12th Unmanned Systems Canada Student UAS Competition 2020

Concept of Operations (CONOPS) and Rules

Version 4.0, 19 December 2019

Contents

This Document

1. This is version 4.0 of the document, released on 19 December 2019; changes since the last version are highlighted. The CONOPS is subject to change at the discretion of the competition committee.

2. Questions posed by student teams, with appropriate responses, are at the end of the document. Where required, the CONOPS has been modified as a result of the questions.

3. The following terms are used in the document:

    a. Unmanned Aerial System – Set of all stuff including UAV(s), UGV(s), control station(s), antennae, etc.

    b. Unmanned Aerial Vehicle – Refers to aerial vehicle(s) that are part of your UAS.

    c. Unmanned Ground Vehicle – Refers to ground vehicle(s) that are part of your UAS.

Foreword

4. This document provides details regarding a "made in Canada" Simulated[1] BVLOS Student UAS Competition. The purpose of the competition is to promote and develop Canadian expertise and experience in unmanned systems technologies at the university and college levels. Small unmanned vehicles are complex systems requiring a well planned and executed design and rehearsed operational approach. In addition, safety considerations are important factors in this competition, as in any other vehicle design project.

5. The mission for the 2020 competition is to provide support to a company who runs medical clinics, by transporting packages containing medical supplies between their storage depots and the clinics themselves.

Competition Format

6. The competition is organized in two Phases, including:

    a. Phase 1 Technical Competition, in which teams complete a design paper describing the team approach and plans, due 12 January 2020 at 5pm EST; and

    b. Phase 2 Airborne Competition, in which teams conduct flying tasks as described later in this document. Phase 2 takes place 1-3 May 2020 in Southport, Manitoba; the competition schedule is in Para 23.

[1] The scenario involves BVLOS tasks for the competition teams, in that the pilot and flight team will not be able to see the UAS during a portion of the flight. However, from the standpoint of Canadian regulations, the entire flight of the UAS will be within the sight of observers who are able to order 'kill' of the UAS in accordance with CONOPS procedures.

7. All teams must complete Phase 1 by submission of a Design Paper to be eligible to participate in Phase 2. There will be separate prizes awarded for each Phase.

Eligibility

General

8. All competitors must be enrolled (part-time or full-time) at a Canadian College or University for Fall 2019 or Winter 2020.

Team Size

9. There is no maximum or minimum team size, and no maximum crew size in the preparation area. However, the flight-line crew is limited to 5 people.

10. Availability of accommodation may limit the number of team members attending the competition, at the discretion of the Southport organizer.

Team Composition

11. Teams may be organized internally at the discretion of their members, and may include graduate and undergraduate students. It is suggested that students from multiple years be encouraged to participate. Joint teams consisting of students from more than one institution are also permitted; for example, a joint university-college team is allowed.

12. The competition is not open to commercial entities; however, sponsorship of the team by commercial entities is encouraged.

13. Each individual vehicle, ground or air, must have a separate operator while being flown or moved; e.g. concurrent operation of vehicles requires separate operators. Yes, one person could fly a UAV, then after landing, control a UGV. **Note that per later paragraphs, all operators of UAVs (the pilots!) must hold Advanced Pilot certificates per the 2019 regulations.**

Number of Teams

14. There is no restriction on the number of teams from any one institution; however, no individual student may be on more than one team, and submitted projects from different teams at the same institution must be substantially different. Teams will be accepted at the discretion of the Judges.

Applications and Registration

15. Teams must send an email indicating their interest to competition@unmannedsystems.ca, and complete the online registration on www.unmannedsystems.ca; including paying the team registration fee of $500+tax. Registration is non-refundable. Once fully registered, teams will

have access to more information from USC. The registration deadline is 8 November 2019 at 5pm EST.

16. Student teams are strongly encouraged to seek sponsorship opportunities for their project. There is no restriction on the level or type of sponsorship that may be provided.

17. Teams are responsible for covering their own costs, including travel to and during the Phase 2 Airborne component of the competition. The onsite participant cost is $250+tax and includes most meals and lodging. Accommodations will be located in Portage la Prairie; all teams will be lodged in the same hotel. Food is provided most days, excluding Saturday evening. This payment is due by 3 April 2020 and is not refundable.

18. The competition ends at about 2200 hrs after the awards banquet on Sunday night. Departing immediately following the banquet is NOT endorsed by USC. Plan to leave on Monday to ensure safe driving home. Ensure that all drivers on a rental car have a full driver's license in good standing. The awards banquet is planned to be held at a different location than the accommodations – teams should be prepared to plan transportation to and from.

Key Dates

19. The following are the key deadlines for the 2020 competition:

    a. **8 November 2019 at 5pm EST** – Submit expression of interest to competition@unmannedsystems.ca and complete online registration, which includes paying the $500+tax registration fee;

    b. **12 January 2020 at 5pm EST** – Submit Phase 1 Design Paper;

    c. **3 April 2020** – Pay $250+tax fee for any onsite participants;

    d. **11 April 2020** – Submit video proof of previous successful flight, as described in Para 60; and

    e. **1-3 May 2020** – Attend the competition in Southport!

Scenario

20. Rapid response times, and the ability to travel routes and distances that are not conveniently accessed by conventional methods, make Unmanned Aerial Systems (UAS) a promising medical delivery method. Applications of UAS for medical delivery include shuttling biological samples between facilities, delivering medication to the homes and hospital rooms of patients, and reaching individuals in need of life-saving medical attention sooner than by ambulance. The possibilities UAS provide to the future of the health care industry have the potential to save time, resources and lives!

21. These possibilities are currently being tested nationally and internationally; from local emergency medical services teams promptly delivering defibrillators to individuals in cardiac arrest, to delivering otherwise inaccessible supplies, such as blood and vaccines, to remote countries.
22. This competition will focus on the development of an Unmanned Aerial System capable of providing efficient deliveries for a company running medical clinics. The clinics are in remote communities, which cannot be accessed easily by roads. Deliveries need to be made to keep the clinics stocked as needs arise, and the company is looking for help to complete the deliveries!

Competition Schedule

23. The schedule for Phase 2 in Southport is shown below; detailed timings and order of the teams will be provided by email on Thursday evening.

    a. Friday morning – Teams give the Chief Judge their presentation **on a USB stick in PowerPoint 2013 format NLT 0715.** Starting at 0800, teams conduct an 8-minute scored oral presentation to present their team and their plan for conducting the Tasks.

    b. Friday following the presentations – teams conduct Flight Readiness Review to demonstrate compliance with aircraft safety requirements as detailed in this CONOPS. A FRR Checklist is in Para 53. Depending on forecast weather for the weekend, operational tasks may begin on Friday afternoon, or there may be practice flight time allocated.

    c. Friday afternoon or evening – teams will be briefed by an 'employee' of the clinics about the medical supply delivery Tasks. Technical requirements and Unmanned Aerial System capabilities will be according to the Mission Requirements contained in the following paragraphs. Teams may ask any questions they wish to clarify the requirements for the Tasks;

    d. Saturday – teams conduct Simulated BVLOS Long-Range Delivery Task (Task 1); and

    e. Sunday – teams conduct Simulated BVLOS Location-Based Delivery Task (Task 2).

Mission Requirements

24. The details of the Tasks, the locations of the BVLOS Depots and Clinics, and identification of the supplies to be delivered will be presented to the teams in a briefing by an employee of the Clinics. Unmanned Aerial Systems which meet the Mission Requirements in the following paragraphs will be capable of accomplishing all of the Tasks.

25. The intention of this competition is that teams have multiple opportunities to gain points, to make strategic decisions about how to accomplish the Tasks, and, if necessary, to decide which sub-tasks to discard or emphasize to maximize points, based on the capabilities of your systems. Teams may enter the competition and choose in advance to not attempt any given Sub-Task(s); however, clearly you would be forgoing the points for any missing Sub-Task(s). In the spirit of innovation and challenge, we encourage teams to attempt all Tasks in the competition.

26. There will be one flight window for each team on each day of the competition. Within each flight window, you may fly your UAS as many times as you wish to achieve the requirements of the relevant Tasks. However, you may not attempt Task 2 on Day 1, or redo Task 1 on Day 2.

27. Both Tasks will involve the transportation of package(s) containing medical supplies from a Depot to Clinic(s). Teams may use any desired combination of vehicle types (rotary wing, fixed wing, hybrid, UGV) to accomplish the Tasks, and you may use different vehicle(s) or vehicle type(s) for the two Tasks if you choose. However:

    a. The terrain between the Depots and Clinics is deemed not suitable for ground vehicles, so packages must be moved from Depot to Clinic(s) by UAV; and

    b. If you choose to use a UGV at a location other than at the Depot for Task 1, it must be delivered to that location by UAV; a UGV for Task 1 at the Depot may be pre-positioned. UGVs transported by UAV must have an easily-identifiable off switch which completely turns off all mechanical, electrical, and communications functionality of the vehicle (so the remote judges can kill the UGV at the end of your flight window).

28. Depots and Clinics will be tents, approximately 10'x10' by 8' tall; one full side of the tent will be open. The terrain at Depots and Clinics will be hard surface (tarmac/cement), both inside the tent and outside, including a straight surface of at least 100m length having good approaches at both ends. This straight surface will not necessarily be oriented per wind direction. Maps provided at the competition will reference the Clinics and Depots by GPS-derived lat/long and/or Google Maps-based visual reference to satellite imagery.

29. **Flying is NOT permitted inside <u>any</u> of the tents. This applies to <u>both</u> Task 1 and Task 2.**

30. **NOTE:** The rules above are not intended to favour any particular type(s) of vehicle(s), **nor does the mention of UGVs in this document suggest that you must or should have one**; the point is to allow YOU the option to do whatever you think will work best. The scenario designers and judges truly don't have the slightest idea what the 'right' answer will be, and we look forward to seeing your design papers!! *(Actually, we all think a fleet of UAVs employing a remote tractor beam to suck the boxes out of the tents then taking off vertically and transitioning to horizontal flight using some new propulsion methodology not restricted by the CONOPS, and dropping the packages using a parachute gliding device to precisely land on target in the tents while the UAVs go pick up more packages is the solution. Work on it ☺).*

31. Packages for both Tasks will be made of cardboard, weigh between 0.5 and 1.0 pounds, and have dimensions of 4x4x4 inches. In fact, here[2] is a link to view the packages on Amazon! (It's actually intended that we'll buy the Amazon ones…but if they stop being available, some other suitable 4 in-cubed corrugated cardboard boxes will be used – the intention is that the boxes be reasonably sturdy but able to be crushed/damaged/dented if you work at it…). Packages will be covered with a layer of clear packing tape for water-resistance, and have QR code labels on top

[2] https://www.amazon.ca/BoxBargain-Corrugated-Shipping-Boxes-Bundle/dp/B079RLDDT2/ref=sr_1_14?keywords=small+cardboard+boxes&qid=1567013534&s=gateway&sr=8-14

of the packing tape, on the top and front of the boxes. To head off questions, some things to consider:

a. Packing tape does vary in its properties somewhat. We are <u>not</u> going to tell you the brand or model of the tape.

b. The tape will be hand-applied; we'll try our best to be consistent.

c. The dimensions are approximate – we're talking about mass-produced cardboard boxes here….

d. So…make sure that your package-carrying mechanism works given some range of the above factors! Making the maximum opening range of a gripper just a teeny bit bigger than the boxes you bought seems like a bad idea, for example, as does having a friction-based gripper that juuuuust manages to hold onto the package! But…don't crush it ☺.

Task 1: Distance-Based Delivery

32. For Task 1, there will be one VLOS Depot containing a package which must be delivered to a single BVLOS Clinic.

33. The Unmanned Aerial System and operator(s) must be able to meet the following requirements:

    a. Enter the Depot and identify, using black-on-white QR codes, the package that must be transported to the Clinic.

        ii. The Depot will be located near the flight line (i.e. not BVLOS). A member of the flight team may walk into the tent to read QR codes, move the package outside the tent, and/or assist their system in picking it up. However, maximum points will be awarded for non-aided pickup, as explained in Table 4**: Distance-Based Delivery (Task 1) Scoring**.

        iii. Although there will be multiple packages in the Depot, there will only be one, specific package that must be transported to the Clinic. The demand for supplies will be presented at the briefing, and the QR codes will serve to identify the correct package – reading a QR code successfully will provide the name of the supplies contained in the package.

        iv. The packages will be arranged in a row, and there will be no less than 30cm between the packages and between packages and the tent walls.

        v. The QR codes, with dimensions between 1 and 4 inches, will be placed on the top and front of the packages,.

    b. Pick up the package and travel to the Clinic.

i. Attachment to the UAV, whether done manually or remotely, must use a mechanism which allows the package to be released remotely. Teams may not modify the package in their attachment strategy, and should avoid crushing it!

ii. Once the UAV has successfully picked up the package (or the package has been manually attached), it completes as many laps around a pre-determined path as the remaining time in the flight window permits, to simulate travelling long-distance to the clinic.

iii. A map provided at the briefing will lay out the path the UAV must follow. Each lap will be no less than 1 km long, and no longer than 6 kilometres. The Clinic location will mark the completion of a lap. Teams will be penalized for not correctly following all parts of a lap (e.g. 'cutting corners'). Once the UAV has departed from the Depot, no physical contact by the team with the UAV is allowed (i.e. you can't interrupt doing laps back at the launch site to change batteries!).

c. Drop-off the package at the Clinic.

i. The location of the Clinic will be provided on the map, but it will be BVLOS for the operator(s). The Clinic will be no farther than 1.5 kilometers in a straight line from the Depot.

ii. The Clinic will have two receiving areas: one inside the tent and one outside; maximum score will be obtained from delivering the package inside the tent. Internal and external drop-off areas will be marked with a 50cm square target as shown below. The internal target will be centered in the middle of the tent and the external target will be at least 1m, and at most 10m, in a straight line away from the tent.

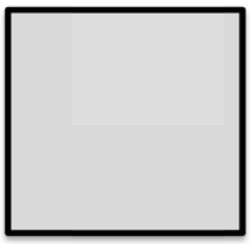

Figure 1: Target Layout.

iii. The package must be remotely released from the UAV.

iv. Scoring for placement of the package on the target is detailed in Table 4**: Distance-Based Delivery (Task 1) Scoring**; note that partial scoring is available for packages that touch the target boundary; which is represented by the bold outline in this Figure. Full points will be awarded for packages that sit completely within the boundary.

v. Following package delivery, UAV(s) must land safely back at the launch location to end Task 1.

34. If desired, a UGV may be pre-positioned at the Depot for Task 1. However, if a UGV is to be used at the Clinic, it must be moved there using a UAV, and have an easily-identifiable OFF switch (see Para 27 b).

35. Teams will be scored on the following, with further scoring details in Para 85.

    a. Ability to read QR codes;

    b. Identification of the correct package for delivery;

    c. Location and autonomy of package pick-up;

    d. Distance travelled to the Clinic;

    e. Location and precision of package drop-off;

    f. Maintaining the integrity of the package; and

    g. Successful UAV landing back at the launch location.

36. A schematic of the Task 1 Mission Requirements is below:

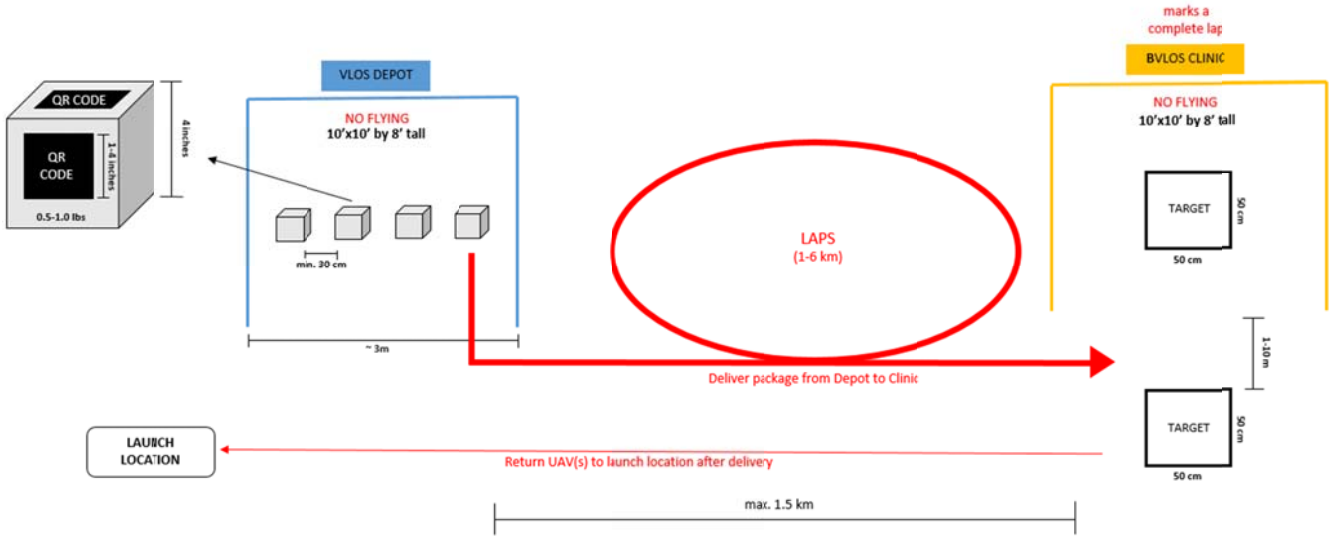

Figure 2: Task 1 Schematic

Task 2: Location-Based Delivery of Multiple Packages

37. For Task 2, there will be one BVLOS Depot containing packages that must be delivered to three different adjacent BVLOS Clinics.

38. The Unmanned Aerial System and operator(s) must be able to meet the following requirements:

a. Enter the Depot and identify, using QR codes, to which Clinic individual packages must be delivered.

    i. In Task 2, the Depot will be BVLOS; the Depot location will be indicated on the map provided at the briefing, but will be no farther than 1 kilometer from the launch location.

    ii. The QR codes will identify the Clinic to which individual packages must be delivered – reading a QR code successfully will identify the Clinic requesting the package.

    iii. The packages in the Depot will all be made of cardboard, weigh between 0.5 and 1.0 pounds, and will have dimensions of 4x4x4 inches – the same packages as in Task 1!

    iv. The packages will be arranged in rows, and there will be no less than 30cm between the packages, and between packages and the tent walls. **The first row will be composed of four packages**.

    v. The QR codes will be placed on the top and front of the boxes.

    vi. The packages will be arranged in order of urgency for delivery, and the staff at the Clinics need the supplies in the first row of packages by the end of the day! In other words, **teams will be scored on their ability to deliver the four first- row packages in the Task 2 flight window.** Teams may deliver the four packages in any order.

b. Pick up the packages and travel to the appropriate Clinics.

    i. A direct path may be taken from the Depot to the Clinics; the locations of the Clinics will be indicated on the map provided at the briefing, but will be no further than 1.5km from the Depot.

    ii. It is intended that the UAV pick up the packages remotely; however, if the UAV is not able to do so, a team member may be stationed at the Depot to manually attach packages. This person does not count towards the 5-person flight-line crew limit, and may not manually read QR codes.

    iii. Teams may specify ahead of time that they wish to pick up packages outside the tent.

c. Drop-off the packages at the appropriate Clinic.

    i. The Clinic locations will be provided on a map at the briefing, but will be BVLOS for the operator(s). There will be no greater than 50 meters between Clinics, and the Clinics will be connected by hard surface. Although the locations of the Clinics may be different than Task 1, the set-up will remain the same.

    ii. Remember that Clinics have two receiving areas: one internal and one external; and that both internal and external drop-off areas will be marked with a target, as in Task

1. This applies to all three Clinics. Since it is possible that multiple packages will be delivered to the same target, you can assume the first package will be cleared by the time the UAV(s) return with a second.

d. Following the delivery of the final package, UAV(s) must land safely at the launch location.

39. **Teams must declare by Saturday at 1800 if they would prefer their packages be set up <u>outside or inside</u> the Depot tent, and/or if they wish to conduct manual package attachment.** However, maximum points are available only to teams who start with the packages inside the tent and use remote attachment, as detailed in Table 5**: Location-Based Delivery of Multiple Packages (Task 2) Scoring**.

40. For Task 2, if teams wish to use a UGV at the Depot or the Clinics, it must be moved into location using a UAV. UGVs must also have an easily-identifiable OFF switch, per Para 27 b.

41. Teams will be scored on the following, with further details in Para 86.

    a. Ability to read QR codes and identify the correct location for package drop-off;

    b. Location and success of package-pick up;

    c. Location and precision of package drop-off;

    d. Maintaining the integrity of the package; and

    e. Successful UAV landing at the launch location.

42. Once the minimum four packages are delivered, teams may use any remaining time in their flight window to deliver any number of the remaining packages from the Depot to the Clinics. The delivery of additional packages will count for Bonus points, as explained in Table 5**: Location-Based Delivery of Multiple Packages (Task 2) Scoring**. Teams may choose which packages they wish to deliver, from the remaining rows at the Depot. There will be at least 1 row of four Bonus packages.

43. A schematic of the Task 2 Mission Requirements is below:

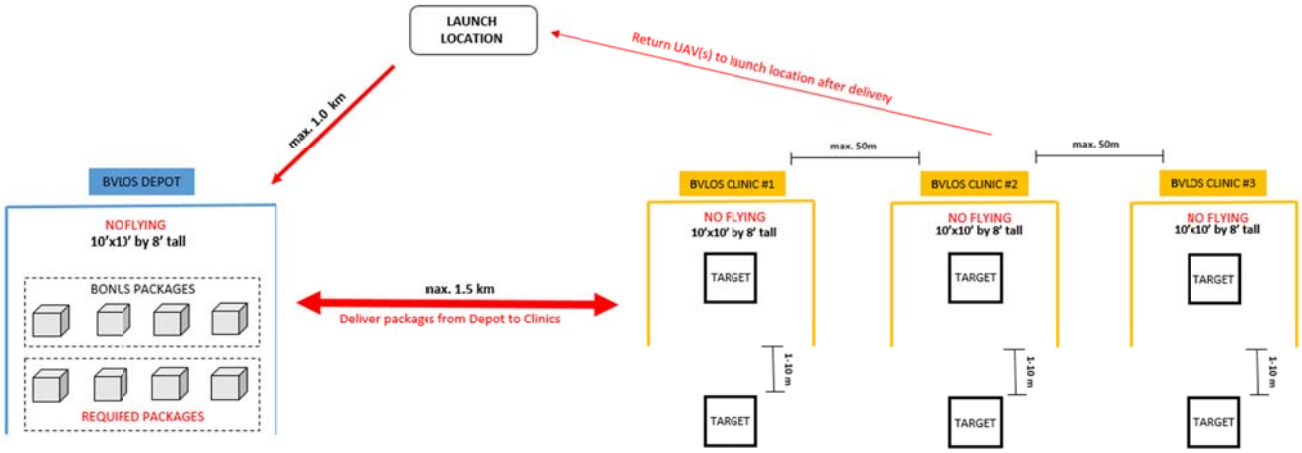

Figure 3: Task 2 Schematic

Unmanned System Design Constraints

44. The following UAV design restrictions will be verified prior to being allowed to fly:

    a. Maximum take-off weight of 10 kg (any payload and batteries included, but not including package weight) for each individual aircraft;

    b. Only internal combustion engines and electric propulsion (solar cells, batteries or fuel cell). Micro gas turbines and pulsejets are not permitted. Any other form of propulsion is acceptable if deemed safe in the Phase 1 Technical Competition by the judges;

    c. UAV must have a flight termination system to safely end flight as described in Para 51.

    d. All UAV must be brightly colored to be visible from the ground and to be easily located in the event of a crash. Safety orange day glow paint is recommended. Vehicles must also clearly display the team name;

    e. Data links can be by radio, infrared, acoustic or other means so long as no tethers are employed. Unmanned Systems may operate autonomously, semi-autonomously, or under manual control at the discretion of the teams;

    f. Radio frequency usage in Canada is defined by ISED. If a licensed band is used, the license must be obtained and provided to the judges before being allowed to fly. Since all transmitters will have to be OFF on the entire airport property during the competition, except for the team flying, it is highly recommended that the teams develop an alternative (wired) method to pre-flight and test their system. Teams may assume that high-speed internet will NOT be available on the field; and

    g. This is an Unmanned Aerial System design competition. Using completely off the shelf UAVs (example DJI Phantom) is not allowed.

Flight Operations

Flight Schedule

45. Teams will have one flight window for each of the 2 Tasks, each of which will be approximately 30-45 minutes. The actual amount of time allotted will be announced prior to the start of the competition flights; the allocated time is subject to number of registered teams and may require change due to uncontrollable factors such as weather.

46. The schedule for team presentations and two flight windows will be determined by random lottery. The schedule will be provided to the teams on arrival at the competition.

47. Teams may be (and are encouraged to be!) setting up while another team is flying.

Flight Teams

48. Teams will designate a 'flight crew' consisting of maximum 5 team members. Only the flight crew may be present while the team is on the flight deck (pre-flight and flight).

49. Each individual UAV or UGV will require a dedicated Operator. All Operators must remain at the launch point for the complete Task, and the focus of an Operator's attention must be on the vehicle. Pilots of UAVs must hold an Advanced Pilot certificate.

50. After their last flight of the competition, teams have 90 minutes to give their report in PDF format to the judges on the provided USB stick. The USB stick must be returned to the judges at the specified time and the contents will be judged according to the report criteria.

Safety

51. All UAVs must be equipped with a safety flight termination system that can be activated either automatically or remotely (kill switch). For fixed wing, this could consist of using a parachute, or shutting down the engine and performing aerodynamic termination, which corresponds to full aileron, elevator up, full rudder and no motor. Circling down is not acceptable. For rotary wing, a quick vertical descent of a minimum of 2 m/s and touchdown must be performed. The flight termination mechanism must be operational at all times. **If the flight termination method is not working, the aircraft must terminate the flight itself automatically and rapidly.** In other words, if unable to kill the aircraft, the aircraft should have already killed itself. Under no possible situation should the UAV be in flight with the crew unable to activate a kill mechanism. This is valid for all flight modes. For instance, losing C2 link while in auto mode shouldn't remove the capability to kill the aircraft. Aircraft must be in termination mode within 10 seconds of the termination function being activated. The flight termination mechanism will be validated during the Flight Readiness Review (FRR) check.

52. In case of a crash, a Corrective Action Plan (CAP) must be provided to the Air Program Director and approved before being allowed to fly again. The CAP must include at least:

a. The exact cause(s) of the crash; and

b. An explanation of why it will not happen again, including changes to equipment, procedures, etc.

53. The Flight Readiness Review performed on the Friday is represented in the Table below:

Table 1: FRR Checklist – USC Student Competition

Team Name:		**Yes**
1	Provided advanced RPAS pilot certificate for Canadians?	
2	Provided proof of training, flight review, and SFOC for Non-Canadians?	
3	Provided certificate of controlled airspace compliance for the RPAS? (SAFE)	
4	Provided copy of RPAS registration?	
5	Provided copy of insurance?	
6	Proof of flight submitted?	
7	Aircraft weight is under 10kg?	
8	Demonstrated that the flight termination system is functional at all times and in all flight modes. Propellers should have been removed already. Make the motors spin, and show that at all time, it is possible to kill the aircraft. An example is that turning off the RC automatically kills the aircraft in all flight modes.	

54. **Teams may turn on transmitters at the start of their flight window. Teams must turn their transmitters OFF after their flight window has elapsed. NO transmissions of any sort are allowed outside the flight window, including Wi-Fi hotspots and the like.**

55. During flight, the GCS must always show the aircraft, the SFOC approved area, and the competition flight area.

56. Rehearsals are not permitted unless specifically authorized by the judges.

57. If the aircraft leaves the flight boundaries, the operator will be asked to bring it back within the boundary. If the operator is unable to do so, they will be asked to activate the kill mechanism.

58. All anomalies with respect to the GPS, Datalink, RC and flight boundaries must be reported to the Air Program Director.

59. Teams must have an electrical or mechanical way of preventing propellers from accidentally spinning when the aircraft is not in takeoff position and ready for takeoff (i.e. when working on the aircraft).

60. Video proof of previous successful flight of the aircraft in the configuration planned for the competition must be presented to judges by 11 April 2020. It must show at least the following elements:

a. Takeoff;

b. Fly by, circle, and (if applicable) hover to demonstrate the stability of the UAV;

c. Approach; and

d. Full-stop landing.

Advanced RPAS Pilot Certificate

61. All flying, including flight testing at local test site and at the competition, is to be performed under Part IX regulations for RPAS.

62. Southport is a certified airport, and consequently each pilot (not each team member, only pilots) must hold an Advanced RPAS Pilot Certificate. To be clear, the Basic operator certificate is not sufficient. It is recommended to initiate this process as soon as possible, as a relatively difficult online exam, in addition to a flight review at a UAV training school, must be passed successfully to obtain the Advanced Operator Certificate. A copy of the Advanced RPAS Pilot Certificate for each pilot must be provided to the Air Program Director as part of the flight readiness review.

63. Since Southport is in controlled airspace, each RPAS needs to be Controlled Airspace Compliant; AC 922-001 details the process. The requirement mostly concerns minimum precision requirements for onboard GPS. It should be noted that it is not necessary to comply with the requirements for flying near people (between 5 and 30m), nor the requirement to fly above people, because sufficient separation will be provided during the competition, and teams will not be asked to fly near or over people. The certificate of compliance to AC 922-001, for the RPAS to be flown, for operations in controlled airspace, needs to be provided to the Air Program Director as part of the flight readiness review.

64. Each RPAS must be registered in accordance with Part IX regulations. It is best if registration is done by a Canadian citizen, under the name of the University, through the Transport Canada portal. For each RPAS to be flown, the registration certificate must be provided to the Air Program Director as part of the flight readiness review.

65. To Confirm: No SFOC is required this year. Instead, all pilots and UAVs must conform to Part IX – for which a high level overview is provided above. USC will independently apply for a Special Aviation Event Certificate. No action is required here from the teams.

66. Non-Canadian Citizens acting as RPAS pilot at the competition must provide proof of completing Ground School training to TP15263 Standard; this step replaces the online advanced exam. Non-Canadians must also pass a flight review, with results on paper instead of being in the portal. Non-Canadian Citizens will then apply for a SFOC in their name; for testing, training and operations for USC 2020 Competition. There is no fee, but the process takes 30 business days.

67. Insurance requirements for flying in Southport have not been determined – to be communicated to teams later.

68. If you need any assistance with regulatory approval, please contact us as soon as possible.

Evaluation Criteria

69. Phase 1 and 2 are scored and prizes awarded separately.

70. Phase 2 has a total possible score of 230 points. The individual criteria are detailed in the following paragraphs, and a summary of the Phase 2 scoring is shown in Table 7**: Overall Phase 2 Scoring**.

Phase 1 Design Paper – **Due 12 January 2020 at 5pm EST**

71. The Phase 1 Technical Competition will consist of a written proposal submitted by each team describing the technical details of their proposed competition design. All teams must complete the Phase 1 Technical Competition in order to be eligible to participate in the Phase 2 Airborne Competition.

72. **Unlike previous years, there is no requirement for an SFOC, and therefore no flight documents are required with the Design Paper**.

73. The design paper will be evaluated according to the criteria in Table 2**: Design Paper Scoring Criteria**. Each criterion is awarded either 0, 4, 7 or 10 points, and each category of criteria are weighted as shown, for a maximum score of 100 points.

74. You will not be evaluated on what you put in the Phase 1 Report versus what you demonstrate in the Phase 2 Competition.

Table 2: Design Paper Scoring Criteria

DESIGN PAPER	**Score**	**Notes**
Days Late		
Overall Presentation	Weight: 15	
Grammar/Spelling Structure/Organization Use of Figures/Charts/Tables References Provided/Correct		
Technical Description of Unmanned System	Weight: 50	
Analysis of Alternate Solutions Features and Capabilities Communications and Control BVLOS Strategy Pick-Up/ Drop-Off Methodology Navigation Strategy		

Safety System Level Testing		
Technical Innovation and Novelty	Weight: 10	
Novel Approach to Mission Requirements Emphasizes Novel Elements		
Safety and Risk Management	Weight: 15	
Description of System Level Safety Issues Identify Potential Single Point Failure Modes Project Risk Management Plan		
Project Management	Weight: 10	
List of Milestones Schedule for Design/Construction/Testing Phases Project Budget		
TOTAL DESIGN PAPER SCORE		

75. The following describes the expected content for each of the evaluation criteria, and provides some advice for maximizing the quality of your paper. Note that hints have been provided for content in most of the criteria – this is NOT to suggest that those specific bits of information are required, or, alternatively, that they're sufficient. They're just hints.

    a. Days Late – The score will be reduced by 10% for each day that the paper is late.

    b. Grammar/Spelling – There is no excuse for illegible grammar or spelling mistakes. Get someone from the team with very good English writing skills to create or review the paper, and don't forget that Word does a pretty good job of review.

    c. Structure/Organization – Word can unfortunately not review this! Make sure the reader is presented with a clear story of what your system will do and how it will meet the competition requirements. MOST IMPORTANTLY – organize the paper according to the evaluation criteria! Judges should not have to search through the paper to determine if you've responded to a criterion.

    d. Uses of Figures/Charts/Tables – Sometimes a picture is worth 1000 words. However, it needs to be large enough to be read, have appropriate titles and labels, and be referenced from the text so the reader knows what it's trying to show.

    e. References – Provide some! Your references might be technical, operational, or…?

    f. Alternate Solutions – You will have decided on a design solution to meet the CONOPS requirements, both from an operational point of view and a technical one. As engineers, whether you realized it or not, you must have done an options analysis to consider other ways to approach the problem(s). Tell us about these other options, and why you chose the solution that you did.

    g. Features and Capabilities – What makes your vehicle special? Don't forget that 'Unmanned System' isn't just the vehicle(s).

h. Communications and Control – How is your vehicle controlled? How is your team going to communicate? Do you have automation?

i. BVLOS Strategy – Both Tasks require simulated BVLOS operation by the flight team. Describe how you will control the UAV, how you'll ensure it won't hit anything, emergency procedures, how you will approach the packages/tents, etc.

j. Pick-Up/ Drop-Off Methodology – How do you plan on delivering the packages from the Depot to the Clinic? What features does your system have to allow for pick-up and drop-off?

k. Navigation Strategy – How will your UAV navigate the terrain between Depots and Clinics, as well as at the Depot and Clinic locations?

l. Safety – Based on the scenario, your UAV would be in close proximity to patients and staff in the clinic. Does it have any features that make it an appropriate system to allow inside of a medical facility?

m. System Level Testing – What testing will you do during development and in preparation for practice flights and scenarios? Consider the complete system – Vehicles, controls, cameras, delivery mechanism, etc.

n. Novel Approach to Mission Requirements – Explain how your overall strategy for accomplishment of the Tasks, and the individual strategy for each Task, are novel. This is NOT talking about the technologies required, which is evaluated in the next criteria.

o. Emphasizes Novel Elements – This criteria speaks to novel technology solutions in the overall System. Think of the baseline as a manually-controlled DJI Phantom – what does your Unmanned Aerial System have that makes it novel in the execution of the Tasks?

p. System Level Safety Issues – Based on the scenario and on your proposed design, what safety issues do you think are important and how are you planning to address them?

q. Single Point Failure Modes – Given your technical solution, what failure modes do you anticipate and how are you addressing them?

r. Risk Mitigation Plan – During design and development of your system, what risks exist that may affect your ability to successfully compete in Southport, and how are you addressing the risks? Risk planning must include:

    i. Identification of the risk;

    ii. Likelihood that the risk will happen;

    iii. Impact on the project if the risk occurs; and

iv. Measures you will take to reduce the likelihood of the risk and to mitigate its effects if it does happen.

s. Milestones – Key events in the project that signal things are progressing as planned, or not.

t. Schedule – You are mostly engineers. Give us a Gantt chart of all significant activities in the development of your system and planning for the event.

u. Project Budget – Don't forget to include travel and other things, in addition to purchase of 'stuff' for the System.

76. Phase 1 Design Papers are due **12 January 2020 at 5pm EST**. 10% will be deducted from the score for each day late.

77. Papers are limited to **15 pages total, including any appendices, title page, table of contents, list of figures, etc. Pages in excess of the 15 page limit will be ignored in the scoring.** Yes, this applies to your team too.

78. The paper must be emailed to **competition@unmannedsystems.ca in PDF** format.

79. Read Para 77 again!

Phase 2 Team Presentation

80. Teams present, to the judges and all other teams, their team and how they are going to accomplish the Tasks. This is not a technical presentation but it is intended to give the client (the clinics) confidence in your team and to 'sell' the planned method of completing the Tasks. Presentations should include:

    a. Who your team is;

    b. The expertise of each team member;

    c. What equipment you propose to use for the work;

    d. How you propose to conduct the required Tasks; and

    e. Why the clients should put their confidence in your team.

81. **All teams are expected to attend all presentations.**

82. **Teams must present a memory stick to the Chief Judge on Friday morning by 0715 with the presentation in Microsoft PowerPoint 2013.** It is your job to find him.

83. The length of this presentation should not exceed **8 minutes**.

84. Presentations will be scored on the criteria in Table 3**: Pre-Flight Presentation Scoring**. Evaluations will be conducted by audience members and the Captain of competing team, and criteria scores will be averaged.

Table 3: Pre-Flight Presentation Scoring

Criteria	Score
Presentation is well organized; most team members participate.	4
Presentation includes all elements in Para 80.	4
Slides are well-prepared, easy to read, contain appropriate media, are not overly technical.	4
The presentation is clear and understandable, with limited jargon or technical terms; good speaking quality.	4
The client would be convinced this is the right team for the job.	4
Total Possible Score	**20**

Phase 2 Task 1 – Distance-Based Delivery

85. An overview of the Task requirements is in Para 33 and 34, and further details will be provided in the pre-flight briefing by the company running the Clinics. Teams will be scored on the criteria shown in Table 4**: Distance-Based Delivery (Task 1) Scoring**:

Table 4: Distance-Based Delivery (Task 1) Scoring

Criteria	Score

Package Identification:
• Read QR codes:
  o QR codes are read by the Unmanned System = 10 pts
  o QR codes are read manually, or QR codes are not read at all = 0 pts
• Choosing the correct package = 10 pts
• Choosing the incorrect package = 0 pts
	20

Picking Up the package: • Package is picked up inside the Depot tent by the Unmanned System = 15 pts • Package is picked up outside the Depot tent by the Unmanned System = 5 pts • Package is manually attached by the flight team = 0 pts	15
Distance travelled to the Clinic: • Highest number of laps completed by a team = 20 pts • Lowest number of laps completed = 0 pts • Others scaled appropriately Any individual lap during which a UAV ‘cuts corners’ will not be counted towards the total number of completed laps. Since the Clinic location marks the completion of a lap, showing up at the Clinic for the first time – whether additional laps are completed or not – will count as one complete lap.	20
Dropping off the package:	

• The package is delivered inside the Clinic:
  o Package sits completely within the target = 20 pts
  o Package touches the target boundary = 10 pts
  o Package is inside the tent but not touching the target = 5 pts
• The package is delivered outside the Clinic (maximum 5 pts):
  o Package sits completely within the target = 5 pts
  o Package touches the target boundary = 2 pts
  o Package does not touch the target = 0 pts
Note: to receive points for package drop-off, the package must be released from your systems.
	20

Maintain integrity of the package: • Package is delivered right-side-up (y/n) = 2.5 pts • No damage done to package (e.g. dents) (y/n) = 2.5 pts	5
Land safely following delivery: • The UAV lands safely at the launch location = 5 pts	5
Total Possible Score	**85**

Phase 2 Task 2 – Delivery of Multiple Packages

86. An overview of the Task requirements is in Para 38, 39 and 40, and further details will be provided in the pre-flight briefing by the company running the Clinics. Teams will be scored on the criteria shown in Table 5**: Location-Based Delivery of Multiple Packages (Task 2) Scoring**:

Table 5: Location-Based Delivery of Multiple Packages (Task 2) Scoring

Criteria	Score
Picking up the packages: • Packages are picked up inside the Depot tent = 5 pts/package • Packages are picked up outside the Depot tent = 3 pts/package • Package is manually attached by the flight team = 0 pts/package	20

Dropping off the packages:
• The packages are delivered inside the Clinic:
  o Packages sit completely within the target = 7 pts/package
  o Packages touch the target boundary = 5 pts/package
  o Packages are inside the tent but not touching the target = 4 pts/package
• The packages are delivered outside the Clinic (maximum 2 pts/package):
  o Packages sit completely within the target = 2 pts/package
  o Packages touch the target boundary = 1 pt/package
  o Packages do not touch the target = 0 pts/package
Note: to receive points for package drop-off, the package must be released from your systems.
	28

Choosing the correct drop-off location: • Packages are delivered to the intended Clinic (regardless of if they are dropped-off inside or outside) = 6 pts/package	24

Maintain integrity of the package: • Packages are delivered right-side-up = 1 point/package • No damage is done to the packages (e.g. dents) = 1 point/package	8
Land safely following delivery of final package: • The UAV lands safely at the launch location = 5 pts	5
BONUS: • 5 points for every additional package delivered inside any correct Clinic, as identified by the QR code. Additional 5 points if placed completely on the target. • 2 points for every additional package delivered outside any correct Clinic, as identified by the QR code. Additional 2 points if placed completely on the target.	4 or 10 per package
Total Possible Score	**85 + Bonus**

Flight Preparation

87. Teams will be scored on their preparation for the flight window, according to the criteria in Table 6**: Flight Preparation Scoring**:

Table 6: Flight Preparation Scoring

Criteria	Score
Team is on the flight line with all required equipment 30 minutes before their flight window, and ready to fly at the start of the flight window (yes/no).	5
Team is well organized, with an obvious and effective leader and obvious tasks for team members, good cooperation between team members, good problem solving. • All characteristics observed = 10 pts • Some disorganization, lack of leadership or cooperation = 5 pts • Disorganized, no real leader, arguing, poor problem solving = 0 pts	10
Unmanned System is designed for easy set-up, with easily assembled components, use of switches rather than connectors at flight line, logical and efficient set-up/initialization procedures, etc. • All characteristics observed = 10 pts • Some flaws in design for easy set up, but overall well designed = 5 pts • Easy set up clearly not part of the design = 0 pts	10
Checklists are used for flight preparation: • Effective and organized use of written checklists = 5 pts • Ad-hoc semi-use of checklists = 2 pts • No checklists = 0 pts	5
Total Possible Score	**30**

Post-Flight Report

88. Teams must submit a report no later than 90 minutes following the close of their last flight window of the competition. The report will be scored according to the criteria in
89.

90. Table **6: Post-Flight Report Scoring**, which includes how well it is written and how clearly the results are presented. The accuracy of the results, which are evaluated in other criteria, will not be scored in this report.

91. The report should contain the following information at a minimum:

    a. Title Page;

    b. Overview of the required Tasks;

    c. Results of each Task;

    d. Overall comments on the flights – how well things went, lessons learned, etc.; and

    e. Conclusion

Table 6: Post-Flight Report Scoring

Criteria	Score
Content: • All required information is present and thoughtful comments are made about the flights = 5 pts • Information is missing or comments are lacking = 2 pts • Majority of information is missing or no comments = 0 pts	5
Presentation: • The report is well formatted, with good grammar, effective presentation of the results = 5 pts • Some formatting or grammar issues; results presentation is not effective = 2 pts • Report is poorly formatted, grammar is difficult to understand, results are difficult to understand = 0 pts	5
Total Possible Score	**10**

Overall Phase 2 Scoring

92. To summarize the above scoring, the total score available for Phase 2 is 230 (+Bonus), weighted as shown in Table 7**: Overall Phase 2 Scoring**:

Table 7: Overall Phase 2 Scoring

Criteria	Score
Presentation	20
Task 1 – Distance-Based Delivery	85
Task 2 – Delivery of Multiple Packages	85
Flight Preparation	30
Report	10

Total Possible Score	230
Bonus for delivery of additional packages in Task 2	4 or 10 points per package

How to Maximize your Success!

93. Winning a competition is like doing well on an exam; the results reflect the effort that was spent preparing for the event. By the time the teams arrive at the competition site, development work should be complete and systems tested and backed up. The actual competition should be an extension of the ongoing proof of your system design. Teams must apply proven project management techniques and procedures that will allow them to manage both time and resources effectively. The following are comments based on experience from previous competitions; ignore them at your peril!

Planning

94. The first and most important suggestion: **Read the CONOPS and Rules!** Understand the scoring system, and understand exactly what you must accomplish and how much each component of each Task is worth! Deliver the results that are asked for! Understand and follow the timing and procedural constraints!

95. Now would be a good time to **develop a schedule with clearly identified milestones that will serve as go/no-go points**. This will allow the team to change direction before additional time and effort is expended working on a sub-optimal solution. Regularly review the schedule and adjust the time lines to reflect the effort required to develop and test potential solutions. The schedule review process is iterative. This will allow your team to assess progress throughout the design/test process so that the effort will not be concentrated at the end of the academic year when there are greater demands on the students' time.

96. **Implement a sound risk management process.** As a first step, create a risk register that will serve as a basis for the initial risk assessment. Revisit the risk analysis at each team meeting to reassess risk items and identify new or emerging risks. Assess risks based on probability and impact and decide early whether to accept, avoid, mitigate, or transfer identified risks.

97. **Prepare yourself to respond to the many variables that could lead to an on-site system failure.** Risk management is only one part of an overall project management approach, but many of the failures observed at the competition could have been avoided has the team used a more disciplined project management approach during their system development process.

System Design

98. **Create a design that is simple to prepare and operate.** Minimize the use of connectors, and maximize switches. Have access panels that are easy to operate… and then have them completely closed before the flight window. In previous competitions, it was amazing how

much time was wasted by teams, either in the tent or on the runway, hooking things up and taping panels, etc., during their flight window! Make sure your design makes it easy to swap key components, like, say, batteries!

99. **Think about the flow for setting up and conducting the flight, and how your design can minimize the time required once the flight starts.** Remember that you cannot turn on any transmitters until your flight window opens – most teams appeared to be surprised by this, and didn't have any processes in place to quickly get going when they could do so. You should have everything plugged in, ready to go, and tested well before your flight window, such that when your flight window opens and you're able to transmit, you can quickly check to confirm things you already know are working are still working… then get airborne.

100. It is highly recommended that teams consider **off-the-shelf components** where possible into the design. For example, teams may consider the use of an "almost ready to fly" radio controlled system as the basic airframe with custom avionics, or they may choose to use a small-scale commercial autopilot in a custom designed airframe.

101. **Develop a pre-event test and practice plan based on the competition criteria**. There is no substitute for training and experience. By the time the aircraft is flown in competition, it reflects the team's readiness to provide a proven solution to a client's problem. The client wants results; it is up to the team to convince the client that their solution is able to provide quality results. Do not forget that quality can be defined as conformance to specification. Designs that attempt to "gold plate" their system inevitably generate additional risks.

Preparation at Home

102. As the competition date approaches, conduct a risk management process specific to the venue and event. This is critical because there are certain risks – high winds, for example – that could easily make requirements other than UAV performance the deciding factor in winning the competition. Prepare contingency plans.

103. Get major issues identified and resolved long before you show up to the competition.

104. **Prepare PRINTED procedures and checklists, and PRACTICE using them.**

105. Make sure you have a leader… who can orchestrate all activities in a calm manner according to procedures you've planned… and who understands the systems and people to make calm decisions when things don't go according to plan.

106. Physically organize all required components to make assembly easy at the flight line.

107. Consider potential failure modes and crash breakage and create a 'medical kit' of extra parts and supplies to enable you to get back in the air as soon as possible.

108. Conduct extensive testing of all aircraft and other systems, including all integrated together.

109. **Be ready to fly in all weather/wind conditions!** One year, the entire weekend had howling winds and most teams crashed at least once. Google and understand 'dynamic rollover' – in high winds you need to transition the UAV from solidly on the ground to away from the ground quickly… and the reverse on landing.

110. Practice fixing and swapping things, and make sure your design facilitates this. Having to remove major airframe components to swap a battery isn't a good idea!

111. **Conduct actual flight trials simulating the entire competition from start to finish**, including set up and initiation of systems within the flight window. Make sure every member of the team knows exactly what they are supposed to do and when they're supposed to do it. Make sure the required technical and flight procedures are known by EVERY member of the team.

112. Just a suggestion: Skydivers practice 'dirt diving', where a jump is rehearsed on the ground so everyone is clear on the sequence of the formations, the grips they need to take, etc. You'll also see skydivers in the airplane with their eyes closed, mentally visualizing and rehearsing just before jumping. Use the Dirt Dive concept to prepare for the competition; even the night before or just before going to the flight line – get your whole team together and mentally run through the entire scenario, from arrival at the set-up site to completion of the mission, including every action that every member of the team must take, talking through it in as close to real time as possible. Do the motions with your hands and imagine what you're doing, to form a mental picture of the entire flight preparation and conduct. Time passing during the flight window is your enemy…

Competition Preparation

113. The night before/hours before:

    a. Check all systems on the Unmanned System, controls systems, and telemetry.

    b. Organize all your Stuff.

    c. Conduct multiple Dirt Dives.

On the Flight Line

114. Arrive on the flight line no later than 60 minutes before your flight time.

115. Set up your flight line equipment, which you already checked, right? Do you have your 'medical kit'?

116. Move the aircraft to a location where it can be immediately moved onto the field at the start of your flight window. Many teams in previous years did final checks in the tent and then wasted time moving the System out to the field.

117. **Use your checklists to make sure everything gets done in the proper sequence!**

118. Use cables to test all telemetry/RC if possible.

119. Be ready to move to the flight line at least 10 minutes before your flight window.

120. At the start of your flight widow, establishing wireless communications between components and confirmation that they all work should take no more than a minute. There should be no hooking up of connectors at this point! **If you have to connect, assemble, close or tape anything during your flight window, you screwed up your system design or your pre-flight preparations.**

Papers and Presentations

121. Pre-Flight Presentation: Remember that this presentation is intended for an audience of clients… they're not interested in a lot of technical detail, and they need to be told exactly how you're going to accomplish their mission and how you're going to meet their requirements. The presentation should not mention the competition! In essence, play the game – it's important to embrace your role as the service provider of a drone solution and pretend that you're actually conducting the briefing to a client. Make sure, however, that you fulfill all of the competition requirements for the presentation – for example, introduce your team! PowerPoint is your friend – it will help ensure you cover everything you're intended to say, and make it easy for the audience to understand exactly what you're saying and how it relates to their requirements.

Wise Words ☺

122. You need to demonstrate what your system can do without being sidelined by gotchas or mishaps.

123. Practice. You need to understand your system and your teammates.

124. Reliability is key. Predictability is almost as good.

125. Time passes during your flight window whether you're flying or not.

126. Corollary: You can't win if you don't fly. Get your UAV in the air and meet at least some of the competition requirements.

127. Corollary: You have no idea how other teams will fare or how many points it'll take to win. Getting some points is a heck of a lot better than getting none.

128. Do not start uploading firmware or assembling the aircraft after the clock starts – have it ready to take to the skies!

129. Your only pre-clock constraint is radio silence. Think about how far you can prepare before radios come on. Use umbilical cables. Minutes count.

130. Checklists are key to a predictable outcome, Checklists after the clock starts must be short.

131. Team radio calls and verbal communications should be practiced when doing flights before the competition. Having standard messages will prevent confusing conversations. Dirt Dive!

132. Boring is good. Boring wins. Flashy often stays on the ground.

133. Corollary: You can win with a well-understood, low-tech approach. You won't likely win with a complex system that you haven't learned to manage.

134. RF and data link technology can be the biggest issue in the system, especially if using more than one frequency. Simple is good.

135. Did we mention: Keep it simple?

136. Test data links extensively before the competition.

137. When testing, understand that ground-to-ground range is short compared with ground-to-air.

138. Corollary: Get your GCS antennas up high.

139. Corollary: Don't stand in front of your team's antennas.

140. Frequencies interfere. Nearby antennas can conflict even if on different frequencies.

141. Look up 'RF interference'. Think of it as a bad thing. Don't forget your GPS has an antenna too.

142. Watch the other teams operate. Look for ways they're being effective, and ways they're not.

143. Bring a spare. Keep software backups. Have a quick response 'medical kit'.

144. Be gentle with your wires, for they cause failure. But you've minimized connectors, right?

145. Practice more.

146. It doesn't matter how well your system works if you fail to do the things that score points!

147. Winning teams are very selective in the changes they make to their system and team.

148. Good Planning and Good Luck!!

Questions from Teams

Where appropriate, the responses will be incorporated in the CONOPS, with appropriate cross-references from the questions.

If in doubt, READ the CONOPS and understand the rules…

Date	Team	Question	Response
11/09/19	University of Toronto	How big are the QR codes on boxes?	Para 33.a.v has been updated to answer this question – QR codes will have dimensions between 1 and 4 inches.
		Is the furthest point in the lap <1.5km from depot for straight line distance?	Considering the Depot location as a point of reference, the Clinic location will be at most 1.5km away in a straight line. This is not necessarily the furthest distance you will travel from the Depot during a lap.
		How far inside is the target inside the tent? How far outside is the target from the tent?	Para 33.c.ii has been updated to answer this question – the internal target will be centered in the tent and the external target will be between 1 and 10 m away from the tent.
		Can you pick up multiple packages at the same time for task 2?	That's up to you!
		What is the tolerance for cutting corners? Will there be a boundary given?	You will receive a map at the briefing which lays out the path you must follow for laps. Any lap during which the UAV cuts corners will not be counted towards the total number of completed laps – see Table 4**: Distance-Based Delivery (Task 1) Scoring** for lap scoring. The path will be designed with fixed and rotary-wing UAV in mind. This is not a test of flight accuracy.
		How many bonus packages are there for task 2?	Para 42 has been updated to answer this question – there will be at least 4 bonus packages.
		What happened to points 87 and 88?	There's no missing information – points 86 and 89 were mistakenly separated.
		How tall are the tents?	Clinic/Depot tents will be about 8' tall. This has been added to Para 28.
		Are the tents connected by nice roads (eg: concrete)?	In both Tasks, the terrain between the Depot and Clinic(s) is not suitable for ground vehicles. However, the terrain between Task 2 Clinics will be connected by hard surface. See Para 28.
		Can we place UGVs at the tents beforehand?	See Para 27.b – you may only preposition a UGV at the Task 1 Depot. UGVs at any other location need to be brought by UAV

			during the flight window.
		Does the package have to be unloaded (from the UGV) or can we just leave it inside the UGV on the target?	The packages must be released from your systems in order to receive points for drop-off. Table 4**: Distance-Based Delivery (Task 1) Scoring** and Table 5**: Location-Based Delivery of Multiple Packages (Task 2) Scoring** have been updated to reflect this. See Para 33.c.iii.
12/09/19	Sherbrooke	Will the map provided during the briefing be detailed enough to be able to land without FPV (e.g. autonomous flight with GPS coordinates)?	The map provided will reference the Clinics and Depots by GPS-derived lat/long and/or Google Maps-based visual reference to satellite imagery. It is your choice if you need FPV or other guidance methodology.
		If a parachute or any kind of dropping mechanism is used for landing a UGV, can the parachute (or any piece of equipment) be released from the UGV upon landing at the clinic and/or depot?	Yes, so long as the package itself is delivered without modification or anything still attached to it. You can leave random stuff laying around – just not on the package. Your system should be designed such that discarded equipment is not carried away by wind.
		Can we ground drive between clinics? If yes, will it also be a hard surface between the clinics?	For Task 2, the Clinics will be connected by hard surface, so it is possible to ground drive between them. However, in both Tasks the terrain between the Depot and Clinic(s) is not suitable for ground vehicles.
		If we choose not to read the QR codes, does it count as a "*QR codes are read by the Unmanned System*" (since it is not read manually…)?	If neither the system nor a team member reads the QR codes, no points will be awarded for QR code reading. See updated Table 4**: Distance-Based Delivery (Task 1) Scoring**.
18/09/19	UBC	Is the entrance for the "medical tents" and "depot" the full wall length of 3m or is it less?	Para 28 has been updated: The Clinic/ Depot tents will be approximately 10'x10' by 8' tall; one full side will be open.
		Under point 49 on the CONOPS, it states that the operator must remain at the launch point for the duration of the task. Does this mean the operator is not allowed to move between where the UAV launches and the ground station (tent), during the flight window?	That's OK, but you can't go to the Depot. Not to worry, control will be exercised on site…
03/10/19	University of Alberta	What is the minimum distance of the packages from the walls of the tent (for both depots and clinics, in both tasks 1 and 2)?	Refer to Para 33.a.iv (Task 1) and Para 38.a.iv (Task 2). There will be a minimum of 30cm between packages and tent walls.
10/10/19	Ryerson	The con-ops states that we cannot fly	Yes, that's OK.

		within the tents. That being said, can the propellers spin inside the tent as long as the aircraft is touching the ground?	
		Can we leave a UGV at the Depot?	See Para 27.b – you may only preposition a UGV at the Task 1 Depot. UGVs at any other location need to be brought by UAV during the flight window. Remote judges will kill the UGV using your off switch, so you can leave it at the Task 2 Depot at the end of the flight window.
		Will we be able to swap batteries in Task 2 between deliveries? Say we deliver 4 packages. Can we then swap batteries to deliver the rest of the bonus packages?	The only restriction on swapping batteries is during the Task 1 laps (see Para 33.b.iii). If necessary, you can bring your UAV back to the launch site to change batteries at any other time.
21/11/19	SFU	The CONOPS only specifies that the UAV that picks up the package will need to complete the laps. Does this mean that we could then have a second UAV that's sole purpose is to deliver a UGV to the clinic via a direct route while still counting the laps completed by the UAV carrying the package?	The CONOPS doesn't say you can only have one UAV. You can use as many vehicles as you want, as long as each individual vehicle complies with the requirements listed in the CONOPS (having a designated Operator, etc.). The CONOPS contains requirements to obtain points and the limitations and conditions around operating vehicle(s), which you must consider in any of your strategies!
03/12/19	École de technologie supérieure	Are the same people marking the Phase 1 design papers?	Some might be the same, others might be new. However, judging will be consistent for all papers.
		Will the QR code have a white background, or contour to distinguish from the box?	The QR code will be black-on-white, and placed on the packages as labels.
		Where is the pilot allowed to be located when operating the UGV (rover)?	We intend for you to have line of sight view of the UGV (Task 1). There may need to be an established stand-off distance for safety reasons (i.e. 50 feet).
		If we have multiple rovers, can one pilot manage each of them as long as only one is moving/active at a time?	Generally, yes; however, if it looks unsafe it will not be permitted, and you will be asked to terminate. A similar rule applies to UAV, ie, one pilot per UAV in the air.
03/12/19	Concordia University	Are the top and front QR codes the same or different?	They are the same QR codes.
		What info does the QR code provide (clinic #, type of medicine, etc.)?	The task is to be able to scan the QR code, no special software will be needed. We aren't trying to trick you.

			Example: For Task 2, you use the QR code to gain the clinic location. The QR code will give the clinic location in some form, may it be text or diagram.
		What is the acceptable radius for each waypoint for Task 1? Essentially what is classed as cutting corners?	Some sort of ground indication (i.e. a pylon) will show the waypoints, and if the UAV passes the waypoint inside the pylon the lap will not count.
		Will the scoring be scaled linearly for Task 1 distance?	It is not scored as distance, it is the number of laps. Example: Best team(s) 6 laps = 20 points Worst team(s) 0 laps = 0 points Scoring then scaled between 0 and 20, depending where your team falls in the number of laps…eg, a team doing 3 laps would receive a score of 10.
		Is there a difference in scoring between having a fully automated package pickup system and a system that is remote controlled via the pilot to pick up the package?	No difference in scoring.
03/12/19	Ryerson University	Are non-full time students allowed to participate on the team (ex. A part-time graduate student for admin/management)?	Yes.
03/12/19	University of Manitoba	Can we purchase an off-the-shelf UGV and remodel/customize it?	Not a problem, as long as safety is maintained.
		Any additive safety measures that should be taken, other than the safety switch?	If we deem something is unsafe, it will not be permitted. Keep in mind we need to have the ability to safely remove the vehicle from the field as to continue with the competition.
		Is insurance necessary?	This has yet to be confirmed with the airport (most likely not). This was a previous requirement of the SFOC, however SFOCs are no longer required. Contact your university to see what their processes are.
03/12/19	UBC	It was stated that the QR code could return a diagram – would we require an internet connection?	You will not be required to use the internet, so QR codes will return text-only.
17/12/19	Ryerson	In Task 2, is it legal to pick up more than the first row of packages right away? Or, must we pick up only the 4 packages in the first row, deliver	You can pick up as many packages as you want, as long as the first four packages are dropped off at the Clinics before any Bonus packages.

		them, and then return to the depot for additional packages? (See Para 42)	