ENAE 788X Term Project Overview

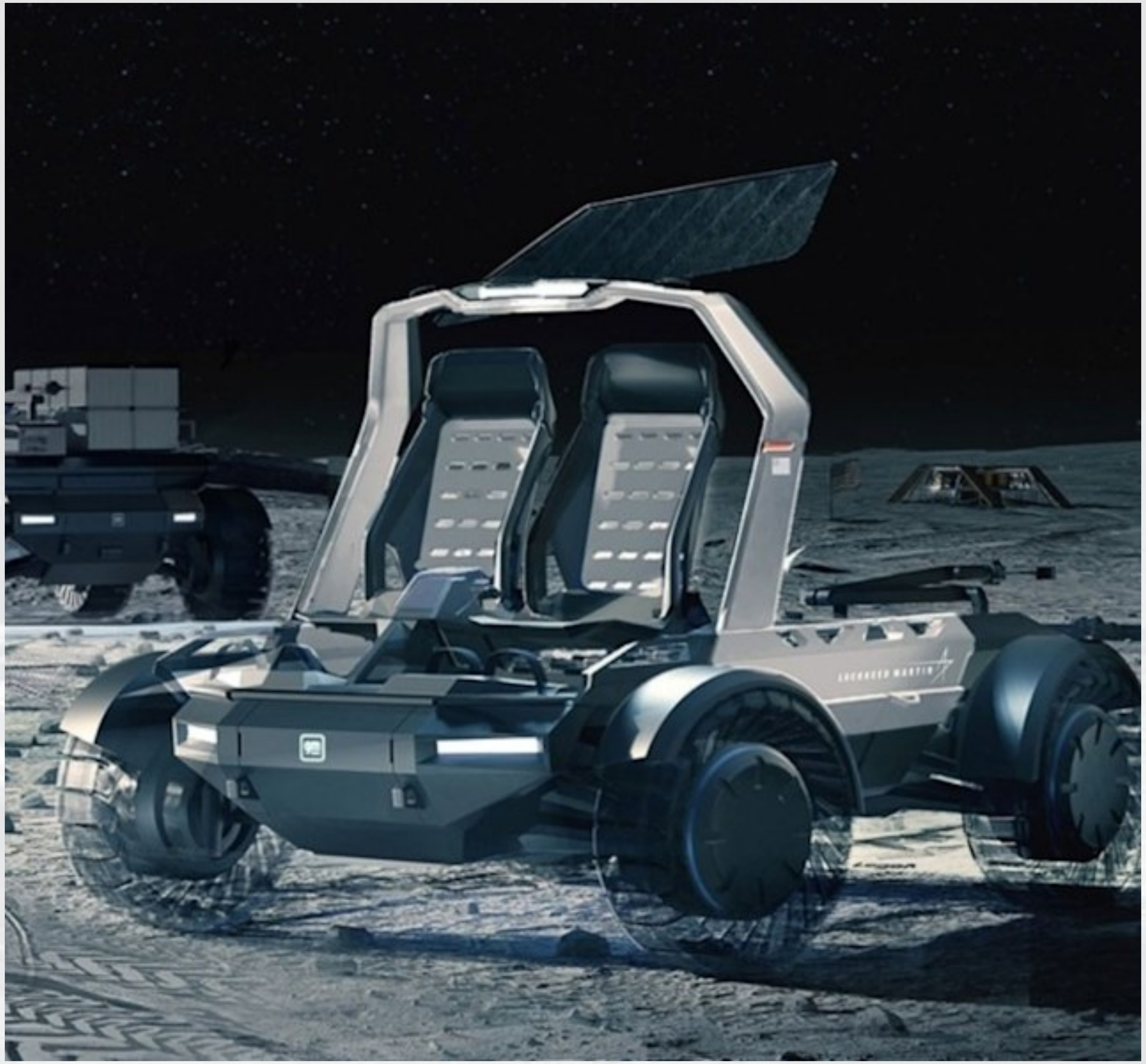
- Overview of Lunar Terrain Vehicle (LTV) and Lunar Logistics Transport (LLT) concepts
- Rover design primer

Term Design Project Goals

- Provide opportunity to use principles of class to perform open-ended realistic design
- Reinforce experiences with engineering in teams, making technical presentations
- Address a problem of real relevance to NASA

Lunar Terrain Vehicle (LTV)

- NASA is about to release a request for proposal (RFP) for a lunar terrain vehicle (LTV)
- Will fill the same role as the Apollo Lunar Roving Vehicle with additions:
  - Rechargeable
  - Longer range
  - Deployable on CLPS landers
  - Remotely controllable without crew
- Details are sequestered until RFP is released



LTV Term Design Project

- Perform the preliminary design of the Artemis Lunar Terrain Vehicle, based on RFP specifications to be released
- (Ideally) 3-person teams
- Design requirements to come as NASA releases them, but probably will include
  - Two suited crew plus 500 kg of cargo
  - Max speed of 15 km/hr
  - Range of 20 km
  - Survive 100 hours of polar nighttime

Lunar Logistics Transport

- Based on NASA RASC-AL 2023 competition theme (https://rascal.nianet.org)
- Carry cargo around lunar South Pole station for assembly, logistics, and other sustaining activities
- Offload payloads up to 15,000 kg, 4.6m diameter x 7.8m high, from a base height of up to 8 m
- Transport maximum payloads up to 1000 m
- Capable of self-deployment from its delivery system

Design Project Statement

- Perform a detailed design of an LTV or LLT rover, emphasizing mobility systems
  - Chassis systems (e.g., wheels, steering, suspension…)
  - Support systems (e.g., energy storage)
  - Navigation and guidance system (e.g., sensors, algorithms...)
- Design for Moon, then assess necessary modifications for Mars, and conversion to Earth analogue rover

Term Project Overview

- Teams of 3-4 students (~6-8 teams in class)
- Review requirements as published
- Consider design approaches and options
- Perform trade studies to refine and verify design(s)
- Use CAD to create vehicle design drawings
- Prepare a "work in progress" status report – due Monday, Oct. 24
- Continue design work and analysis, incorporating feedback from status report and adding analysis areas as they are presented in class
- Final report due Monday, Dec. 12

How To Design a Rover? A Primer…

- Define the requirements – payload mass, volume, dimensions; surface velocity
- Terrain requirements – max slopes, max obstacles/gaps, surface characteristics
- Back of envelope (BOE) stability – height of CG $\Longrightarrow$ wheelbase/wheel span for static stability with margin
- Terramechanics – trade studies on number of wheels, wheel diameter(s) and width(s) $\Longrightarrow$ baseline design with number and placement of wheels, diameter and width of wheels, details of grousers

Rover Design (2)

- Suspension – based on mission requirements (speed, slopes, payload variations) perform trade studies on suspension approaches (e.g., fixed, independent, rocker variants, articulated body) $\Longrightarrow$ baseline on suspension design
- Steering – based on mission requirements (speed, energy, terrain) perform trade studies on steering approaches (e.g., skid-steer, differential drive, single/double Ackermann, independent steering) $\Longrightarrow$ baseline of steering approach
- Synthesis – bring everything so far into baseline design of mobility chassis $\Longrightarrow$ CAD model of baseline configuration concept

Rover Design 3

- Alternate concepts – if desired, consider alternative concepts (e.g., legs, tracks) and perform analyses to define them at similar level of detail to wheels baseline, compare to decide whether to pursue alternate design(s) or stick with baseline
- Advanced analyses – perform analyses at finer levels of detail than required for initial configuration studies, e.g. dynamic analysis of suspension elements (springs and dampers), lateral forces on wheels for steering, details of weight transfer over obstacles and/or slopes
- Mechanisms – find required torque for actuators (e.g., wheel motors, steering, active articulation) and select candidate motors/gear systems for each category

Rover Design 4

- Power – Considering motors and mission parameters, calculate energy storage requirements for vehicle and specify battery capacity required
- [Caveat – the details of this section will depend on how I revise the last section of the class for this term]
- Sensors – consider options and select sensors for vehicle operations
  - Interoceptive: sensors for measurements interior to the rover (e.g., suspension/body angles, actuator motions, power usage)
  - Exteroceptive: sensors for measurements exterior to the rover (e.g., cameras, lidar, radio/satellite navigation)
- Path planning algorithms – if and when…

Rover Design 5

- [These are "reach goals"/extra credit]
- Analyze required modifications to the design for use on Mars
- Analyze required modifications to the design for use as in analogue field simulations on Earth