Engineering Student Technology Committee
Walter Scott, Jr. College of Engineering
Colorado State University

1. Title of Proposal:

Drones and Sensors for Engineering Student Instruction and Projects

2. Proposal Participants:

Primary Contact for Proposal

Name: Sonia Kreidenweis   E-Mail: Sonia@atmos.colostate.edu

Department/Major: Atmospheric Science / Associate Dean, Scott College of Engineering

Check One: __X___ **Faculty**   _____ **Staff**   _____ **Student**

Additional proposal participants

Name: Sean Freeman   E-Mail: Sean.Freeman@colostate.edu

Department/Major: Atmospheric Science

Check One: _____ **Faculty**   _____ **Staff**   ___X__ **Student**

3. Proposal Abstract (limit to 100 words):

CSU has recently funded the launching of a UAS Center, aimed at providing resources and support to the CSU community in the application of drone technologies for research, education, and outreach. This proposal requests equipment for use by engineering undergraduate and graduate students to train in flying drones, and in collecting and analyzing data from drone-mounted sensors. We propose to purchase three "training drones" and an array of sensors to cover current main applications across CSU: photography / infrastructure inspection; agricultural monitoring; meteorological observations; and air quality measurements. We will also purchase two years of required liability and damage insurance.

4. Proposal Budget

List of items to purchase and cost of each

Requested from ESTC:

training drones	DJI Tello	$99
	DJI Inspire 1 v2.0 (2)	$3,998
camera, multispectral	Tetracam ADC Micro	$2,995
camera, zoom	Zenmuse Z3	$899
VOC sensor	MOCON	$600
H2O / CO2 sensor	CO2METER	$299
meteorological sensors (3)	iMet XQ2	$1,050
	TOTAL	$9,940

paid by Core Facility:

liability insurance, 3 drones	$225 per year, 2 years (2)	$1,350
insurance, Inspire, 5.25% value (2 years)	$209.90 each year	$840
insurance, Tetracam, 5.25% value	$157.24 each year	$314
extra batteries for DJI	DJI Inspire 1 v2.0 Battery (2)	$318
drone-ground instrument communication system	5 drones, $300 per drone	$1,500
	TOTAL	$4,322

Dollar or percentage amount requested from ESTC: $9,940
Dollar or percentage amount cost shared: $4,322

5. Full description of proposal:

In Spring 2018, the Office of the Vice President for Research selected for funding a proposal from Kreidenweis, Freeman, Chavez, Chandra, and Smith, to support the launch of a UAS Center at CSU. The proposal was motivated by campus-wide interest in the use of drones for research projects and other applications (e.g., precision agriculture; nature photography), as evidenced by the "UAVlist" listserve that has accumulated over 40 names since its launch in 2015. Despite this interest, little guidance was available to help potential users understand how drones might be used in their research, or to help them obtain experience or pilot-study data.

The purpose of the Center is to (1) educate the CSU community about drone technologies and the applications of drones in obtaining data for research and projects; (2) help the CSU community obtain pilots' licenses and FAA approvals, including conducting training; (3) provide

expertise to design experiments using drones; (4) provide equipment for users to learn how to fly and to learn how to obtain and interpret data; (5) serve as a campus resource for scheduling drone flights at Christman Field and coordinating with the CSU Office of Risk Management and Insurance, Facilities Management, and the CSU Police Department.

The Center's first action has been to launch a search for a Center Coordinator who will work with the 5 steering committee members to develop the structure for the Center; initiate activities, training, and outreach; and put together an inventory of drones and sensors to be used for training and pilot studies. We already have some equipment that was obtained two years ago from a joint grant from the OVPR and Scott College of Engineering, with the intent of being used as "Center" drones if/when our proposal to create the Center was realized. These are two DJI Matrice drones, costing about $5,000 each. They are relatively large and expensive, and are thus more complex to set up and learn how to fly, and expensive to repair or replace.

We are requesting funds from the ESTC to purchase additional drones, specifically for undergraduate and graduate student use, that are less expensive yet capable of carrying up to two sensors (e.g., a camera and a temperature probe). We have selected the DJI Inspire for this purpose, due to its compatibility with our existing software and hardware and its reasonable price ($1,999). We will also purchase a DJI Tello ($99). This very small drone is controlled by smartphone, has a short range, and cannot carry sensors, but is ideal for first-time pilots in a training setting – it can even be flown indoors. The control interface looks the same as that for the other DJI drones and thus it offers practice with using the control panels and features.

We have also selected for purchase an array of sensors that we anticipate will have the greatest interest from CSU engineering students. The multispectral camera can be used in various remote sensing strategies: its measurement bands are at green, red and near-infrared wavelengths, equivalent to Landsat Thematic Mapper bands TM2, TM3 and TM4, widely used to monitor plant and soil conditions. The zoom camera has a multitude of applications, including nature photography and infrastructure inspection. The VOC sensor can pick up pollutant / spill plumes, and the H_2O / CO_2 sensor can be used for profiling of the atmosphere and agricultural applications. The meteorological sensors provide basic temperature, humidity, and pressure data, required in nearly all applications. All of the sensors are relatively simple and inexpensive and should provide excellent pilot data for students beginning to explore the possibilities of data from drones.

To cost share expenses, we will use funds from the Center grant to provide needed accessories, such as extra batteries, as shown in the budget; CSU-required liability insurance; and the needed communications system. We will likely model this latter off the existing Raspberry Pi-Powered instrument communication system built by Freeman for the van den Heever research group.

The UAS Center is an exciting collaborative effort that is just getting started. Once the Director is hired, we will announce the Center's creation and that it is "open for business" via emails to campus and a new website that will include a site to sign up for training and to request instrumentation. This equipment grant would be a great boost for the Center, especially in providing instrumentation for training and pilot testing that can be freely loaned to students just getting started with drone-enabled research. Such "hands-on" experience for engineering students will open up new ideas for how drones could enhance their projects and research.