Special Applications of Drone Technology

Level: 3
Career Cluster: Advanced Manufacturing
Program: Engineering
Pathway(s): Engineering Applications UAS

Course Catalog Description

Explores specialized applications of drone technology through mission planning, data collection, and real-world problem solving. Students use advanced drone systems to investigate careers and applications in mapping, agriculture, inspection, public safety, media, and other industry settings.

Summary

This course explores specialized applications of drone technology through advanced systems integration, mission planning, data collection, and real-world problem solving. Students investigate how drone hardware, software, sensors, payloads, and geospatial tools are used across a variety of industries, including mapping and remote sensing, precision agriculture, environmental science, infrastructure inspection, public safety, emergency response, and media production. Throughout the course, students develop an understanding of how operational goals, environmental conditions, regulations, safety protocols, and ethical considerations influence the planning and execution of drone missions. They also analyze data collected through aerial systems, interpret findings for decision-making, and evaluate the strengths and limitations of drone-based solutions in comparison with traditional methods. In addition, students explore career pathways, postsecondary opportunities, leadership, and workplace readiness skills that connect technical learning to future education and employment. The course culminates in an applied capstone project in which students design, justify, and present a drone-based solution to an authentic industry scenario using technical communication, data evidence, and professional practices.

Notes

Compared with the older course, this revised version broadens and modernizes the scope by moving beyond a general overview of industrial drone uses to a more structured study of specialized applications and industry-specific problem solving. The updated course includes stronger emphasis on advanced drone systems, geospatial mapping, remote sensing, precision agriculture, environmental science, infrastructure inspection, public safety, emergency response, media production, and data analysis, providing students with a wider and more current view of how drone technology is applied across professional settings. It also strengthens mission planning, operational strategy, safety, risk management, and ethical decision-making, while adding leadership and work-based learning components that were not previously as explicit. The addition of a capstone-style applied drone technology project further increases rigor by requiring students to integrate technical knowledge, communication skills, and professional practices in a real-world scenario. Overall, the new course is more comprehensive, better aligned to current industry applications and workforce expectations, and more clearly designed to support career exploration, technical skill development, and postsecondary readiness.

Student Learning Outcomes

1. Career Exploration and Postsecondary Opportunities

Objective: *Students will analyze career pathways in engineering and drones by exploring industry roles, workplace expectations, required education, certifications, professional organizations, and postsecondary opportunities available in Colorado in order to make informed academic and career decisions.*

1) Identify employment opportunities in various fields with a focus in the area of engineering and drones
    a. Recognize the work typically performed, tools and technology used, and nature of work environments
    b. Identify potential certifications within the careers
    c. Find membership organizations associated with the careers
    d. Understand the necessary education associated within the careers
2) Define professionalism within the context of engineering and drones
    a. Criticism and evaluation
    b. Presentation
    c. Assessment
3) Recognize laws, regulations, and ethics significant to the fields of engineering and drones
4) Identify postsecondary opportunities offered in the state of Colorado
    a. Technical college, community college, 4-year institutions
    b. Certificates, associates, bachelor, and advanced degree opportunities

2. Advanced Drone Systems and Technology Integration

Objective: *Students will examine advanced drone systems and analyze how hardware and software integrate to support specialized missions.*

5) Identify advanced drone components such as LiDAR, multispectral cameras, thermal sensors, and RTK GPS
6) Explain how sensors and payloads support specialized applications
7) Analyze system integration between flight hardware, software, and control systems
8) Evaluate how different configurations impact mission performance
9) Compare commercial drone platforms for different application purposes
10) Design a drone system based on a specific application scenario

3. Geographic Data, Mapping, and Remote Sensing

Objective: *Students will interpret geospatial data and apply drone technologies for mapping and remote sensing applications.*

11) Define geographic information systems and remote sensing concepts
12) Explain how drones collect geospatial data
13) Analyze mapping outputs such as orthomosaics, 3D models, and elevation maps
14) Interpret sensor data for applications such as agriculture, land surveying, and inspection
15) Compare different mapping techniques and outputs

16) Evaluate the accuracy and limitations of drone-collected data
17) Apply mapping tools to a project-based scenario

4. Drone Applications in Agriculture and Environmental Science

Objective: *Students will evaluate how drones are used in agriculture and environmental monitoring to improve efficiency and sustainability.*

18) Describe drone applications in precision agriculture and crop monitoring
19) Explain how drones support environmental data collection and conservation efforts
20) Analyze how sensors detect plant health, moisture levels, and environmental changes
21) Evaluate the effectiveness of drone use compared to traditional methods
22) Interpret agricultural and environmental data outputs
23) Recommend drone-based solutions for real-world agricultural or environmental challenges

5. Infrastructure Inspection and Industrial Applications

Objective: *Students will analyze how drones are used in industrial inspection and apply engineering concepts to inspection scenarios.*

24) Identify infrastructure systems such as bridges, power lines, pipelines, and buildings
25) Explain how drones are used to inspect infrastructure safely and efficiently
26) Analyze inspection data for identifying damage, wear, or risk
27) Compare manual inspection methods with drone-based inspections
28) Evaluate safety advantages and limitations of drone inspections
29) Develop a basic inspection plan for an infrastructure scenario

6. Public Safety, Emergency Response, and Disaster Management

Objective: *Students will evaluate the role of drones in emergency response and apply decision-making skills to crisis scenarios.*

30) Describe how drones are used in search and rescue, firefighting, and disaster response
31) Analyze scenarios where drones improve response time and situational awareness
32) Evaluate risks and benefits of drone deployment in emergencies
33) Interpret aerial imagery for situational assessment
34) Apply critical thinking to emergency planning scenarios
35) Recommend drone-based strategies for emergency response situations

7. Media, Communication, and Creative Drone Applications

Objective: *Students will apply drone technology to media production, communication, and creative industries.*

36) Explain the role of drones in photography, videography, and media production
37) Analyze camera angles, movement, and composition in aerial imaging
38) Evaluate legal and ethical considerations for media use
39) Compare storytelling techniques using drone footage
40) Apply drone technology to a creative media project
41) Create a storyboard or concept for an aerial media product

8. Advanced Mission Planning and Operational Strategy

Objective: *Students will design complex drone missions that incorporate environmental, technical, and operational constraints.*

42) Define mission parameters including objectives, constraints, and success criteria
43) Analyze factors such as weather, airspace, terrain, and equipment limitations
44) Develop mission plans using mapping and planning tools
45) Evaluate mission risk and safety considerations
46) Justify mission decisions based on data and operational goals
47) Revise mission plans to improve efficiency and outcomes

9. Data Analysis, Interpretation, and Decision-Making

Objective: *Students will analyze drone-collected data and evaluate its use in decision-making processes.*

48) Interpret data collected from cameras, sensors, and telemetry systems
49) Analyze patterns and trends in drone-generated datasets
50) Evaluate the reliability and accuracy of collected data
51) Apply data insights to solve engineering or operational problems
52) Compare different data visualization methods
53) Justify decisions using evidence from drone data

10. Safety, Risk Management, and Ethical Considerations

Objective: *Students will evaluate risks and apply ethical principles to drone operations and data use.*

54) Identify risks related to drone operations, data collection, and system failures
55) Explain ethical concerns such as privacy, surveillance, and data security
56) Analyze real-world incidents involving drone misuse or accidents
57) Evaluate safety protocols and mitigation strategies
58) Apply ethical reasoning to operational decisions
59) Defend responsible use of drone technology in society

11. Applied Drone Technology Project

Objective: *Students will design, develop, and present a real-world drone application project that integrates course knowledge.*

60) Define a problem that can be solved using drone technology
61) Design a complete drone solution including hardware, mission plan, and data strategy
62) Develop a proposal or prototype demonstrating the application
63) Analyze performance and outcomes of the design
64) Present results using technical communication and data evidence
65) Evaluate effectiveness and propose improvements

12. Leadership

Objective: *Students will demonstrate leadership skills through communication, collaboration, responsibility, and ethical decision-making in classroom, project, and industry-based settings.*

66) Demonstrate effective communication, teamwork, and problem-solving skills in collaborative settings
67) Apply leadership strategies to manage tasks, resolve conflicts, and support group goals
68) Model professionalism, accountability, and ethical behavior in academic and technical environments
69) Evaluate personal leadership strengths and identify areas for growth
70) Participate in leadership roles within projects, classroom activities, or student organizations

13. Work-Based Learning

Objective: *Students will connect classroom learning to career pathways through authentic work-based learning experiences, industry engagement, and reflection on workplace expectations and skills.*

71) Identify the purpose and value of work-based learning experiences in career development
72) Demonstrate workplace readiness skills such as punctuality, communication, adaptability, and responsibility
73) Apply technical knowledge and employability skills in authentic workplace experiences
74) Analyze feedback from instructors, peers, or industry partners to improve performance
75) Reflect on work-based learning experiences to evaluate career interests and future goals

14. Career and Technical Student Organizations

Objective: *Using the CTSO Resource Document, chapter activities will provide some of the best opportunities CTSO members will have to learn by doing. A successful program of work creates a positive learning atmosphere in the classroom. CTSO members learn how to accept responsibility, work as a team, manage a budget, and handle success and failure. Per the CTE Admin Handbook, CTSOs are embedded into curriculum.*

Professional Development

Prepare each member for entry into the workforce and provide a foundation for success in a career. Becoming a professional does not stop with acquiring a skill, but involves an increased awareness of the meaning of good citizenship and the importance of labor and management in the world of work.

Community Service

Promote and improve goodwill and understanding among all segments of the community through services donated by CTSO chapters, and to instill in its members a lifetime commitment to community service.

Business and Industry Connections

Increase awareness of quality job practices and attitudes, and increase the opportunities for employer engagement and eventual employment.

Financial Leadership

Plan and participate in activities to allow all members to carry out the chapter's projects. Educate members on their own personal finance for current and future success.

Public Relations

Make the general public aware of the good work that students in career and technical education are doing to better themselves and their community, state, nation, and world.

Social Activities

To increase cooperation in the school and community through activities that allow CTSO members to get to know each other in something other than a business or classroom setting.

Academic Standards Alignment

Colorado CTE courses are required to integrate academic and essential skills into course content. The following academic standards have been identified as aligned to this course and should be integrated throughout instruction.

CO CTE Academic Standards Resources (Rubrics, integration strategies, etc)
CDE Colorado Academic Standards Online (Online standards lookup tool)

Note: Mathematics and Science standards will be added in the future. Visit the Colorado Academic Standards page for the most current version.

Reading, Writing and Communicating Crosswalk

Course: Specia Applications of Drone Technology
Colorado Academic Standards – Reading, Writing, and Communicating

Standard	Prepared Graduate Competency	Description	Course Evidence / Alignment
Standard 1: Oral Expression and Listening	Prepared Graduate 1 – Collaboration	Collaborate effectively as group members or leaders who listen actively and respectfully; pose thoughtful questions, acknowledge the ideas of others; and contribute ideas to further the group's attainment of an objective.	Students collaborate on mission planning for industrial drone applications, communicate roles and safety considerations, and contribute during evaluation of operational scenarios.
Standard 1: Oral Expression and Listening	Prepared Graduate 2 – Oral Presentations	Deliver effective oral presentations for varied audiences and varied purposes.	Students explain drone applications, present operational plans and risks, and communicate findings from applied UAS missions.
Standard 2: Reading for All Purposes	Prepared Graduate 4 – Informational Texts	Read a wide range of informational texts to build knowledge and to better understand the human experience.	Students read and interpret FAA regulations, industry documentation, technical specifications, and safety materials related to UAS operations.

Standard 2: Reading for All Purposes	Prepared Graduate 5 – Language in Context	Understand how language functions in different contexts, command a variety of word-learning strategies to assist comprehension, and make effective choices for meaning or style when writing and speaking.	The course requires accurate use of UAS and aviation terminology, interpretation of regulatory language, and communication adapted to technical, safety, and client-facing contexts.
Standard 3: Writing and Composition	Prepared Graduate 6 – Craft arguments	Craft arguments using techniques specific to the genre.	Students justify mission decisions, defend compliance and safety choices with evidence, and support conclusions with data and situational analysis.
Standard 3: Writing and Composition	Prepared Graduate 7 – Informational Writing	Craft informational/explanatory texts using techniques specific to the genre.	Students produce mission plans, operational summaries, explanations of industrial drone workflows, and technical documentation.
Standard 3: Writing and Composition	Prepared Graduate 9 – Writing Process	Demonstrate mastery of their own writing process with clear, coherent, and error-free polished products.	Students draft, revise, and finalize professional documentation and apply correct technical and regulatory conventions.
Standard 4: Research Inquiry and Design	Prepared Graduate 10 – Research and Ethics	Gather information from a variety of sources; analyze and evaluate its quality and relevance; and use it ethically to answer complex questions.	Students research industry uses of drone technology, analyze environmental and regulatory constraints, and use information ethically to support real-world drone missions.

Free Resource Links

1. Career Exploration and Postsecondary Opportunities

- Bureau of Labor Statistics Drone Careers (drone careers aviation jobs education pathways workforce trends)
  https://www.bls.gov/ooh
- FAA UAS Careers and Certification (FAA Part 107 certification training drone workforce pathways)
  https://www.faa.gov/uas
- CareerOneStop Engineering Careers (career pathways certifications job exploration robotics aviation)
  https://www.careeronestop.org
- NASA STEM Careers (STEM aviation engineering robotics career opportunities)
  https://www.nasa.gov/stem

2. Advanced Drone Systems and Technology Integration

- DJI Enterprise Technology Overview (drone sensors payloads thermal lidar RTK systems)
  https://enterprise.dji.com
- DroneDeploy Platform Overview (drone software mapping data integration systems)
  https://www.dronedeploy.com
- Pix4D Technology Overview (photogrammetry mapping data processing drone systems)
  https://www.pix4d.com
- Parrot Drone Solutions (commercial drone platforms sensor integration applications)
  https://www.parrot.com

3. Geographic Data Mapping and Remote Sensing

- ESRI GIS Resources (GIS mapping geospatial data drone applications analysis)
  https://www.esri.com
- NASA Earth Observatory (remote sensing satellite data earth observation systems)
  https://earthobservatory.nasa.gov
- USGS Remote Sensing (geospatial mapping environmental observation data systems)
  https://www.usgs.gov
- Pix4D Mapping Learning (drone mapping orthomosaic 3D modeling photogrammetry)
  https://www.pix4d.com

4. Drone Applications in Agriculture and Environmental Science

- USDA Precision Agriculture (agriculture technology drones crop monitoring sustainability)
  https://www.usda.gov
- NASA ARSET Remote Sensing (environmental monitoring satellite drone data analysis)
  https://appliedsciences.nasa.gov
- DroneDeploy Agriculture Use (crop health mapping drone agriculture applications)
  https://www.dronedeploy.com

- Climate.gov Environmental Data (environment monitoring climate data analysis)
  https://www.climate.gov

5. Infrastructure Inspection and Industrial Applications

- FAA UAS Inspection Use Cases (infrastructure inspection drones industrial applications safety)
  https://www.faa.gov/uas
- Skybrary Infrastructure Inspection (aviation inspection safety structural monitoring drones)
  https://www.skybrary.aero
- DJI Industrial Inspection (powerline bridge inspection drone systems industrial use)
  https://enterprise.dji.com
- ESRI Infrastructure Mapping (GIS infrastructure inspection asset management mapping)
  https://www.esri.com

6. Public Safety Emergency Response and Disaster Management

- FEMA Drone Use in Disasters (emergency response drones disaster management applications)
  https://www.fema.gov
- DHS Drone Safety and Response (public safety drones search rescue response strategies)
  https://www.dhs.gov
- NASA Disaster Response (disaster monitoring response remote sensing drones)
  https://disasters.nasa.gov
- Red Cross Disaster Response Technology (emergency response planning technology applications)
  https://www.redcross.org

7. Media Communication and Creative Drone Applications

- DJI Creative Drone Media (aerial photography videography storytelling techniques drones)
  https://www.dji.com
- National Geographic Storytelling (media storytelling visual communication aerial imaging)
  https://www.nationalgeographic.org
- Adobe Creative Cloud Resources (media production editing visual storytelling tools)
  https://www.adobe.com
- Film Riot Aerial Filmmaking (drone cinematography camera movement composition techniques)
  https://www.filmriot.com

8. Advanced Mission Planning and Operational Strategy

- DroneBlocks Mission Planning (drone missions waypoint planning automation decision making)
  https://droneblocks.io

- UAV Forecast Planning Tool (weather planning constraints mission safety operations) https://www.uavforecast.com
- SkyVector Flight Planning (flight planning mapping routing airspace analysis) https://skyvector.com
- FAA Risk Management Handbook (risk planning decision making aviation operations) https://www.faa.gov

9. Data Analysis Interpretation and Decision Making

- Khan Academy Data Analysis (data interpretation statistics analysis trends visualization) https://www.khanacademy.org
- ESRI Data Visualization (GIS data visualization mapping analysis decision making) https://www.esri.com
- NASA Data Tools (earth data analysis visualization remote sensing datasets) https://data.nasa.gov
- Tableau Public Data Visualization (data dashboards visualization insights analysis tools) https://public.tableau.com

10. Safety Risk Management and Ethical Considerations

- FAA Safety Risk Management Handbook (risk identification mitigation safety aviation decision making) https://www.faa.gov
- Common Sense Digital Citizenship (ethics technology privacy responsible data use) https://www.commonsense.org/education
- CISA Cybersecurity Awareness (system security data protection risk management drones) https://www.cisa.gov
- IEEE Ethics in Technology (engineering ethics responsibility innovation safety systems) https://www.ieee.org

11. Applied Drone Technology Project

- UCAR Teaching with Drones (drone projects engineering design mission planning payload testing) https://scied.ucar.edu/teaching-box/drones
- NASA L'SPACE Program (mission planning technical proposals teamwork project development) https://www.lspace.asu.edu/
- CITRIS Initiative for Drone Education and Research (experiential learning drone innovation industry partnerships) https://cider.ucsc.edu/
- USI High School Drone Program (capstone applications FAA readiness career-aligned drone projects) https://www.flyusi.org/education/high-schools

12. Leadership

- Leading Teams Open Textbook (leadership teamwork communication collaboration motivation)
  https://pressbooks.usnh.edu/leadingleadingteams/
- Ethics Unwrapped (ethics integrity decision making leadership professionalism)
  https://ethicsunwrapped.utexas.edu/about
- A Practical Guide to Effective Group Work (teamwork accountability collaboration communication professionalism)
  https://cte.tamu.edu/resources/practical-guide-effective-group-work.html
- Leadership Lesson Plans (active listening conflict management emotional intelligence collaboration)
  https://involvedliving.osu.edu/leadership-lesson-plans

13. Work-Based Learning

- Colorado Workforce Development Council Work-Based Learning (Colorado work-based learning career pathways employer partnerships)
  https://cwdc.colorado.gov/strategies/work-based-learning
- CareerOneStop Find Training (career readiness training internships apprenticeships workforce planning)
  https://www.careeronestop.org/findtraining/find-training.aspx
- U.S. Department of Labor WIOA Workforce Programs (work-based learning job training employability workforce development)
  https://www.dol.gov/agencies/eta/wioa/programs
- USA.gov Free Job Training (job training career exploration workforce preparation employability skills)
  https://www.usa.gov/job-training

Technology Student Association – National Competitive Events

Drone Challenge (UAV)

Objective: *Students will design, build, document, test, fly, and present an open-source UAV drone that meets TSA Drone Challenge requirements for safety, flight performance, documentation, and mission completion.*

- Research the annual TSA Drone Challenge specifications, mission requirements, safety expectations, and applicable drone regulations.
- Design or modify an open-source UAV drone that meets TSA requirements for size, motors, propellers, guards, payload, camera, and mission function.
- Assemble and configure drone components, including motors, flight controller, electronic speed controllers, camera, antenna, and related systems.
- Document the UAV through a portfolio that includes photo logs, wiring schematics, programming explanation, engineered drawings, bill of materials, and work log.
- Test and troubleshoot the drone during setup, safety inspection, flight practice, and mission preparation.
- Complete the timed flight challenge according to TSA procedures.
- Participate in an interview explaining the drone design, components, programming, safety decisions, and mission performance.

Resources

- Technology Student Association – Drone Challenge (UAV) competition guidelines https://tsaweb.org/competitions-programs/tsa/themes-problems
- Federal Aviation Administration – Drone safety and regulations https://www.faa.gov/uas
- ArduPilot Documentation – Open-source autopilot software https://ardupilot.org/
- PX4 Autopilot User Guide https://docs.px4.io/

Technology Student Association – National Competitive Events

Geospatial Technology

Objective: *Students will collect, analyze, map, synthesize, and defend geospatial data in response to the annual TSA Geospatial Technology challenge.*

- Research the annual TSA Geospatial Technology challenge and identify the geographic issue or prediction being investigated.
- Collect geospatial data such as imagery, boundaries, transportation data, earth observations, historical maps, or basemaps.
- Use an online mapping platform to represent and analyze geospatial data.
- Prepare a digital documentation portfolio explaining the challenge, collected data, analysis maps, prediction, resources, and work log.
- Create a visual infographic map that communicates the predicted outcome and clearly supports it with data.
- Present and defend the team's prediction during the semifinal presentation/interview.
- Evaluate the final entry using TSA criteria for data use, prediction quality, visual communication, analysis, creativity, and presentation.

Resources

- Technology Student Association – Geospatial Technology competition guidelines https://tsaweb.org/competitions-programs/tsa/themes-problems
- ArcGIS Online – Mapping and geospatial analysis tools https://www.arcgis.com/
- NASA Earthdata – Earth observation and geospatial data https://www.earthdata.nasa.gov/
- QGIS – Open-source geospatial analysis software https://qgis.org/

Technology Student Association – National Competitive Events

Photographic Technology

Objective: *Students will capture, edit, document, and present a photographic portfolio that meets TSA Photographic Technology requirements for image quality, technical settings, editing process, copyright compliance, and presentation.*

- Research the annual TSA Photographic Technology theme and plan images that respond to the required challenge criteria.
- Capture original images that meet the required categories, such as color, black and white, macro, still life, and student choice.
- Apply photographic principles such as composition, exposure, focal length, lighting, perspective, and image clarity.
- Edit images using appropriate graphic editing software while preserving documentation of original and final versions.
- Document camera make, camera model, f-stop, exposure time, ISO speed, focal length, image interpretation, and edits made.
- Prepare required references/resources, copyright checklist, and consent/release forms when recognizable individuals are included.
- Present and explain the photographic portfolio using TSA criteria for technical quality, creativity, composition, documentation, and theme connection.

Resources

- Technology Student Association – Photographic Technology competition guidelines https://tsaweb.org/competitions-programs/tsa/themes-problems
- Adobe Lightroom – Photo editing and image organization https://www.adobe.com/products/photoshop-lightroom.html
- Federal Aviation Administration – Drone safety and regulations https://www.faa.gov/uas
- Pix4D – Drone mapping and photogrammetry resources https://www.pix4d.com/