



BRIGHAM YOUNG UNIVERSITY  
AUVSI CAPSTONE TEAM (TEAM 45)

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## 2019 AUVSI Competition Summary

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AF-012	0.1	06-17-2019	Created	Kameron Eves	Jacob Willis
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## Introduction

This document summarizes the results from the AUVSI Competition, held June 12th - 15th, 2019.

## Pre-Competition

We got lucky and drew got to choose our flight time second. (there is some speculation that our high paper and video scores helped us get to choose our flight time first). We choose one of the last times on Saturday morning, so we could hammer out some bugs.

We spent basically all-day Wednesday, Thursday, and Friday debugging, tuning gains, flight testing, and repeating. We had a minor crash on Friday when we drained the battery in flight and ended up in a tree. Luckily it was in the tree and not on the ground because it was suspended right over the biggest puddle ever. Blessedly, there was no damage. Also, of note, we removed the filleted paths from the path manager because it was causing us to fly away into the distance without making turns. This worked, but we didn't test it for the first time until the competition.

## Competition

We were surprised on Saturday with how quickly we got to the flight line (we flew basically as soon as we got there), so things were a bit rushed. The weather was windy, but overall favorable. The mission proceeded as follows:

- Andrew gave a boss briefing, nameing each team member and describing their role.
- Manual takeoff. An autonomous takeoff should work, but we didn't want to try it for the first time in the competition and didn't want to risk testing it just a day or two before the competition.
- We began autonomous flight immediately after take off and loitered for 3 minutes. We wanted to ensure we got the full autonomous flight points because we weren't 100 percent confident in the path manager. In hindsight this was a mistake, the path manager worked fine, and we ran out of time in the end.
- The aircraft planned, flew, and hit the waypoints beautifully and fully autonomously. However, we did not notice until we received our score that we forgot to change one parameter (the location of the origin used by the interop client). This meant that

for our entire flight we reported our location to interop as if we were in the park where we spent the week testing and not at the actual competition field. Changing this parameter was on the checklist but got skipped in our rush. So, we got no points for hitting the waypoints. On the plus side, because we were reporting our location incorrectly by several miles, we also didn't hit any obstacles (although this benefit was negligible).

- We then planned and attempted an autonomous UGV drop. We flew the path successfully but the command to actually drop was not sent autonomously (there's probably a bug in the payload drop code, this was one of the first autonomous drop attempts). So, we took over RC, flew the path manually, and sent the drop command manually. This worked; however, we did not have enough accuracy to hit the target this way. So, we got no points from this portion of the competition.
- We then entered an autonomous loiter while we planned a search path for the vision team. This in hindsight was also a bad idea. The drop location was right next to a boundary and the tents, so we flew out of bounds and over the tents. They called this an "Unsafe Out of Bounds" and we received a huge penalty for it (Equivalent to all our autonomous flight points).
- We then attempted to fly the search path, while flying the search path we realized it was going to take too long to fly there autonomously and so Kameron manually took over for a third time and flew over as much of the search area as he could before we ran out of time. We successfully identified 4 targets manually, and one target autonomously. We actually were the only team to successfully identify a target autonomously. We received the Cyber Award for it.
- At that point we didn't have time to continue searching for targets and returned for a manual landing. (An autonomous landing would have given us no additional points while also risking a fourth manual takeover.)
- We exited the airfield with seconds to spare.

In the end we received a score of 25th for the flight, 3rd for the Mission Readiness Review and 5th for the Journal, resulting in 17th overall. All in all, we're proud of the performance and don't feel like our score represented our actual performance. Because our paper and flight readiness review were so good, and because we were the only team to autonomously identify a target, we received \$1,750 in prize money. (More than last year.)

## Appendix: Judges Feedback

Included here is the feedback we received from the Judges.

### 2019 AUVSI UAS Competition

Rank	Name	Mission	FRR	Journal	Prize Money
1	Ecole de Technologie Supérieure	1	6	20	\$ 7,650
2	Flint Hill School	2	18	14	\$ 5,700
3	Yildiz Technical University	3	7	19	\$ 4,700
4	University of Cincinnati	4	8	18	\$ 3,100
5	Université de Sherbrooke	6	2	7	\$ 3,400
6	Indraprastha Institute of Information Technology	5	19	32	\$ 2,250
7	Cornell University	10	1	10	\$ 1,700
8	Istanbul Technical University	9	5	16	\$ 1,000
9	Royal Thai Air Force Academy	7	22	51	\$ 950
10	North Carolina State University	12	26	2	\$ 1,950
11	Palos Verdes High School	8	33	61	\$ 700
12	Rutgers University	13	11	42	\$ 700
13	Konya Technical University	11	44	58	\$ 700
14	University of Texas at Austin	15	16	3	\$ 1,200
15	Embry-Riddle Aeronautical University, Daytona Beach	14	27	40	\$ 700
16	Harvard University	19	32	27	\$ 700
17	Brigham Young University	25	3	5	\$ 1,750
18	University of Split	21	24	17	\$ 950
19	University of Hawai'i at Manoa	20	25	46	\$ 450
20	University of British Columbia	22	21	37	\$ 450
21	Virginia Tech	26	13	11	\$ 450
22	UCLA	27	14	4	\$ 850
23	Thomas Jefferson High School for Science and Technology	18	40	44	\$ 450
24	Concordia University	16	36	60	\$ 700
25	Loyola University Maryland	23	28	59	\$ 700
26	Vaughn College of Aeronautics and Technology	24	42	28	\$ 450
27	Rashtriya Vidyalaya College of Engineering	28	15	39	\$ 450
28	California State Polytechnic University, Pomona	29	17	35	\$ 700
29	Polish Air Force Academy	17	48	65	\$ 450
30	Mukesh Patel School of Technology Management and Engineering	31	4	12	\$ 400
31	Military Technical College	31	10	8	\$ 450
32	Monroe Community College	31	9	13	\$ -
33	SRM Institute of Science and Technology	31	23	1	\$ 1,450
34	Istanbul Sehir University	31	12	22	\$ 700
35	Institute of Technology, Nirma University	31	20	33	\$ -
36	Kansas State University	31	31	24	\$ -
37	University of New South Wales	31	30	31	\$ -
38	University of Alberta	48	35	9	\$ -
39	Kent State University	48	29	36	\$ -
40	Pennsylvania State University	48	34	29	\$ -
41	University of Maryland College Park	31	45	6	\$ 200
42	Kocaeli University	31	43	26	\$ -
43	Fr. Conceicao Rodrigues College of Engineering	31	41	34	\$ 500
44	Vellore Institute of Technology	31	38	49	\$ -
45	University of Arizona	48	37	56	\$ -
46	Norfolk State University	30	46	64	\$ 200
47	Christopher Newport University	31	39	67	\$ -
48	Bursa Technical University	31	47	52	\$ 450
49	University of Rome, La Sapienza	31	49	53	\$ -
50	McGill University	48	53	15	\$ -
51	University of California, San Diego	48	53	21	\$ -
52	University of Michigan	48	53	23	\$ -
53	M.S. Ramaiah Institute of Technology	48	53	25	\$ -
54	Purdue University	48	53	30	\$ -
55	Florida Institute of Technology	48	50	63	\$ -
56	Saint Louis University	48	53	38	\$ -
57	Michigan State University	48	53	41	\$ -
58	Duzce University	48	53	43	\$ -
59	University of Central Florida	48	53	45	\$ -
60	University of California, Irvine	48	53	47	\$ -
61	Virginia Commonwealth University	48	53	48	\$ -
62	Mississippi State University	48	53	50	\$ -
63	United States Naval Academy	48	53	54	\$ -
64	Clark College	48	53	55	\$ -
65	Southern Methodist University	48	53	57	\$ -
66	Calvert Hall College High School	31	51	66	\$ -
67	Karabuk University	31	52	68	\$ -
68	University of Minnesota Twin Cities	48	68	62	\$ -

# **Brigham Young University**

## **SUAS 2019 - Flight Readiness Review**

### **Feedback to School on Experience, Roles, Responsibility**

Past experience should be more than just the time spent with the team.

Question whether all students are part of class of 2019 as indicated in the Video, Concern with actual Flight Line responsibilities, since all 12 Team members were identified with roles but only 10 persons can be on the Flight Line

Straightforward introduction but missing each member's degree of experience with UAS technologies

Good selection of students with appropriate skills

### **Feedback to School on System Overview and Planned Tasks**

Well-done

Outstanding Systems Overview, No reason provided for not completing UGB Drive Task Successfully

Good summary of all the system components.

### **Feedback to School on Developmental Testing**

Well-done

Excellent description of testing conducted, Could use charts to synopsise data for better understanding, No mention of Localization algorithms

Great explanation on all aspects of developmental testing. I appreciated the footage of all of the testing done, especially the clip with someone holding the airframe fuselage right out of the window. My only complaint is that the imaging performance section should have included the team's strategy for ensuring the best image quality.

Some work needed to meet the competition requirements

### **Feedback to School on Mission Testing**

Good

Excellent synopsis of Full Mission Testing and its value in discovering and resolving flaws to enable mission success, Slight concern that no Autonomous testing was completed prior to taping of FRR

Although full mission testing was not achieved, scores across various runs should have been included for each section on the rubric provided in the Mission Demonstration section of the rules.

More work needed for competition. Appears not fully ready.

### **Overall Feedback on Flight Readiness Review**

Great presentation!!!

Overall an Excellent Review, which based on its 12:05 time length could be improved to further address the few concerns expressed

Overall, great presentation, and good luck at the competition! Though, next time you may want to tune down the intro/background music or remove it completely. While I did not factor that into your scores, judges have tended to dislike music in these presentations.

Overall ratings 65%

## **SUAS 2019 - Technical Design**

### **Feedback on Systems Engineering Approach**

A reasonable approach - seems to leverage much from previous experience or achievements; however, the system engineering principals are covered and woven into their analysis.

Mission Req Analysis: You have a list of requirements placed on the UAS but don't discuss the design trades for each requirement or what systems need to be built. Design Rationale: more details on design options/trades would help justify team decision. for example: a table comparing the diferent airframe designs charateristics. You state that your budet is \$3500 how did your design meet this budget. Same for man hours of 2500. What other drop methods did you consider and where is the data that shows your choice is best?

Very good section. Could have mentioned ground station/comms requirements.

Good work

One of the best system engineering approach I have read. Good flow and covered all the points very clearly and affectively. Just loved it.

### **Feedback on System Design**

Good design and appears to be well thought out and validated. The consideration of trade space was an important reflection within the work.

autopilot; map capabilities to competition tasks comms; what antennas and link range Cyber; light on details

Impressive development and use of sim/testing data.

Good work

Block diagram of communication system and GCS image was missing. You could represent data in tabular for more clarity. Your imaging system does not tell more about resolution of image as per competition need. rest all was good.

### **Feedback on Safety, Risks, & Mitigations**

Overall, seems to have covered the most significant risks and show stoppers.

Good to know your crash rate went from 100% to less than 5% after implementing the use of a checklist.

Any risks during system construction?

**Good work**

Font was way too small. Difficult to read and difficult to understand complex table structure.

**Feedback on Overall Paper**

A little more attention to details (e.g., verbiage or editing) when finalizing the paper.

the flow from your options to the design decision were always clear or supported by data

Excellent journal! Well written, meticulous attention to detail, and professional formatting. Got a little dense in a couple spots.

Keep up the good work.

Overall paper was very good. Some improvement would have made this one of the best. Happy flying ..

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Team Name: BYU

**Feedback to Team:**

Good team communication in flight

Work on altitude tuning

Range test telemetry links more

Amazing amount of development this year!