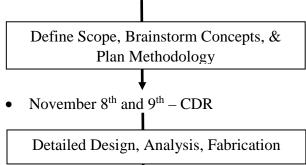
Scope of Work

Cal Poly will oversee and administer the MEP Design Competition described in the attached Exhibit A. Cal Poly students will work with Cal Poly faculty and graduate students to design Autonomous Flight Vehicles. The vehicles will compete against each other in two challenges that will occur at Cal Poly facilities. The competition schedule is shown below.

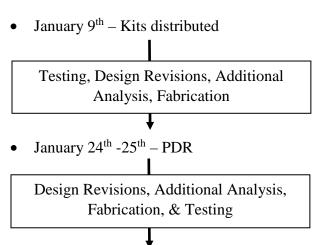
Fall 2017

- September 27th Mandatory Kick-Off Presentation & Team Registration Opens
- October 12th Registration Closes
- October 27th Teams Announced
- November 1st Mandatory FRR Training



- Week of Nov 13th FRR Presentations: Pre-plan
- Week of December 2nd FRR Presentations: Final plan

Winter 2018



- February 24th Competition
- March 2nd Final Design Review Due

Sponsor:	Lawrence Livermore National Labs
Title:	Cal Poly Drone Design Challenge
Project Term:	July 1, 2017 through June 30, 2018
GDO #:	17-349

Project Term: GDO #:	July 1, 2017 through Ji 17-349	une 30, 2018	
Personnel*		Year	1
Jackie Duerr	no compensation		\$0
	:	Subtotal Personnel	\$0
	Subto	otal Fringe Benefits	\$0
	TOTAL I	Personnel Services	\$0
Other Direct Costs	<u>:</u>		
Materials & Supplie	<u>es</u>		
Kits - 450 Quadcopter drone kits - \$875 per team for 6 teams			250
Replacement parts for use during testing - \$150 per team for 6 teams			900
Design budget - \$250 per team for parts and design supplies			500
Testing set-up - or	range cones and other supplies	for competition \$3	300
	SUBTOTAL M	aterials & Supplies \$7,	950
<u>Other</u>			
FAA Registration	\$5 per team		\$30
Shipping of supplies	to Cal Poly	\$	120
			\$0
			150
	TOTAL	Other Direct Costs \$8,	100
	TOTA	AL DIRECT COSTS: \$8,	100
Indirect Costs			
Cal Poly Indirect Co	st Base	\$8,	100
Cal Poly IDC	38.5% of Total Direc	t Costs \$3,	119
	<u>TOTAL</u>	SPONSOR COSTS \$11,	219

BUDGET JUSTIFICATION - CAL POLY STATE UNIVERSITY

OTHER DIRECT COSTS:

SUPPLIES AND MATERIALS: (Items \$5K and under)

Kits:

Each team will be provided with parts to create a basic 450-quadcopter drone kit. The cost of the kit is estimated at \$875 per team.

Replacement Parts:

Each team will be allocated \$150 to replace parts that are broken during testing.

Design Budget:

In addition to the \$150 budget for replacing broken parts, each team will receive \$250 for parts, materials, and/or off-campus services required to complete their modifications to the kit.

Testing set up:

\$300 is requested to support the costs of supplies needed to set up the competitions, including, but not limited to, orange cones.

OTHER:

\$5 per team is requested to support the cost of FAA registration of the drones.

\$120 is requested to support the costs of shipping supplies to Cal Poly.

INDIRECT COSTS:

Cal Poly's federally negotiated indirect rate is 38.5% of modified total direct costs, effective July 1, 2015. Modified total direct costs exclude equipment, capital expenditures, charges for patient care, tuition remission, rental costs of off-site facilities, scholarships, and fellowships as well as that portion of each subgrant and subcontract in excess of \$25,000.



MEP Design Competition

Overview

The Cal Poly Multicultural Engineering Program (MEP) has partnered with Lawrence Livermore National Labs (LLNL) to bring you this year's Winter Design Challenge: an unmanned aerial vehicle (UAV) design competition. This competition provides students with an opportunity to gain valuable design experience and showcase their talents to LLNL staff. Students who would like to participate are encouraged to form multidisciplinary teams of 4-6 students and submit their resumes to the MEP office (application details provided later).

Six teams will be selected and each team will be provided with a basic 450-quadcopter drone kit, similar to the kit shown in Figure 1, and a budget to purchase additional parts or materials. The teams will/can then participate in three competitions: Drones winning fastest course time trial, drones able to carry the most weight over the longest distance, and the best design review.

Prizes include:

Trophies

LLNL T-Shirts and bennies

Group tour of LLNL's laser, additive manufacturing and Supercomputers Credit towards usage of the AM machines at Cal Poly



Figure 1 Example of 450-Quadcopter Kit

 $Source: https://pixhawk.org/platforms/multicopters/dji_flamewheel_450$

Resources

The Kit

Table 1 lists the parts included in the kit that each team starts with. Teams will also be given six ball bearings, identical to the bearings used in the second challenge. Each team will be allocated \$150 to replace parts that are broken during testing. Please note that this budget is only for replacement parts, and cannot be used to purchase upgraded parts.

Table 1 Parts List

Item	Part Provided
Flight Controller	3DR Pixhawk Mini
Telemetry	3DR 915 MHz Telemetry Radio Set
Chassis	Flame Wheel F450 Basic Quadcopter Drone Kit
Motors/ESC	TBS Discovery 900 kV2 Motor + ESC Set
Props	TBS Self-tightening prop set 9x5"

Item	Part Provided
Battery	TBS 4500 mAh 4S
	30C Lipo Battery
Charger	TBS 50W/4A
	Charger
Transmitter &	DXe transmitter with
Receiver	AR610 Receiver
Remote Receiver	DSMX Remote
	Receiver
Power Connectors	XT60 Type
	Connector Set

FAA Registration

Each team is required to have one teammate register their vehicle for flight on this website: https://registermyuas.faa.gov/ There is a fee for registration; however, teams should save their receipts to submit for reimbursement. The reimbursement will come out of the parts budget listed below. The one registered teammate must always be present during testing and flight. *Note*: the UAV's will be returned to MEP after the competition.

Design Budget

In addition to the \$150 budget for replacing broken parts, each team will receive \$250 for parts, materials, FAA registration, and/or services required to complete their modifications to the kit. Teams may not spend more than the allocated budget or use free parts/materials.

Reimbursement

Students must provide the MEP office with **itemized receipts** for all purchased. The deadline to submit all receipts is **April 30**th.

Access to Additive Manufacturing Facilities and Testing

Teams are encouraged to utilize the additive manufacturing (AM) resources on campus. There are several departments and clubs that offer rapid prototyping services. Details of AM campus resources can be found in Appendix A. All flight tests and the flight competition will be held at the Educational Flight Range.

Faculty & Graduate Advisors

Appendix A lists faculty and graduate students who are willing to help teams with technical questions. Please feel free to contact the advisors listed in the Appendix but be respectful of their time and come prepared with questions. Your first resource for the project should always be your team members. The list of faculty will be updated periodically throughout the quarter and the update Appendix can be found in the MEP 24-hour study room. Please do not limit yourself to the advisors listed on the form.

Time Trial Challenge

Objective

The objective of the time trial course is to complete three laps of the course in the fastest time while remaining within the fly zone shown in Figure 2.

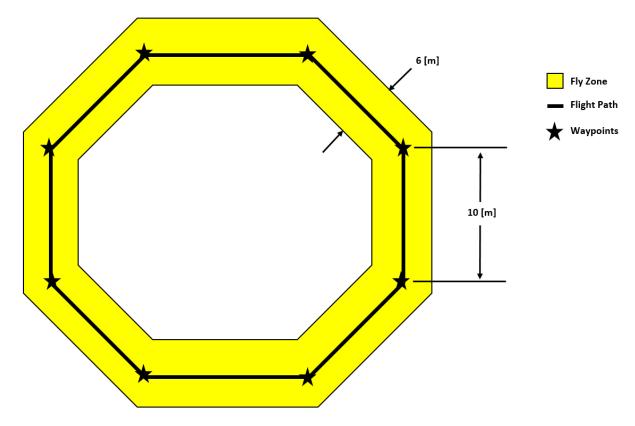


Figure 2 Time Trial Course

Constraints

Teams are allowed to modify any components on their drones. This includes editing the flight controller software; however, teams cannot replace the flight controller. Additionally, teams must use the real-time operating system (OS) loaded on the Pixhawk Mini or write their own. The team must produce any non-original software. Please note that the ball bearing mechanism for the second challenge does not have to be attached for the time trials.

Scoring

Each team will be given three practice laps followed by three timed laps. A penalty of 5 [sec] will be added every time a drone leaves the fly zone during its flight. The team with the lowest total time will receive 12 points, the second lowest will receive 10 points, and so on.

Ball Bearing Delivery Course

Objective

The objective of the ball bearing course is to deliver one of six 1 [in] ball bearings to each of the designated target areas shown in Figure 3.

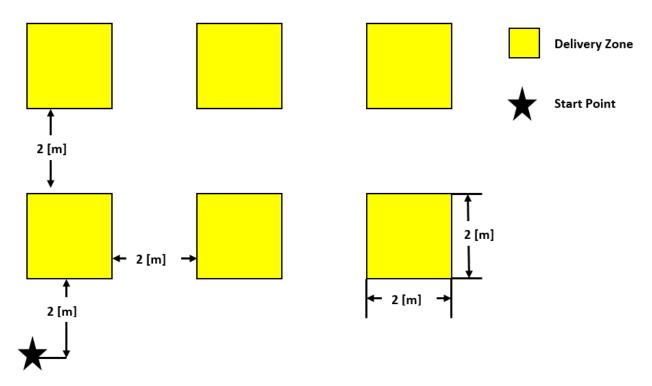


Figure 3 Ball Bearing Delivery Course

Constraints

Teams will load all six ball bearings into their drones at the start point and will be allowed to make minor adjustments (no more than 5 [min] can be spent loading bearings and making adjustments). Once the drone leaves the start point no more adjustments can be made.

The bearing release mechanism can be remotely operated.

Scoring

Teams will receive 2 points for every bearing successfully delivered and lose 1 points for any bearing dropped outside of the delivery zone. Teams will also lose 1 point for every additional bearing dropped in a delivery zone that already has a ball bearing in it.

An additional 4 points will be given to teams who automate the bearing release mechanism. In order to receive credit, no commands can be given to the drone after it leaves the start point.

Deliverables

Flight Readiness Review (FRR)

Completing and approving a Flight Readiness Review is mandatory before flying any UAV. Each team will be required to have a safety lead. This lead and any additional members available will attend a Flight Readiness Review Training.

Teams will present their FRR plan (15-minute presentation) to the FRR board. After receiving feedback, they will make changes to their plan and present their final plan. Once the FRR Board approves the team's plan, they can start flying their aircraft.

Conceptual Design Review (CDR)

Each team will conduct a brief CDR with Cal Poly faculty, graduate students, and/or LLNL staff. The purpose of this CDR is to demonstrate that your team understands the assigned problem, has the technical skills necessary to solve the problem, and has a plan to complete the task in a timely manner.

The format for the CDR will be a 5-10 [min] informal presentation. In the CDR teams should formally define the scope of the project, discuss specific design requirements, list several proposed concepts, and briefly describe their design selection methodology.

Prior to CDR, teams should:

- 1. Discuss the purpose of the CDR
- 2. Review both challenges and determine specific requirements
- 3. Brainstorm several solutions to the problems presented in both challenges
- 4. Investigate new materials and fabrication processes
- 5. Discuss a plan for performing analysis, manufacturing, and testing
- 6. Create a Gantt chart to show your proposed timeline

Note: A good introduction to Gantt charts can be found at http://www.gantt.com/. Students can create Gantt charts using Microsoft Project which is preloaded on most campus computers.

Preliminary Design Review (PDR)

Teams will present a PDR to Cal Poly faculty, graduate students, and/or LLNL staff. The purpose of this PDR is to justify the selected design and review the analysis performed. Additionally, the results of any testing conducted should be discussed.

The format of the PDR will be a 20-30 [min] presentation. Please refer to the points rubric listed in Appendix B for scoring information.

Team Applications

Interested students can independently form teams or contact the MEP office for help finding a team. Once a team is formed, they must submit their team name, resumes and names, majors and emails of each team member to mep@calpoly.edu. MEP will send the teams to LLNL for consideration. Teams must consist of:

- 4-6 members
- A minimum of 1 upperclassman
- Multiple engineering disciplines (for example 2 ME, 2 EE, and 1 CPE)
- One student must be designated "safety lead"
- At least one student must be affiliated with the Multicultural Engineering Program