DTFC application F2018

Team name: McGill Rocket Team

Team contacts

Position	Name	Email	Phone
Captain	Liem Dam-Quang	liem.dam-quang@mail.mcgill.ca	514-431-1559
Captain	Daniil Lisus	daniil.lisus@mail.mcgill.ca	438-929-8328
Financial liaison	Camille Richer	camille.richer@mail.mcgill.ca	581-994-6438

Team overview

The McGill Rocket Team (MRT) is an EUS design team with the objective of designing, building and launching experimental sounding rockets and their payloads. To complement these goals, the MRT also encourages participation in aerospace-related activities and events, especially those concerning space.

The team is one of the largest design teams at McGill: we have 70 returning members from last year and have freshly recruited 140 new members, putting our total team size at 212 members.

The team primarily competes in the Spaceport America Cup, held annually in Las Cruces, New Mexico. We also attends launch events held by the Club Quebecois de Fuseonautique (CQF) on a non-competing basis in order to test its rocket subsystems.

In terms of outreach, we participated in a launch event at Vanier College, in order to raise awareness about rocketry and hopefully interest prospective engineering students in rocketry before they even join the team. The team also played an important role in organizing the 1st Montreal Space Symposium, which was a huge inaugural success with over 300 attendees. This year, we will be tabling at the 2nd MSS, and some team members will be speaking at the symposium. The team helped found the Canadian Rocketry Consortium (CRC), a group of Canadian rocketry university design teams with the goal of coordinating policies and lobbying the government to facilitate the development of space technology in Canada. The CRC was granted an audience with the Minister of Innovation, Science and Economic Development, Navdeep Bains last year, where it made the case for fostering grassroots innovation.

Projects last year

Last year, the team participated in the 2nd Spaceport America Cup (SAC), in Las Cruces, New Mexico. We participated in two categories: 10,000 ft commercial-off-the-shelf (COTS) and 30,000 ft COTS. The number of feet represents the target apogee, or peak altitude, above ground level (AGL).

Our 10,000 ft entry, Blanche, carried a deploying payload for high-altitude biological sampling. Our 30,000 ft entry, Stella II, carried a payload for measuring G-forces on a scale model of a human brain. In addition to our competition entries, we built a third rocket, Bertrand, which was used to test our recovery systems and flew at a CQF event in early May.

In general, there was a heavy emphasis on simplicity and in-house manufacturing this year, and as a result nearly all of our rocket components were produced in-house, with a few exceptions such as the competition-mandated COTS avionics and our COTS motors and casings. All three rockets featured the same single-separation, dual-deployment scheme which was a result of heavily revising our recovery scheme from the previous year, and used interchangeable parts, such that the airframes could even be swapped around if necessary.

Our vacuum-assisted resin infusion (VARI) composite manufacturing process was heavily refined, allowing us to obtain much higher quality parts than before. Our composites had similar properties to those obtained from pre-preg processes, but at a much lower cost and lead time.

We also revised our production pipeline - our manufacturing timeline was very aggressive to make time for rigorous testing. This allowed us to test our separation mechanism, our igniters and our parachutes, among other things.

Some of our senior members also worked on a hybrid rocket engine for their capstone project, assisted by the Propulsion subteam. The result was a successful hot fire test in March 2018, and although the engine was not ready to fly by competition, the team is well poised to further develop the engine this year.

Our performance at the SAC was a resounding success, with Blanche winning the 10,000 ft category award. We then went on to win the Genesis Cup, as the best overall team!

Improvements/changes from previous year

This year, the team is revamping its training to better integrate new members. Our aerostructures subteam had excellent member retention last year, and we are taking lessons from that to ensure that every member can contribute to the team. One significant change is that we are significantly condensing our training schedule so that members from all subteams can proceed to hands-on work as quickly as possible. In the past “learning by doing” has been much more successful than teaching theory. In particular, we are investing significantly more resources into both avionics and propulsion, hoping to emulate the huge success of aerostructures in building up knowledge and transferring it to newer members. These subsystems were mostly developed by small groups of experienced members last year, and we hope to eventually be able to involve everybody in some form.

One issue that has plagued the team is inconsistent record keeping, with many different internal documents being created for similar purposes. This led to a lot of clutter and confusion when it came to keeping track of the team's records. The new administrative team has standardized many of the sheets used for record keeping and consequently cut down on the administrative overhead. In the same vein, we will be expanding our management team to take much of the burden off of the Captains and reduce the chance of human error affecting our administrative work.

Last year, we allowed anybody who signed up for the competition to attend, which made it difficult to predict how much money would need to be allocated to competition expenses such as registration fees, hotel rooms, car rentals, etc, even after charging an attendance fee. This year we are implementing a hard cap on the competition budget and a soft cap on the number of attendees. This amount is budgeted for 24 people and any further signups after that will have to cover their own expenses if they wish to attend.

We are also participating in a new competition, the Base 11 challenge. This is a multi-year competition with the objective of being the first student team to launch a single-stage liquid rocket to the Karman line, at 100 km altitude by 2021. The prize for doing so is $1M, but there are also peripheral awards for achieving certain competition deliverables.

Finances

Overview of expected funding sources

Potential funding source	Link to funding sources if available	Revenue expected ($)	Status	Notes on how you qualify
Membership fee	N/A	7,000	Pending	Every member is expected to pay $40 in order to participate in team activities. This is a conservative estimate assuming 30-40 people fail to pay their fee.
MESC	https://www.mcgill.ca/engineering/current-students/undergraduate/student-life/student-initiatives-funding-request-form	9,000	Not applied	The team is confident it can secure this amount based off of last years' application. We have not applied for money from MESC yet, pending funding from DTFC first.
Seeds of Change		9,181	Pending	This is the amount raised by the team the previous year.

SSMU		3,000	Pending	The team is confident it can secure this amount as it received this amount last year.
SSMU Ambassador fund		6,000	Not applied	The team hopes to obtain this amount based off of previous experience applying for the Ambassador fund.
MIAE		10,000	Pending	The team is confident it can secure this amount as it received this amount last year.
CRIAQ	https://www.mcgill.ca/miae/mcgill-institute-aerospace-engineerin	1,000	Pending	The team is confident it can secure this amount as it received this amount last year.
DTFC		16,000	Pending	This is the amount the team believes it should get based off of last year's allocation formula.

How EUS funds will be used

EUS funds will be used to support our general engineering activities. The most notable difference compared to last year is the significant expansion of our propulsion subteam.

We are in the process of negotiating space for the team at MacDonald campus, to be used as a test site for our experimental rocket engines. We will be using the funds to build test site infrastructure and acquire instrumentation, plumbing, electronics, tooling, etc. that will be needed. Examples of equipment that need to be purchased include: pressure transducers, flowmeters, thermocouples, data acquisition suites, electrical relays, metal frames as well as equipment to clean our piping for oxygen service, such as a HEPA filtering unit. All this instrumentation is likely going to be quite expensive, even with material sponsorships. These items all take time to ship and set up and therefore having them as soon as possible is essential to staying on schedule.

In light of this, the team is asking for **$10,000 from the EUS for the Fall semester.**

We are aware that our projected revenue is significantly higher than our projected expenses. We budgeted conservatively to ensure that we will be able to accomplish all of our projects this year. Any surplus money will go towards either 1) making more capital purchases sooner or 2) increasing the competition budget to allow more members to go.

Comprehensive budget

See submitted Excel file.

Team plan

Planned competitions

1. **Spaceport America Cup**

10,000 ft SRAD hybrid/liquid	30,000 ft COTS solid
● Target apogee is 10,000 ft; ● Payload should be less than 10 lbs and recoverable; ● Can use either a hybrid or liquid motor ● Must be student researched and designed ● Vehicle launched into the competition must be equipped with a recovery system in order to return the vehicle safely onto the ground; ● The vehicle must be equipped with an altitude logging mechanism and location tracking for recovery.	● Target apogee is 30,000 ft; ● Payload should be creative, engineering or scientific rather than non-functional or passive; ● Propulsion system is not limited by category ● Vehicles are recommended to have a dual deployment recovery system, the first is to reduce speed to 75 to 100 m/s and the second should occur at an altitude no higher than 1500 ft to reduce the speed to no less than 30 m/s.

2. **Base 11 challenge**

Preliminary design competition
● Preliminary design is due in March 2019 ● Up to $25,000 for best design report and $50,000 total prize money ● Judged on innovative problem solving and technical rigor ● Hot fire test demonstration scheduled after report submission

McGill Representation

The team is currently planning on attending and/or organizing the following public events:

1. Outreach sessions with Vanier and Dawson College to introduce students to rocketry
2. Tabling and speaking at the Montreal Space Symposium
3. Tabling during McGill's Open House
4. Participation in the CQF's Fusée Fête event

5. Participation in the 2019 Spaceport America Cup
6. Representing McGill at the Base 11 Challenge

Recruitment regime

The team was very proactive in recruiting members. We tabled at Frosh, OAP, SSMU Activities Night and Engineering Involvement Day. We also had several in-class announcements and posted extensively on Facebook. Over 300 people expressed interest in attending the team's info session and 144 people applied to join the team by the end of the recruitment period.

Training plan

All new members are given a "RCKT101" tutorial on the basics of rocketry and get to participate in a mini-launch event, where they design and build a small model rocket. The event was refined based off of last year's feedback. Each subteam also gives an information session on its activities, to let new members pick the best fit for them. Additional tutorials and/or work sessions are offered by the sub-teams at their discretion in order to train new members on relevant topics, including composites manufacturing, CFD, CNC router operation, hot-fire procedures. There is an emphasis on providing hands-on training for new members rather than theoretical lectures, wherever possible.

Capital expenditures and investments

As previously mentioned, we are in the process of negotiating a test site for our engines on MacDonald campus. We envision this site as something we will gradually build up over the years with additional instrumentation and functionality until we have a fully fledged test site capable of accomodating a variety of engines in all shapes and sizes, with different propellants. The same can be said in terms of building up knowledge: propulsion is heavy on theory and will require several years of training and learning before there is a sustainable knowledge base that can be transmitted year-to-year.

Plan for this and upcoming years

The team's main priority for the year 2018-2019 is to greatly build up its expertise in its propulsion and avionics subteams with the goal of building student researched and designed engines. Avionics has always been our biggest weakness at competition, and we hope to address that by massively expanding the size of our avionics team, tripling the number of projects and technical leads compared to last year. Propulsion on the other hand is still a relatively undeveloped sub-team with only a few completed projects to its name. Rigorously training up these teams will enable us to embark on bigger and better projects in the years to come.

At the same time, the primary competition focus this year remains the Spaceport America Cup. In fact, we will be participating in even more advanced categories than last year, and we hope to repeat our success from last year.

With that said. one of the big steps in our plan is transitioning away from the Spaceport America Cup as our reason for existence. Although it is and will always be an important part of the team's annual agenda, the SAC regulations limit what the team is capable of developing. We want to develop the team into an entity that develops rockets and rocketry technology year-round, without targeting a specific competition in particular. To achieve this, the team needs to be able to compete in other competitions and also develop its infrastructure to greatly expand its range of activities.

The team is in contact with the Canadian Space Agency and through our connections, we have learned that there is a good chance that an exclusively Canadian rocketry competition will be organized by the CSA and affiliated aerospace players in the near future, with an emphasis on student-designed propulsion. In the event that this competition takes place, we will almost certainly be spearheading its participation among Canadian teams.

The Base 11 challenge will be a side project this year, but eventually will evolve to become the team's main focus. Although the chances of meeting their timeline and successfully launching the rocket are slim, it will give us an opportunity to greatly expand our capabilities and improve our relationship with potential sponsors and industry partners.

By the end of 2021, the team should hopefully have an advanced propulsion group with expertise that rivals any other rocketry university team in the world and is capable of designing and building advanced liquid rocket engines. We really want the team - and McGill - to be renowned for its prowess for building rockets.