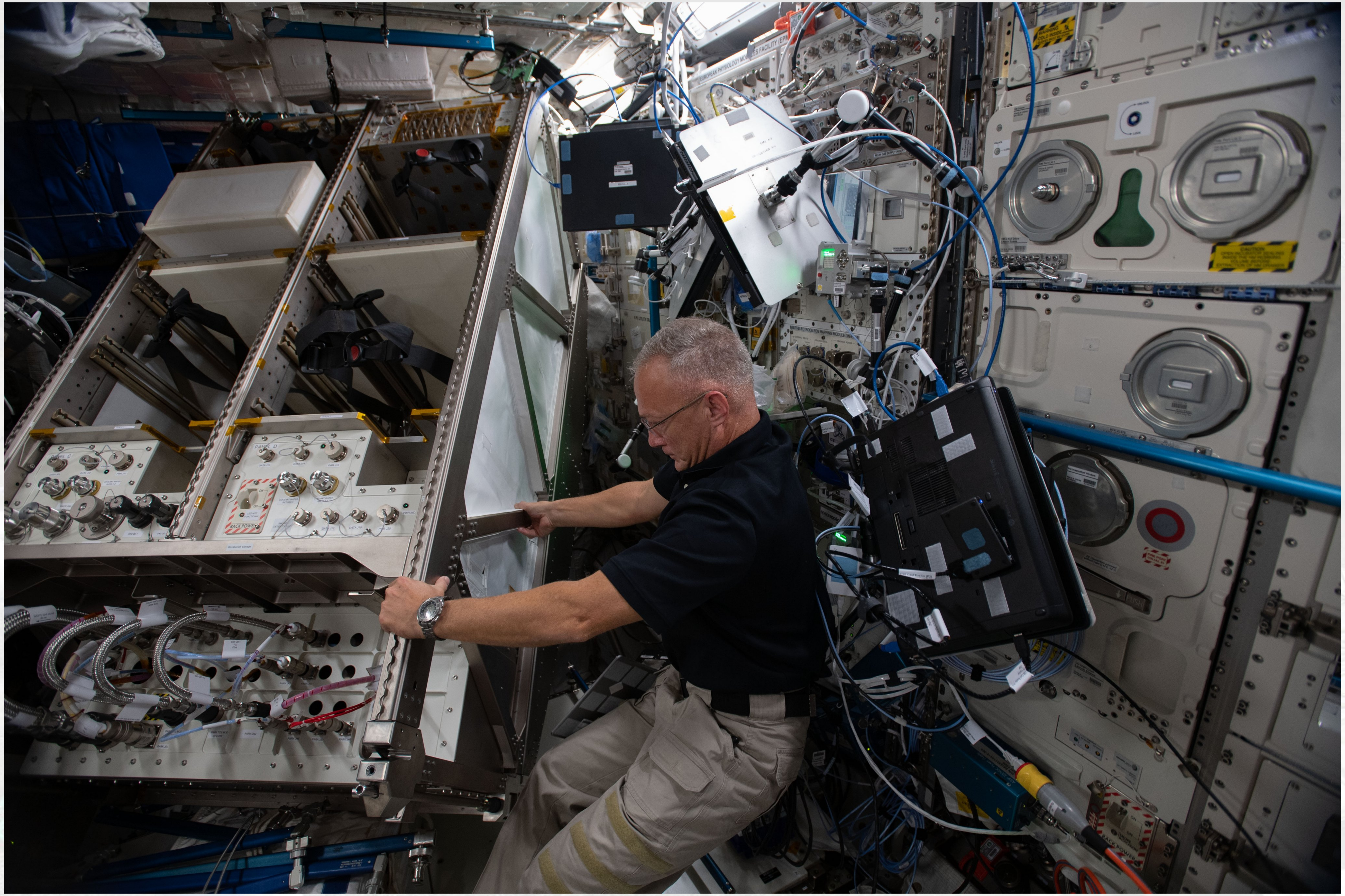
Comet Divers (NASA GSFC Collaboration)

- Fleet of small spacecraft of various types to explore a comet by landing on the core, penetrating the tail, and exploring local space environment
- Details of concept are still being worked out by NASA Goddard scientists and engineers
- Team will work in close consultation with NASA Goddard personnel

Comet Divers – Discussion

- Based on previous years, will have ~weekly interaction with 6-8 NASA Goddard scientists/engineers
- They may not have a good idea of what they want, or may change their minds mid-term
- Lots of people to ask for mentoring, but they are not doing the project for you
- Doesn’t involve RASC-AL (could be seen as good or bad)
- Probably no hardware opportunities, but lots of orbital mechanics!
- Not a human system

Standardized Habitat Rack Design and Testing



Standardized Habitat Rack Design and Testing

- Equipment interfaces on ISS are made modular by use of international standard payload racks (ISPRs)
- Major upgrades can be accomplished by crew rack replacement (made possible by microgravity)
- NASA wants a design for a new standard rack that is compatible with any gravity environment
- Requirements include designing, fabricating, and testing a standard rack including internal components, with 1g and partial gravity (underwater) testing

Habitat Rack Design – Discussion

- $20K funding from NASA through X-Hab program
- Interaction with NASA habitat design engineers from NASA Marshall and JSC 4-5 times per year
- Definitely benefits from SSL experience, facilities, and hardware
- Significant human-in-the-loop testing, including underwater
- Not a lot for power/propulsion/thermal to do?

Matrix Organization

- The project team is divided into six specialty groups for ENAE484
  - Systems Engineering, Analysis, and Integration (SEAI)
  - Mission Planning and Analysis (MPA)
  - Loads, Structures, and Mechanisms (LSM)
  - Power, Propulsion, and Thermal (PPT)
  - Crew Systems (CS)
  - Avionics, Flight Software, and Simulation (AFSS)
- You will be assigned to a specialty group - but you do get to express your preferences

Systems Engineering, Analysis, and Integration

- Mission architecture
- Systems engineering, including schedules and planning
- Creation and tracking of budgets, particularly mass and cost
- Maintenance of canonical system configuration documents
- Vehicle- and system-level trade studies
- Cost estimation
- Tracking of vehicle center of gravity and inertia matrix
- Advanced technology (e.g., robotics, EVA)

Mission Planning and Analysis

- Creation and maintenance of design reference mission(s) (DRM)
- Orbital mechanics and launch/entry trajectories
- Determination of operational mission objectives
- Concept of operations (CONOPS)
- Programmatic planning (sequence of missions)
- Science instrument/payload definition

Loads, Structures, and Mechanisms

- Identification and estimation of loads sources
- Structural design and analysis
  - Selection of structural shapes and materials
  - Stress modeling
  - Deformation estimation
  - Design optimization
- Design of mechanisms (e.g., docking/berthing ports, separation mechanisms, launch hold-downs, engine gimbals))
- Tracking of critical margins of safety

Power, Propulsion, and Thermal

- Electrical power generation
- Energy storage
- Power management and conditioning
- Primary propulsion (orbital maneuvering)
- Reaction control system (rotation/translation)
- Design of propellant storage and feed systems
- Thermal modeling and analysis
- Thermal control systems
- Power budgets

Crew Systems

- Internal layout
- Emergency egress systems
- Lighting and acoustics
- Window and viewing analysis
- Life support systems
  - Air revitalization
  - Water collection and regeneration
  - Cabin thermal control
  - Waste management
  - Food and hygiene
- EVA accommodations

Avionics and Software

- Data management (flight computers)
- Networking
- Sensors
- Power distribution
- Guidance system
- Control systems, including attitude control
- Communications
- Robot control systems
- Software, including simulations
- Data transmission budgets

Class Schedules

- The four sections of ENAE 484 will be offered at the following days/times
  - TuTh 11:00-12:15
  - TuTh 5:00-6:15
  - Mon/Wed 12:00-1:15
  - Mon/Wed 3:30-4:45
- Please IMMEDIATELY check your schedule for next term so you know if you have a conflict with any of these times

Establishing the Spring ENAE 484 Teams

- Please consider the five possible projects, the six specialty groups, and figure out if you have conflicts with any of the four possible section times
- By Friday, 9/27, go to https://go.umd.edu/484S25selection and take the survey so we know everyone's preferences and conflicts
- If you are doing the hypersonics capstone or not taking 484 for some other reason, please send me an e-mail (dakin@umd.edu) letting me know (and then you don't have to take the survey)

ENAE 484 Activities – Fall 2024

- Work in your ENAE 484 teams to do the planning and initial stages of design activities for ENAE 484
  - Level 1 requirements
  - Requirements flow-down
  - Work breakdown structure
  - Design reference mission
  - Baseline systems architecture
  - List of trade studies
  - Plans for experiments/hardware development
  - Schedule for Spring term

Requirements Development

- Level 1 requirements: externally imposed by sponsor (e.g., RASC-AL, faculty)
- "Flow-down" to successively finer levels of detail, and branching into discipline areas
- Requirement Verification Matrix (RVM) should track connection between lower and higher level requirements
- Every requirement at every level should have a clear path connecting it to one or more Level 1 requirements

Work Breakdown Structure

- Basically an outline of everything that has to be done to complete the systems design for ENAE 484
- Hierarchical breakdown into systems, subsystems, assemblies, components, etc.
- Frequently tied into scheduling process to ensure everything gets done in a timely manner
- Write it down now so it gets done later

Design Reference Mission (DRM)/CONOPS

- Detailed description of how a standard mission should proceed from beginning to end
- Could be graphical, numerical list, prose – just needs to provide information for designing the systems that accomplish the mission

Systems Architecture Baseline

- Closely related to DRM/CONOPS, but outlining how things happen (as opposed to what things happen)
- Conceptual representation of each component of transportation/construction/operations of each phase of program development
- Usually graphically presented with icons for each major system (e.g., transport, lander, habitat, etc.)

List of Trade Studies

- Every design decision should be based on an analytical trade study (Akin's Law #1!)
- Brainstorm the issues that affect design decisions, how you would quantify the parameters, and how you will perform the analysis to identify the best design decision
- Responsibility for each trade study should be assigned to specific group within the project
- Should also have schedule for when each trade study (design decision) should be completed

Plans for Experiments/Hardware Testing

- Each project may (and some must) have a plan for incorporating hardware testing into the Spring activities
- Develop and document list of hardware development activities, with justification, challenges, and benefits
- Prioritize hardware testing objectives
- For top priorities, develop initial designs and list of items which need to be ordered prior to the end of the term

Schedule for Spring Term

- Develop a Gantt chart for 484 design activities next term
- Include Preliminary Design Review (PDR) last week of February, Critical Design Review (CDR) last week of April, comprehensive final report at the end of the term
- Include deadlines such as RASC-AL deliverables or X-Hab design reviews
- Set your own internal milestones/deadlines to avoid crunches around PDR/CDR

Deliverables

- Each project should document all of their development plans in the form of a Powerpoint presentation due at the end of this term
- There will be intermediate milestones throughout the second half of the term – specifics TBD

Operational Notes

- Each project will have a Microsoft Teams site - USE IT! This is the most effective way to have archival access to everything submitted by each team member, and also is convenient for remote meetings
- Remember, you don't get credit for work I can't see - storing everything in Teams is the easiest solution
- You WILL need to meet outside of class times as teams (both project teams and within specialty groups) to do this planning work - and it's good practice for next term

Teams for Team Project 1

Team 1
William Covington
Samir Rathore
Nathaniel Nurlegn
Nicholas Varro
Joessel Ruiz

Team 2
Kevin Franzblau
Dean Hall
Andrew Dolecki
Tadhg Martinez
Sean Jordon

Team 3
Benjamin Leazer
Connor Byrne
Avery Lowe
Yuhan Wang
David Labrique

Team 4
Nathan Roy
Alejandro Tovar
Maisha Jahan
Victoria Vidmar
Donald Mestas

Team 5
Yasada De Silva
Brendan Bauer
Francesca Sciarretta
Oksana Mikhaylenko
Arul Ramachandran

Team 6
Michael Mallamaci
Lukas Bieneman
Samantha Krakovsky
Riley Edgar
Dheer Patel

Team 7
Max Harris
Teaghan Doran
Ari Julius
Fiducia Finny
Aidan Ellwanger

Team 8
Eli Mirny
Scott Sessa
Shirah Abrishamian
Zachary Hart
Alexander Batska

Team 9
Fouad Ayoub
Anthony Huynh
James Doss
Arnav Kalotra
Christian Waidner

Team 10
Tom Bigot
Raymond Encarnacion
Daniel Grammer
Kurt Klaus
Kai Zen McKeown

Team 11
Christopher Blaisdell
Rachel Boschen
Jeremy Kuznetsov
Alexa Patnaude
Allison Rahr

Team 12
Sofia Correia
Gbemitireoluwa Daramola
Zuha Islam
Nathan Kerns
Romeo Perlstein

Team 13
Brendan Bullock
Liam Foley
Alexander Grecco
Cole Hershman
Tyler Rivenbark

Team 14
Leonello Cillis
Colin Keller
Corey Meehan
Owen Moran
Spencer Quizon

Team 15
Trinity Aguilar
Shazali Audu
Kurt Feinauer
Norina Kwanmongkholpong
Ava Ward

Team 16
Vladimir Flores
Chaitanya Garg
James Hecker
Grace Johnson
Kaitlyn Reidy

Team 17
Muhammad Chaudhry
Zachary Duncan
Mason Eberle
Dev Shanker
Gregory Vanderham

Team 18
Evan Gary
Richard Huang
Sean McCurry
Vandan Patel