

1 PART's Mission:

Purdue Aerial Robotics Team (PART), an IEEE team, manages a portfolio of Uninhabited Aerial System (UAS) design projects. The organization consists of three divisions: (1) a competition team to represent Purdue in an international competition; (2) a Research & Development (R&D) division to design UAS for specific research applications; and (3) a business management division (BMD) to ensure the long-term sustainability of PART. **PART's strategic goal is to execute a comprehensive approach to interdisciplinary design, prototyping, and systems engineering by incorporating industry best-practices to mature students into principled industry leaders for their post-undergraduate careers.**

1.1 The Competition Team

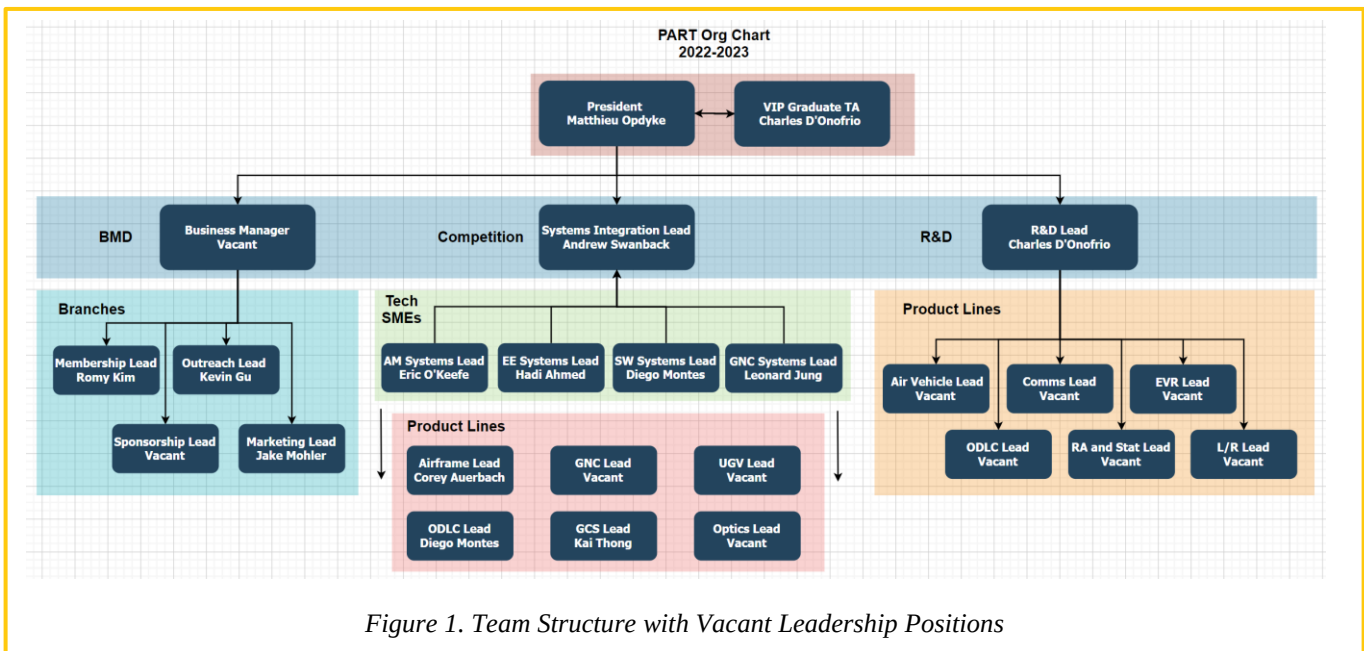
The competition team is developing a two-vehicle system to compete in the Association of Unmanned Vehicle Systems International (AUUSI) Student Unmanned Aerial Systems (SUSA) competition. PART's Uninhabited Aerial System (UAS) air-drops an Uninhabited Ground Vehicle (UGV), both of which will complete a series of tasks demonstrating their ability to operate and navigate autonomously while performing remote sensing missions representative of real-world problems. The competition team's goal is to place top five in the competition.

1.2 The R&D Division

Beginning in Fall 2022, the R&D Division will develop a prototype system-of-systems for a graduate research project. The vision behind this project is to improve patient outcomes, optimize emergency response time, and reduce safety risks to first responders by integrating First Responder Network Drones (FRNDs) with the tactical elements of an emergency response team and the national airspace (NAS). The objective of this project is to test the system in an operationally relevant environment by November 2023.

1.3 The BMD

PART's Business Management Division (BMD) ensures PART is more than a student club — the BMD plans for the future to guarantee the longevity and sustainability of PART as an organization. The objective of the BMD is to recruit and retain new members, organize public outreach events, organize team social events, manage PART's brand strategy, and find funding and sponsorship sources for PART.

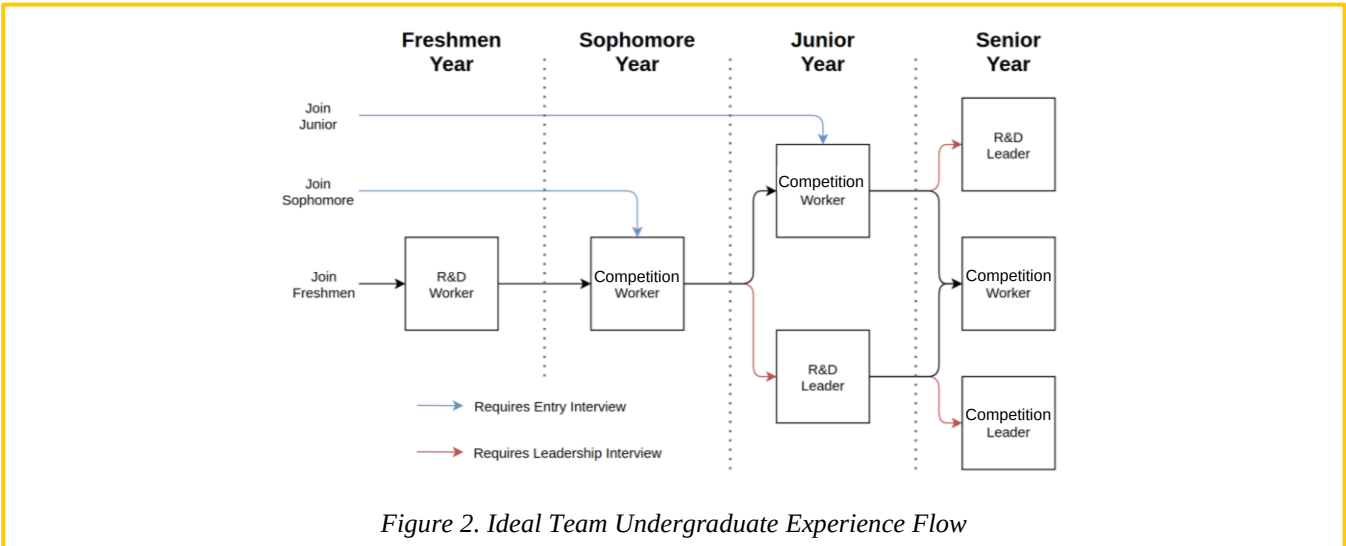


Purdue Aerial Robotics Team

2 Approach:

PART is an interdisciplinary team comprised of students studying business, computer science, and engineering. The team structure, Figure 1, includes PART's three divisions and their sub-teams. These three divisions are linked by a student led leadership team advised by a Board of Advisors (BOA) that consists of industry, government, and academic sponsors.

The team structure facilitates the flow of experienced team members from the R&D division to the competition division. The goal of this flow is to ensure each member of the competition team can make a meaningful contribution to the competition ready UAS without requiring too much guidance from the leadership team, while each member of the R&D division can learn new skills at a slower pace with guidance from the leadership team. Figure 2 shows the ideal experience flow in diagram form; note, there may be exceptions to the flow. In addition to the new flow, the team will begin interviewing for select positions. Interviews will be held by the current leadership team.



3 The Vertically Integrated Projects (VIP) Program

PART team members can receive credit for their time spent on PART. Learn about the VIP registration process here: [Register - Vertically Integrated Projects - Purdue University](#)

Fall 2022 VIP Sections:

All sections meet on Monday 6:30pm – 8:20pm at WALC 2127; sub teams will arrange their own mandatory meeting times

Sophomores: CRN 30643

Juniors: CRN 30644

Seniors, General: CRN 30645

Seniors, ECE Senior Design Requirement Credit (must complete fall and spring semesters): CRN 30646

4 Competition Team Positions:

The competition team consists of 40 undergraduate team members. The competition team is staffed exclusively by undergraduate STEM students with experience in designing, building, and coding, autonomous systems. The leaders of the competition team, typically seniors, have the opportunity to synthesize what they have learned throughout their academic career and put it to use leading a team that builds a winning design. Competition team members, typically juniors and seniors, have the opportunity to apply design fundamentals to component design and manufacture.

4.1 Open Competition Team General Positions:

General positions require applicants fill-out an application. No interview is required. Individuals who do not meet competition team admission requirements will be asked to join the R&D team. Graduate students may not apply for this team.

Airframe Team

Experience Level: Junior or senior in fall 2022 with 1-yr experience on PART or equivalent

Hours Per Week: 6 hours average, includes working weekends

Description: Members of the airframe team are responsible for building the fuselage, wings, and the propulsion and power system. The airframe team is responsible for all structural and electro-mechanical features on-board the Uninhabited Aerial Vehicle (UAV) such as bay doors, motors, servos, and aircraft control surfaces. The airframe team is responsible for providing power to all necessary on-wing systems including the ODLC computing device (owned by the ODLC team) and the optical system (owned by the optics team). Members of this team primarily consist of mechanical, aerospace, and electrical engineering students who want to perform design work and then build physical systems and components themselves.

Guidance Navigation Control (GNC) Team

Experience Level: Junior or senior in fall 2022 with 1-yr experience on PART or equivalent

Hours Per Week: 6 hours average, includes working weekends

Description: Members of the GNC team are responsible for the: (1) aircraft's avionics and all on-board systems responsible for ensuring the aircraft knows where it is and what it is supposed to be doing, (2) the UGV's descent control and stabilization system that ensures the air-dropped UGV hits its target. The GNC team is responsible for the aircraft's flight controller, and autopilot system. Members of this team primarily consist of aerospace and electrical engineering students who want to perform software design work and then code controllers.

Uninhabited Ground Vehicle (UGV) Team

Experience Level: Junior or senior in fall 2022 with 1-yr experience on PART or equivalent

Hours Per Week: 6 hours average, includes working weekends

Description: Members of the UGV team are responsible for building the UGV structure and electro-mechanical features including the propulsion and power system, and the electro-mechanical actuators responsible for the UGV's descent control and stabilization system. Members of the UGV team are also responsible for the code that determines the UGV logic. Members of this team primarily consist of computer science, and mechanical and electrical engineering students who want to perform design work and then build physical systems and components themselves.

Object Detection, Localization, and Classification (ODLC) Team

Experience Level: Junior or senior in fall 2022 with 1-yr experience on PART or equivalent

Hours Per Week: 6 hours average, includes working weekends

Description: Members of the ODLC team develop algorithms that locate, identify, and classify targets on the ground, and stitch individual images together into full orthomosaics. The team uses artificial intelligence and machine learning (AI/ML) algorithms to detect targets in images taken by the UAV's camera. Their algorithms identify the shape of the target, its color, and the alpha-numeric symbol painted on the target. The ODLC team also utilizes edge computing devices to host their algorithms on-wing. Members of this team primarily consist of computer science students who want to write, test, and implement their own code.

Purdue Aerial Robotics Team

Ground Control Station (GCS) Team

Experience Level: Junior or senior in fall 2022 with 1-yr experience on PART or equivalent

Hours Per Week: 6 hours average, includes working weekends

Description: Members of the GCS team design the UAS's communication, telemetry, control system, and a graphical user interface (GUI) where GCS operators can review the UAS's target identification, localization, and classification performance. Their work ensures all in-flight images and the output of the ODLC algorithms make their way back to the GCS. Additionally, the GCS team ensures the manual flight override is successful and maintains a strong connection. Members of this team primarily consist of computer science and electrical engineering students who want to design and build communication systems.

Optics Team

Experience Level: Junior or senior in fall 2022 with 1-yr experience on PART or equivalent

Hours Per Week: 6 hours average, includes working weekends

Description: Members of the optics team determine imaging system requirements and select a system to meet those requirements. The optics team is responsible for all electro-mechanical systems that steer the camera, damp vibrations, and transmit images to the on-board computing device (owned by ODLC). Members of this team primarily consist of mechanical and electrical engineering students who want to develop sub-component requirements and identify existing systems that can meet those requirements.

4.2 Open Competition Team Leadership Positions

General positions require applicants fill-out an application. An interview is required. Individuals who do not meet competition team admission requirements will be asked to join the R&D team. Graduate students may not apply for this team.

Guidance Navigation Control (GNC) Lead:

Experience Level: Junior or Senior in fall 2022 with 2-yrs experience on PART or equivalent

Hours Per Week: 10 hours average

Description: The GNC lead works with their experienced team and with the GNC Subject Matter Expert (SME) to complete GNC objectives (see GNC team description in section 4.1). The individual is responsible for:

- maintaining a schedule and holding himself/herself accountable to the schedule
- leading milestone reviews
- performing GNC design, prototype, test, activities
- leading a team of between 5 and 10 experienced team-members
- work with other product line leads to address overlapping interface concerns

The individual should:

- exhibit a deep understanding of control theory and UAS control
- project management skills
- demonstrate patience and the ability to teach
- be independent

Uninhabited Ground Vehicle (UGV) Lead:

Experience Level: Junior or Senior in fall 2022 with 2-yrs experience on PART or equivalent

Hours Per Week: 10 hours average

Description: The UGV lead works with their experienced team and with the GNC, Electrical Engineering (EE), and Aeromechanical (AM) Subject Matter Experts (SME) to complete UGV objectives (see UGV team description in section 4.1). The individual is responsible for:

- maintaining a schedule and holding himself/herself accountable to the schedule

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- leading milestone reviews
- performing UGV design, prototype, test, activities
- leading a team of between 5 and 10 experienced team-members
- work with other product line leads to address overlapping interface concerns

The individual should:

- exhibit a deep understanding of mechanical and electrical engineering
- project management skills
- demonstrate patience and the ability to teach
- be independent

Optics Lead:

Experience Level: Junior or Senior in fall 2022 with 2-yrs experience on PART or equivalent

Hours Per Week: 10 hours average

Description: The optics lead works with their experienced team and with the Electrical Engineering (EE), Software (SW), and Aeromechanical (AM) Subject Matter Experts (SME) to complete optics objectives (see optics team description in section 4.1).

The individual is responsible for:

- maintaining a schedule and holding himself/herself accountable to the schedule
- leading milestone reviews
- performing optics requirements analysis, selection, and integration activities
- leading a team of between 5 and 10 experienced team-members
- work with other product line leads to address overlapping interface concerns

The individual should:

- exhibit a deep understanding of optical and mechanical engineering
- project management skills
- demonstrate patience and the ability to teach
- be independent

5 R&D Division Positions

The R&D division consists of 75 team members, mostly freshman, sophomores, and graduate students. Undergraduate members of the R&D team have the opportunity to develop their engineering skills and gain experience bringing a product from a set of requirements to reality. The leaders of the R&D team, typically sophomores and graduate students, have the opportunity to develop their leadership skills while producing prototype systems for cutting-edge graduate student UAS research projects. Graduate students in particular conducting research have the opportunity to produce a set of requirements for the R&D team to help support their research.

5.1 Open R&D Division General Positions:

Air Vehicle Team

Experience Level: All experience levels

Hours Per Week: 6 hours average

Description: The air vehicle team is responsible for designing, building, and testing the air vehicle and all self-contained elements of the air vehicle including aeromechanical structures, propulsion and power, GNC, electronics, and imaging systems. This team is highly interdisciplinary and includes aerospace, mechanical, electrical, and computer engineering, and computer science students. This team will consist of additional product aligned sub-teams once all design requirements are solidified. A senior or graduate student shall lead this team.

Communications and Ground Control Station (GCS) Team

Experience Level: All experience levels

Hours Per Week: 6 hours average

Description: The communications team is responsible for all intersystem communications, including interfacing with the emergency response dispatch system, emergency vehicles, other air vehicles, and the GCS. This team primarily consists of electrical engineering students. A senior or graduate student shall lead this team.

Emergency Vehicle Retrofit (EVR) Team

Experience Level: All experience levels

Hours Per Week: 6 hours average

Description: The EVR team will design and retrofit existing emergency response vehicles with the electro-mechanical systems required to communicate with the air vehicle and on-the-ground first responders. This team primarily consists of mechanical and electrical engineering students. A senior or graduate student shall lead this team.

Object Detection, Localization, and Classification (ODLC) Team

Experience Level: All experience levels

Hours Per Week: 6 hours average

Description: The ODL team develop algorithms that locate, identify, and classify objects and conditions that are hazardous to first responders. The team uses artificial intelligence and machine learning (AI/ML) algorithms to detect targets in images taken by the UAV's camera. The ODL team also utilizes edge computing devices to host their algorithms on-wing, and they develop a graphical user interface (GUI) that an incident commander can use to review the UAS's target identification, localization, and classification. Members of this team primarily consist of computer science students who want to write, test, and implement their own code. A senior or graduate student shall lead this team.

Risk Analysis (RA) and Statistics (Stat) Team

Experience Level: All experience levels

Hours Per Week: 6 hours average

Description: The RA and Stat team will ingest object and condition classification data and use this information to create a hazard risk index and instantaneous risk rate for first responders on the ground. The RA and Stat team leverage the on-wing edge computing device (owned by ODL) to run their algorithms and relay their output to the GUI (owned by ODL).

Members of this team primarily consist of math, statistics, and computer science students who want to write, test, and implement their own code. A senior or graduate student shall lead this team.

Launch and Recovery (L/R) Team:

Experience Level: All experience levels

Hours Per Week: 6 hours average

Description: The L/R team designs, builds, and implements a launch and recovery system for the air vehicle. The L/R system provides shelter and refuel/recharge for the air vehicle while it is off duty. The L/R system is highly dependent on the air vehicle design (owned by Air Vehicle). Members of this team primarily consist of mechanical and electrical engineering students. A senior or graduate student shall lead this team.

5.2 Open R&D Division Leadership Positions

All leadership six product aligned sub-team positions are open on the R&D Division, see descriptions of the technical teams above (section 5.1) and the vacancies presented in Figure 1. There is an opportunity for unfunded graduate students to receive compensation via tuition remission and a stipend or an hourly wage depending on their masters/PhD program and their performance during the fall of 2023. All positions have the following entry criteria:

Experience Level: Senior or Grad Student with 2-yrs relevant experience

Hours Per Week: 10 hours average

Description: R&D leadership consists of trailblazers who will design and prototype a real system for a technology demonstration to be held in November 2023. R&D leaders shall be proficient in:

- maintaining a schedule and holding himself/herself accountable to the schedule
- leading milestone reviews
- performing requirements analysis, setting functional requirements
- leading a team of between 5 and 10 inexperienced team-members
- forming product oriented sub-teams within your own team
- design and implementation in their field

The individual should:

- exhibit a deep understanding of their field
- possess project management skills
- demonstrate patience and the ability to teach
- be independent

Purdue Aerial Robotics Team

6 Business Management Division (BMD) Positions

The business management division is a team of 25 undergraduate business and liberal arts students whose purpose is to ensure the longevity and sustainability of PART as an organization. The BMD consists of a marketing team, membership team, public outreach team, and a sponsorship team.

6.1 Open BMD General Positions

Sponsorship Team

Experience Level: All experience levels

Hours Per Week: 2-4 hours average

Description: The sponsorship team raises money for team activities through applying for grants, pursuing industry and government sponsors, and pursuing donations from team alumni and parents. Members of the sponsorship team develop skills in grant writing, technical writing, public speaking, marketing, management, and networking.

Marketing Team

Experience Level: All experience levels

Hours Per Week: 2-4 hours average

Description: The marketing team manages PART's brand strategy and image by promoting our organization through multiple mediums. The branch is responsible for social media content, print advertising, the team website (purdueAerial.com), and managing the team merchandise store. Members of the marketing team develop skills in web design, graphic design, photoshop, advertising, and content creation.

Outreach Team

Experience Level: All experience levels

Hours Per Week: 2-4 hours average

Description: Members of the outreach team are extremely passionate about community service and giving back. The branch is responsible for organizing community events that inspire the next generation of Purdue students. Members of the outreach team develop engaging lesson plans and demonstrations for students in elementary through high school. Member of the outreach branch develop interpersonal skills, teaching skills, leadership, and communication.

Membership Team:

Experience Level: All experience levels

Hours Per Week: 2-4 hours average

Description: The membership team is responsible for recruiting and retaining new members, and maintaining a connection with our alumni. The membership team organizes tabling and callout events, and by hosts social events for the organization. Additionally, the membership team fosters relationships with existing Purdue student organizations to leverage each other's strengths. Members of the membership team develop skills in leadership, public speaking, marketing, and management.

6.2 Open BMD Leadership Positions

Business Manager:

Experience Level: Junior or senior in fall 2022 with 2-yr experience managing a team

Hours Per Week: 10 hours average

Description: The business manager works with the BMD leadership team to support the competition and R&D division. The individual is responsible for:

- maintaining a BMD event schedule and holding each branch accountable
- maintaining a PART 5-year business plan, including projected budget and staffing requirements
- lead a team of mix-skilled team members
- picking up any slack from other BMD branches that fall behind

The individual should:

- have a vision for improving the team's soft-aspects
- have connections with other student led organizations
- be highly trustworthy
- be independent

Sponsorship Coordinator:

Experience Level: 1-year experience working with BOSO and SAO

Hours Per Week: 4 hours average

Description: The sponsorship coordinator raises money for team activities through applying for grants, pursuing industry and government sponsors, and pursuing donations from team alumni and parents. The individual is responsible for:

- raising \$50,000 per year
- tracking who, when, and how much each funding source provides
- maintaining a relationship with each funding source
- enforcing the sponsorship package
- arranging an annual sponsorship dinner for each spring to align with R&D and competition test flights
- lead a small team

The individual should:

- possess excellent writing skills
- possess negotiation skills
- understand the federal governments fiscal year and expenditure requirements
- perform independently