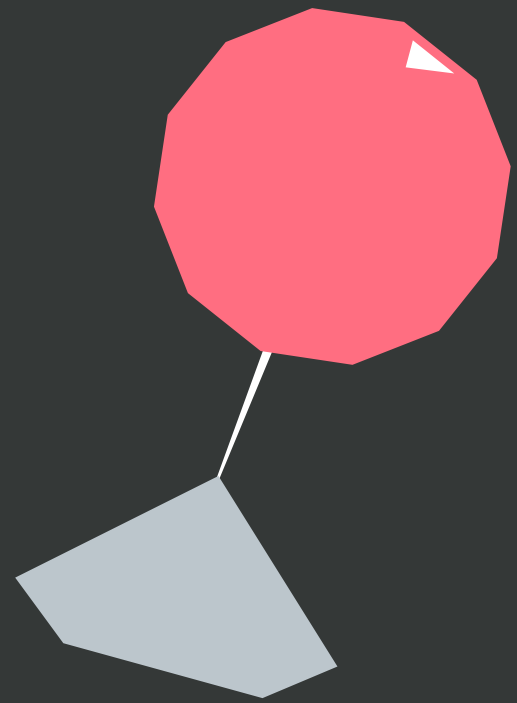
TEAM DESCRIPTIONS & RELEVANT SKILLS



** information might not be final, consult website for latest updates.*

AIRBORNE PROGRAM

Project Polaris' third year is coming up soon and we would like to welcome new members to join us.

Prototype of the Star Rover at the Costa Rica Institute of Technology, inspired on a Titan exploration concept.

PROGRAM OBJECTIVES

March – October 2023

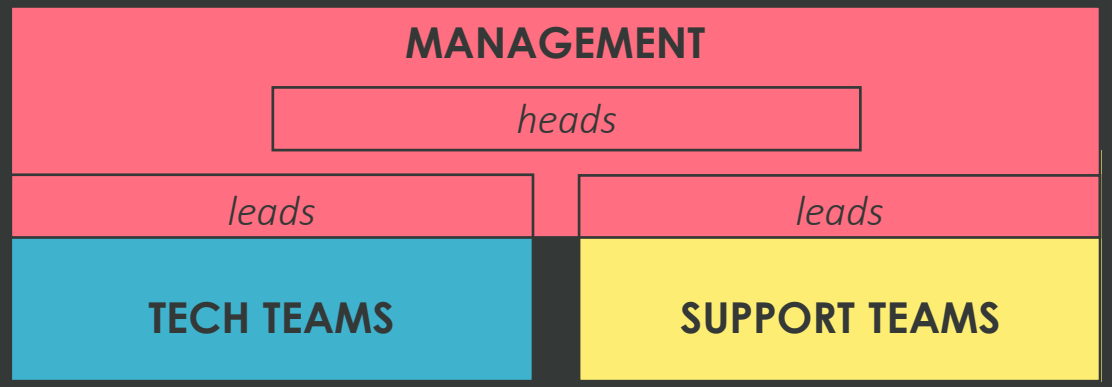
To improve and integrate all the engineering systems of the rover prototype required to achieve a controlled airborne mission by the end of the Action Stage (August 2023)

To help Polarians increase their intercultural agility both virtually and in person through Tropical Space 2023

To write one or more extensive papers that resume our project's technical and cultural findings and submit them to one or more conferences/congresses.

ROLES AVAILABLE

Airborne is composed of five technical teams and four support teams. They are led by a Management Team which has a representative of each team, called a Lead. Additionally, Management has four heads which take care of additional aspects of the program. Each technical team has an integration contact which will meet with the Head of Systems Engineering (HoSE) to guarantee the engineering cohesion of the project. Member positions are open in each team.



The Management members will soon be presented on the website.

AIRBORNE TEAMS

MEET MANAGEMENT

Jerry Varghese,
Head of Systems Eng.

John Ramthun
Head of Informatics

Pilar Vega
Head of Funding

Ana Paula Alvarado
Head of Management

Arnaud Somville
Propulsion Lead

Dominik Gentner
Structures Lead

Alexandre Benoist
Balloon Lead

Diego López
Electronics Lead

Mariana Londoño
GNC Lead

Brigitte Gómez
Mission Logistics Lead

Valerie Romero
Hosting & Travel Lead

Gabrielle Witt
Relations Lead

Michelle Lacouture
Content Lead

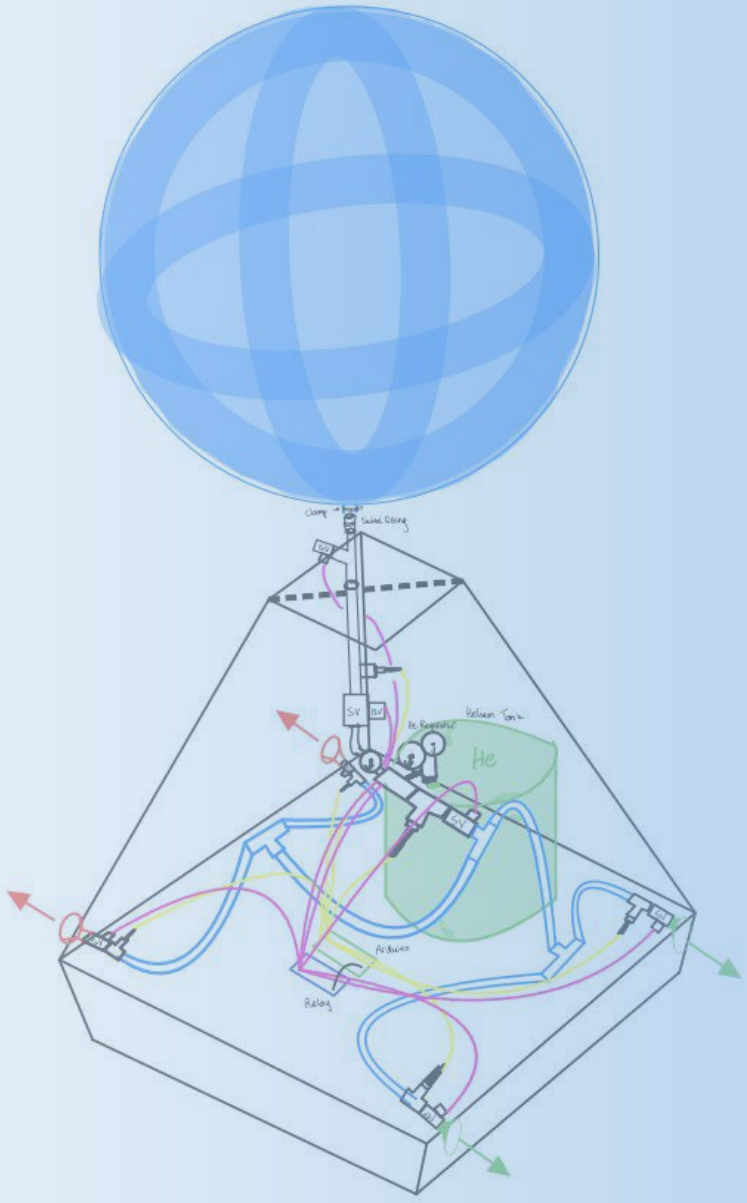
Check the website soon for more info on our management board! ***PROTIP****: use the Ask a Polarian button on the website to ask management questions about Polaris or the teams that interest you.*

TEAM DESCRIPTIONS & RELEVANT SKILLS

The following slides contain preliminary descriptions of each technical team and a list of skills that are useful to have for each team. You do not need to know all of them in order to apply to a team. Everyone, will specialize in different specific sub-areas within the team and you are not expected to know how to do absolutely everything. In fact, you can (and will) learn many of these things through Polaris!

GUIDANCE NAVIGATION & CONTROL

The main goal of Guidance, Navigation and Control (GNC) is to develop a dynamic model representative of the engineering systems onboard the Star Rover and a controller that can accurately perform a determined scientific mission up in the air until landing.
The controller must not only consider the nominal trajectory and attitude of the rover, but also be responsive to changes in the conditions of the environment where the Star Rover is going to be tested, which might alter the flight.
To achieve the goal, it is necessary to improve the mathematical model of the rover that has been previously done, to update the dynamics simulation according to the model, and to develop the operational software that the Onboard Computer (OBC) will use. To guarantee the controller's success, GNC will need to consider the interfacing between the OBC, sensors, instruments, and actuators used by other teams. In essence, GNC creates the rover's brain.

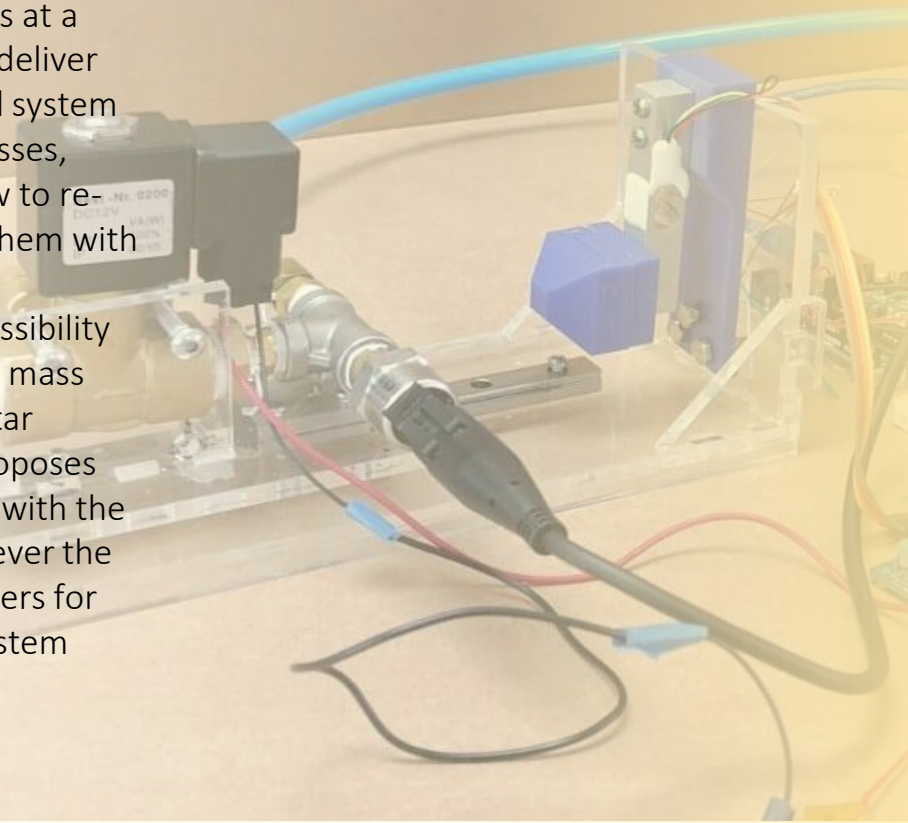


relevant skills

- Classic Control theory
- Modern Control Theory
- Classical Physics (kinematics, dynamics, rigid body)
- College junior-level mathematics (Laplace ODE, PDE)
- Programming skills (MATLAB, Python)
- Dynamic model simulation (Simulink, Python)
- Experience with microcontrollers (Arduino, Raspberry Pi)
- Familiarity with instrumentation and sensors
- Problem solving, critical thinking and self-learning skills
- Technical writing

PROPULSION

Propulsion designs the engineering systems required to control the rover's attitude and horizontal movement. For attitude control, the rover uses a cold-gas propulsion system currently running with air. This system starts at a pressure vessel and follows a feed system that will deliver helium to four 2-5 N 3D-printed thrusters. The feed system needs to be re-designed accounting for pressure losses, leakage and mass flow rate metering. This will allow to re-design and optimize the thrusters by cold-flowing them with air and posteriorly adapting them to helium gas.
For horizontal control, the team will explore the possibility of having electric propellers by estimating the inert mass addition, power required, and thrust output. The Star Rover's original design (which is based on Titan) proposes passive navigation by making use of wind currents, with the propulsion system limited to attitude control, however the team will investigate the possibility of using propellers for horizontal displacement. Improving the thruster system might enable this as well.



relevant skills

- Internal fluid dynamics (ideal/real gasses)
- Isentropic flow
- Compressible flow
- Electric propeller design
- Piping systems (theory, familiarity with fittings, valves, and other components)
- Ideal rocket theory (isentropic flow, nozzle design)
- Mechanical design (CAD, manufacturing)
- Computational Fluid Dynamics (CFD)
- Programming (MATLAB, Python)
- Microcontroller/ sensors
- Problem solving
- Curiosity
- Teamworking

STRUCTURES

Structures is responsible for the design, study and integration of the main and selected auxiliary structures that allow to house and protect the engineering subsystems within the Star Rover. The rover's main structure is a lightweight truncated octahedron frame in black iron covered in the sides with eight acrylic panes. It has a metallic base where the helium tank sits and an acrylic shelf where various systems are stored.

Structures will design both internal and external support structures that will allow holding instruments, sensors, and computers. For this, with the help of the Head of Systems Engineering, the team will need to keep track of the space being used and the weight distribution using a master CAD and Valispace. This will allow updating the final inert weight and center of mass which are required by GNC. Similarly, structures will check the mechanical connections/interfaces between the subsystems and do structural analyses; this might include the balloon connection and perhaps a balloon deployment mechanism. Additionally, the team will work on the landing gear and do a stress analysis to see how the rover would react to different impact heights and angles.

relevant skills

- Mechanical design (CAD/ manufacturing, 3D printing)
- Structural analysis (theory, FEA, thermal/stress simulation)
- Systems engineering (keeping track of top-level mechanical requirements and interfacing)
- Hands-on mechanical workshop experience (welding, drilling, soldering)
- Programming (MATLAB/ Python)
- Critical thinking, problem solving
- Teamworking
- Creativity

BALLOON

Balloon's goal is to model/characterize the Star Rover's balloon (which has already been selected and acquired), and to ensure its integration and operability. The balloon must provide the rover with sufficient buoyancy to control its altitude while making use of inflation, deflation, and venting mechanisms. For this, a strong physical knowledge of the processes involved is required ranging from the balloon's hyper -elasticity to its interaction with the atmosphere.

For example, Balloon will have to model the balloon's dynamic response to inflation and deflation, to perform an aerodynamic characterization of the balloon through CFD simulations, do a material study to characterize the loading capacity of the balloon, and to manage the interface between the envelope, the feed system, and the structure. The definition of a range of tests and their procedures which will be carried out in Costa Rica in order to validate the performances of the balloon.

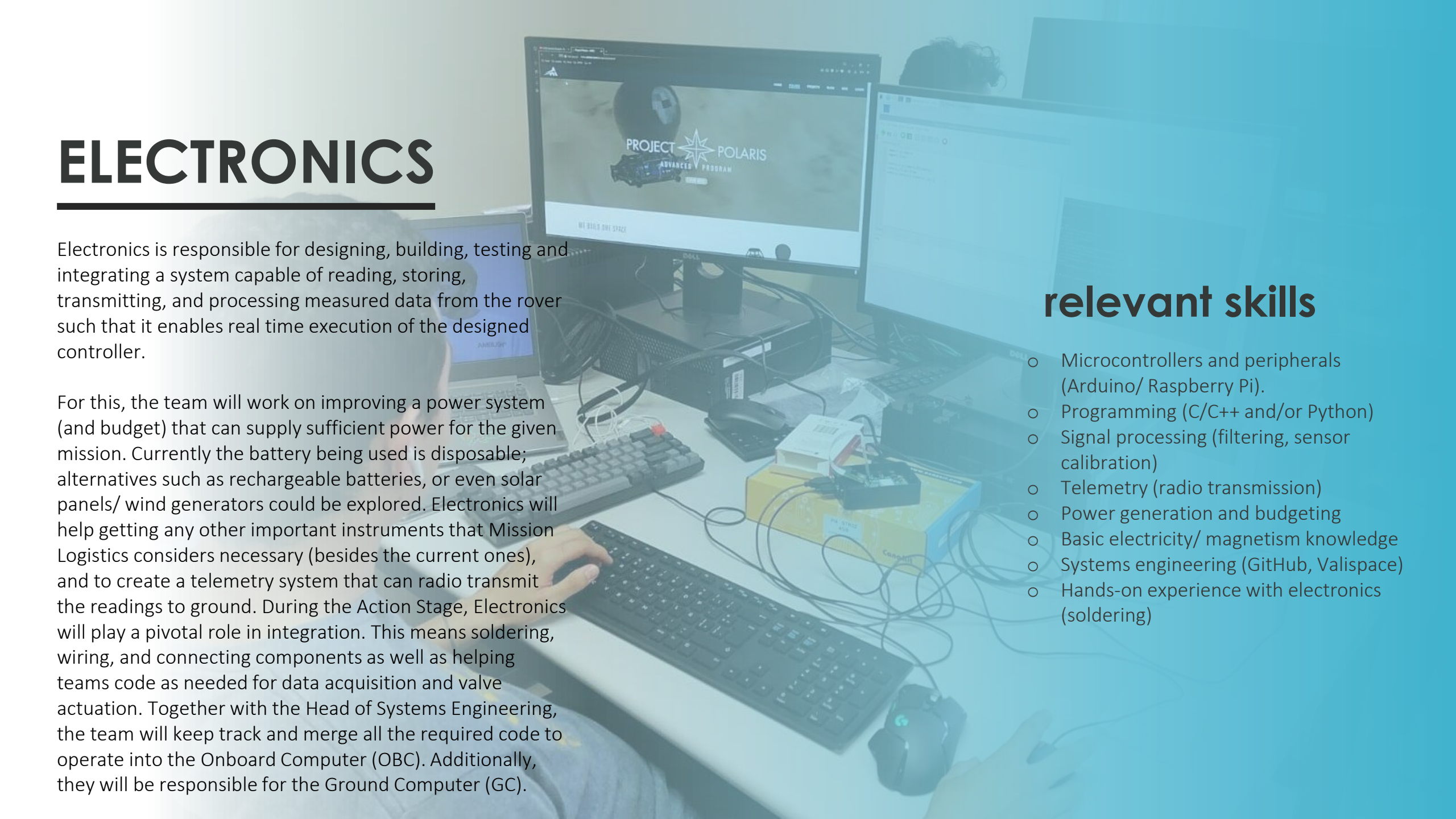
relevant skills

- Mathematical modeling of non-rigid systems (hyper-elastics)
- Classical physics (kinematics, dynamics)
- Compressible gas theory
- Structural analysis (theory, FEA)
- Material engineering knowledge (degradation under harsh environments, gas diffusion, fatigue)
- Aerodynamics (drag/lift estimation)
- Computational Fluid Dynamics (CFD)
- Mechanical design (CAD, manufacturing)
- Experience with weather balloons

ELECTRONICS

Electronics is responsible for designing, building, testing and integrating a system capable of reading, storing, transmitting, and processing measured data from the rover such that it enables real time execution of the designed controller.

For this, the team will work on improving a power system (and budget) that can supply sufficient power for the given mission. Currently the battery being used is disposable; alternatives such as rechargeable batteries, or even solar panels/ wind generators could be explored. Electronics will help getting any other important instruments that Mission Logistics considers necessary (besides the current ones), and to create a telemetry system that can radio transmit the readings to ground. During the Action Stage, Electronics will play a pivotal role in integration. This means soldering, wiring, and connecting components as well as helping teams code as needed for data acquisition and valve actuation. Together with the Head of Systems Engineering, the team will keep track and merge all the required code to operate into the Onboard Computer (OBC). Additionally, they will be responsible for the Ground Computer (GC).



relevant skills

- Microcontrollers and peripherals (Arduino/ Raspberry Pi).
- Programming (C/C++ and/or Python)
- Signal processing (filtering, sensor calibration)
- Telemetry (radio transmission)
- Power generation and budgeting
- Basic electricity/ magnetism knowledge
- Systems engineering (GitHub, Valispace)
- Hands-on experience with electronics (soldering)

MISSION LOGISITCS

Mission Logistics' main objective is to continuously refine the Star Rover's mission and to synchronize all the processes, plans, and arrangements required to usefully carry out that mission during the allotted time of the Action Stage.

For this, the team will establish an effective strategy that considers the technical needs and constraints of the program to streamline the integration and testing process of the rover all while reducing and mitigating associated risks. Mission Logistics will have to help coordinate workspaces at TEC including reaching out to faculty, and logging progress and inventory used. With the help of the Head of Systems Engineering, it will help develop a master timeline that explains how activities should happen during the Action Stage including possible scenarios. The team will continue mapping the terrain where the mission will be conducted and prepare testing procedures that account for the meteorological conditions (there is a weather station nearby which gives us live data). For example, for a passive flight, different wind speeds and targeted airborne time might require deploying from different parts of the terrain. Mission Logistics should answer questions such as when, how many times, where, how long, will the rover be tested. Additionally, they will be responsible for settling a Ground Station (GS) with the resources required to operate the rover from a distance, including electrical power, tools and safety equipment. This team might collaborate with H&T specially during Tropical Space 2023. Mission Logistics is considered both a technical and support team.

relevant skills

- Engineering planning (Gannt diagram, outcome forecast, assessing resources, constraint)
- Systems engineering knowledge
- Safety and risk analysis
- Planetary science
- Familiarity with classic control theory
- Field work experience
- Basic technician knowledge (using mechanical tools, electric installations)
- Good interpersonal skills, especially team working and communication
- Good time availability and adaptability
- Experience managing logistic problems

RELATIONS

Relations plays a critical role by connecting all internal and external stakeholders to Polaris and its values. Relations is the project's heart and hands helping bring to life its taste, look and feel!

At an internal level, the team does this by facilitating communication across teams ensuring that our core value of interculturality is present every step of the way. Team members will work on planned projects including the Polaris language exchange, resumption of the Polaris newsletter, virtual and in-person social activities/ events and more. Members are highly encouraged to present their own ideas for the team to develop. As a diverse organization with members from different backgrounds, Relations will additionally serve as the primary mediator between potential conflicts among members. At an external level, the team will maintain a close relationship with the project's mentors and partners (TEC is the exception), always trying to expand Polaris' network. Moreover, they will organize the project's Internal Presentations (IP's) and two External Panel Presentations (EPP's). In the latter, panelists from both academia and industry are invited to a hybrid (synchronous and asynchronous) event where they can listen about the project and give feedback to students. Previous editions of these have had representatives from NASA, ESA, SpaceX, and various universities. They will also assist in the internship finding process with the Costa Rica Aerospace Cluster and other companies

relevant skills

- Good communication and interpersonal skills
- Creative writing, journalism
- Interest in science
- Experience in conflict resolution and problem solving
- Ability to work individually and in a team
- Intercultural agility
- Creativity
- Interest in representing Polaris to external partners and in working closely with all Polaris
- members
- Highly social and outgoing
- Previous experience working with student organizations

HOSTING & TRAVEL

Hosting & Travel's main role is to plan and execute the in-person experiences that embody all the pillars of Project Polaris; mainly the Action Stage (Tropical Space 2023) and the Presentation Stage (in case Polarians travel).
H&T will continue its Global Home program which allows Polarians to find hosting during in-person activities most of the time with Polarian colleagues or with host families. H&T helps traveling Polarians with travel logistics considering their dates, visa requirements, hosting preferences, cultural guidelines, and internships (learn more in our website). This team organizes group activities including tourism, community service, cultural events, and social gatherings. Examples of this from previous years are dancing lessons, water polo, local science outreach, trips to the beach, volcano, rivers, hot springs, ATV riding, beach cleaning, flashflood relief, tree planting, and more! H&T works closely with TEC to get access to residence halls, student permits for foreign students, and transportation.

relevant skills

- Experience with tourism (preferably in Costa Rica)
- Experience with coordinating mobility
- Logistics of organizing big activities (for example camps, fund raising, concerts, etc.)
- Passion and hardworking
- Outgoing and open minded
- Responsible and organized
- Interculturally agile
- Adaptability

CONTENT

Through attractive visuals and meaningful designs, Content provides context and information that help people understand the concepts behind what we're building, and how it will improve the globalization of space. Content carries the Polaris flag up high for everyone to see.

The members of this team play different and important roles. From creative writers and editors to graphic designers and infographics experts, everyone is in charge of building brand recognition and creating content that resonates with our audience. Content specialize in video editing, social media design, graphic design, photography, content creation, and writing.

relevant skills

- Adobe Creative Cloud
- Figma
- Miro
- Photo editing
- Video Editing
- Copywriting
- Branding
- Creative Storytelling
- Color Theory
- Design principles
- Attention to detail
- Time Management
- Compromise
- Team work

SYSTEMS ENGINEERING

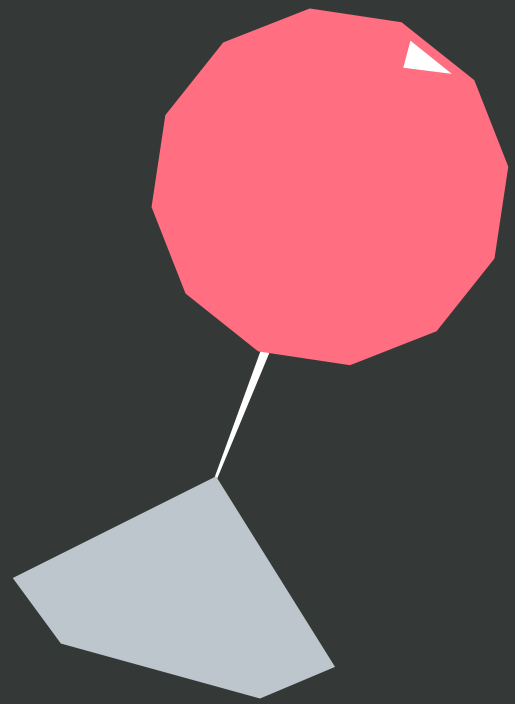
Systems engineering is a team embedded inside other teams that ensures interoperability between separately designed systems and compliance with overall mission requirements. Systems engineering will comprise **integration contacts** within each technical team that will ensure that any interfaces with other technical teams are congruent and that all designed systems serve to overall requirements of the program. Compliance will be ensured through project data/lifecycle management software.

relevant skills

- Model based system engineering
- Strong communication/summary skills
- Previous systems engineering experience
- Any PLM/PDM experience
- Relevant technical background for embedded team

POLARIS

AIRBORNE



Project Polaris is an Aerospace Research and Exploration Company SRL Project

AEROSPACE RESEARCH AND EXPLORATION COMPANY