Emerging Technologies: Electric Propulsion in Part 147 Curriculum

Aviation Technician Education Council – March 26-29, 2023

Aviation and Transportation Technology

AVIATION TECHNICIAN EDUCATION COUNCIL ATEC

Presenters

Mary Johnson, PhD

Professor
Aviation & Transportation Technology
Purdue University

mejohso22@purdue.edu

Tracy Yother, PhD

Assistant Professor
Aviation & Transportation Technology
Purdue University

tyother@purdue.edu

Deployment and Curriculum Choices

Deployment Options (i.e. How?)

Don't

Don't. Maintain existing Part 147 curriculum requirements.

- You might do this if your program fulfils existing workforce needs.

Integrate

Integrate into existing Part 147 program using new technologies as applications.

- The benefit is that this is relatively easy to incorporate.

Bolt On

Develop new courses focused on new technologies

- Use industry standards as the foundation for curriculum

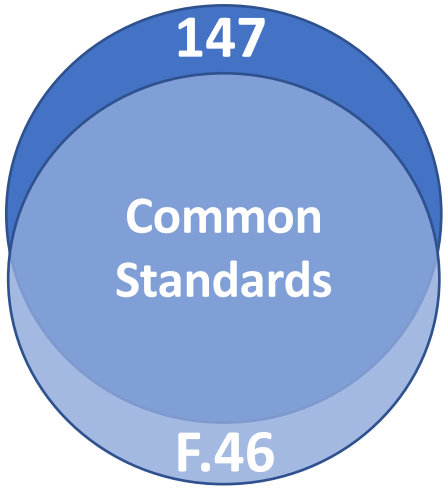
Curriculum Deployment Model – Integrate

2 Unique Standards

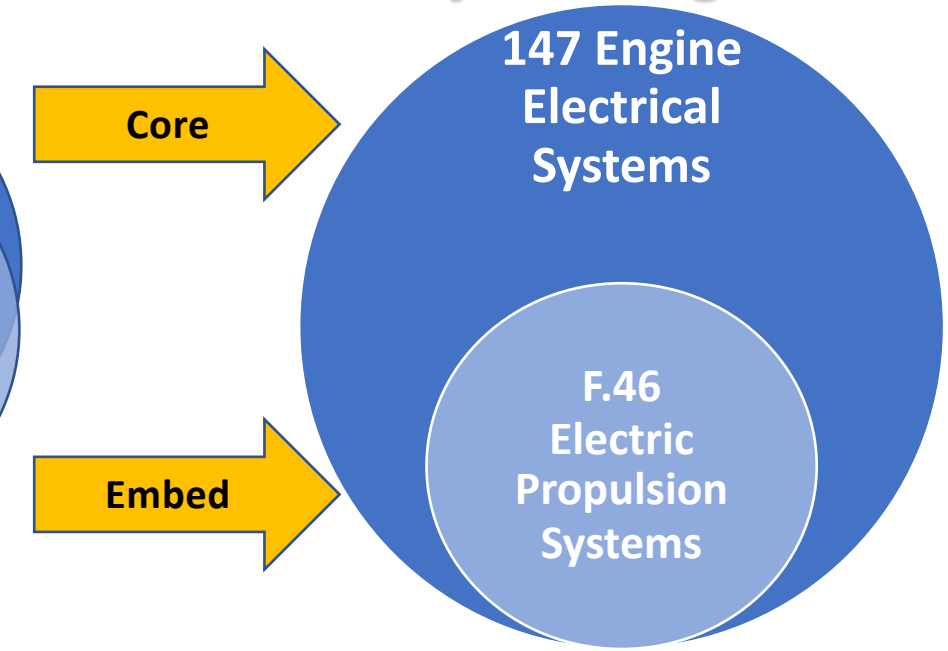
147 Engine Electrical Systems

ASTM F.46 Electric Propulsion Systems

Shared Standards



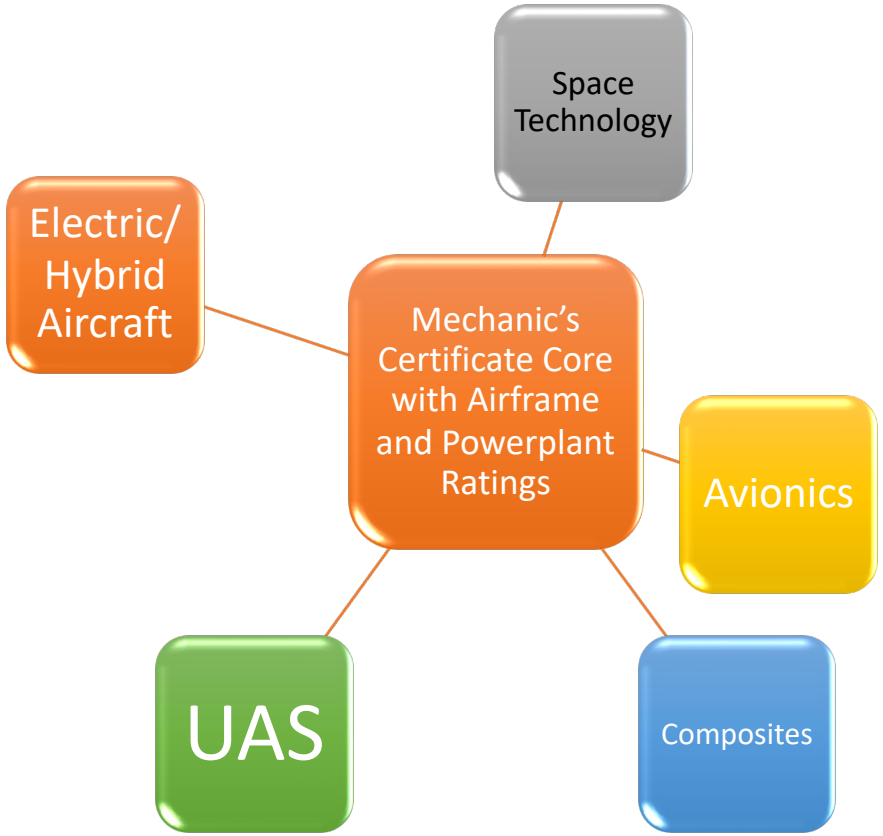
147 Subject Integration



Curriculum Deployment Model – Bolt On

Part 147+ Model

- Additive programs bolted to established mechanics certificate core
- Flexible
- Localized workforce development



Where is the curriculum?

This is where we need your help.

Simple Steps for Curriculum Development

Design

Develop

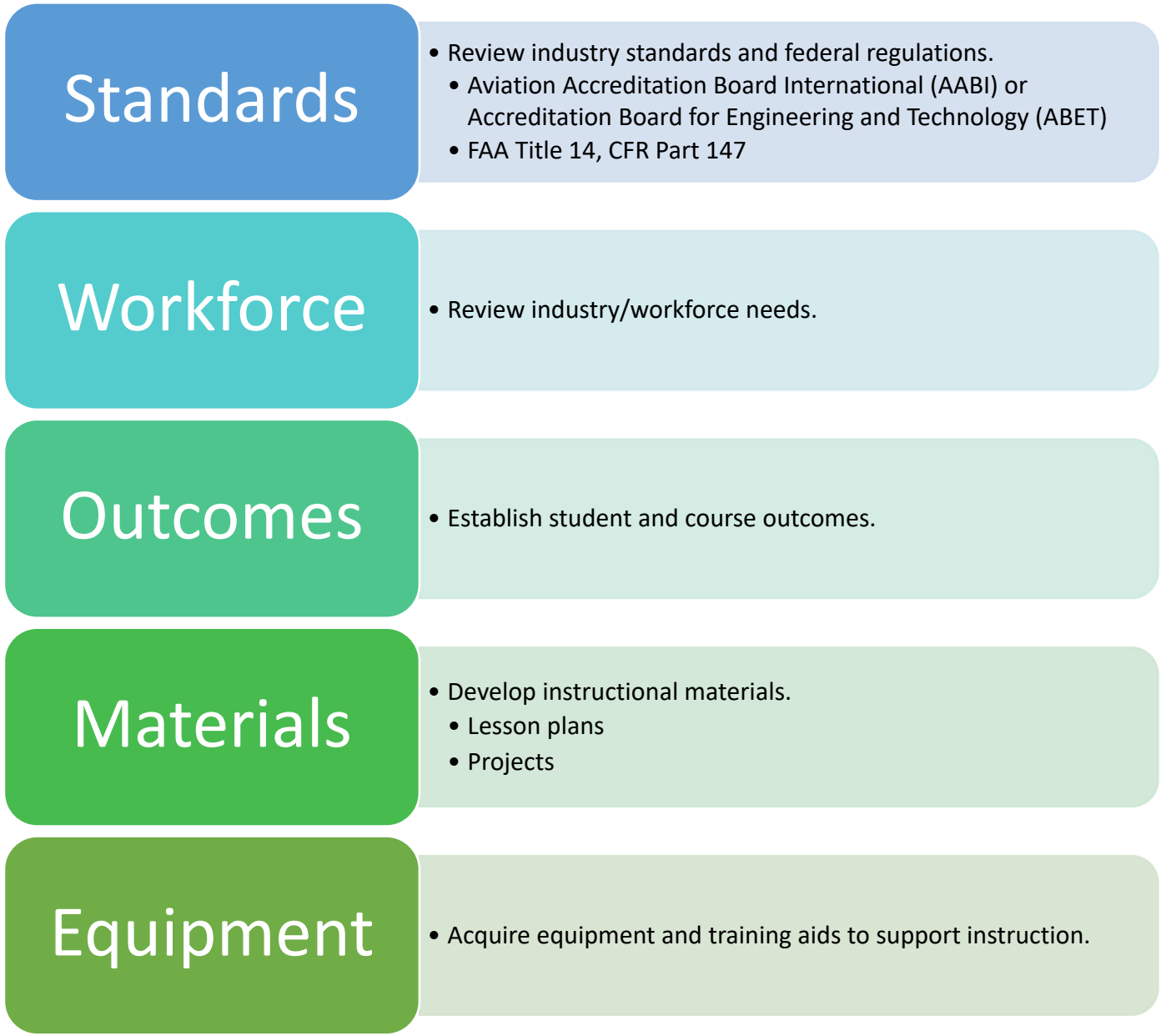
Implement

Monitor

Evaluate

Review

Curriculum Development



Textbook Resources

- *Designing Unmanned Aircraft Systems, A Comprehensive Approach* (2nd Ed), Jay Gundlach, AIAA Education Series
- *Introduction to UAV Systems* (4th Ed), Paul Fahlstrom & Thomas Gleason (Wiley Publishing, 2012)
- *Unmanned Aircraft Systems*, R. Austin (AIAA Education Series, 2010)
- *Aircraft Design: A Conceptual Approach* (5th Ed), D. Raymer (AIAA Education Series, 2012)
- *Introduction to Remote Sensing* (5th Ed), J. Campbell & R. Wynne (Guilford Press, 2011)

Other Resources and Opportunities

- Some research currently exists
  - UAS Curriculum for Students Using an Active Learning Approach Michael C. Hatfield ; Catherine F. Cahill ; John Monahan
  - Integrating the UAS in Undergraduate Teaching and Research – Opportunities and Challenges at University of North Georgia Sharma, J. B. ; Hulsey, D.
  - Curriculum Enhancement to the Mechanical Engineering Graduate Program and Undergraduate Aerospace Option by Including Contemporary Issues of Integrating Unmanned Aircraft Systems into the National Airspace System; Daniel S. Kaputa

- Grants
  - NSF Grant ATE
  - NSF Mentor Connect
  - FAA Workforce Development Grant
  - NIST Standards Services Curricula Development Cooperative Agreement Program

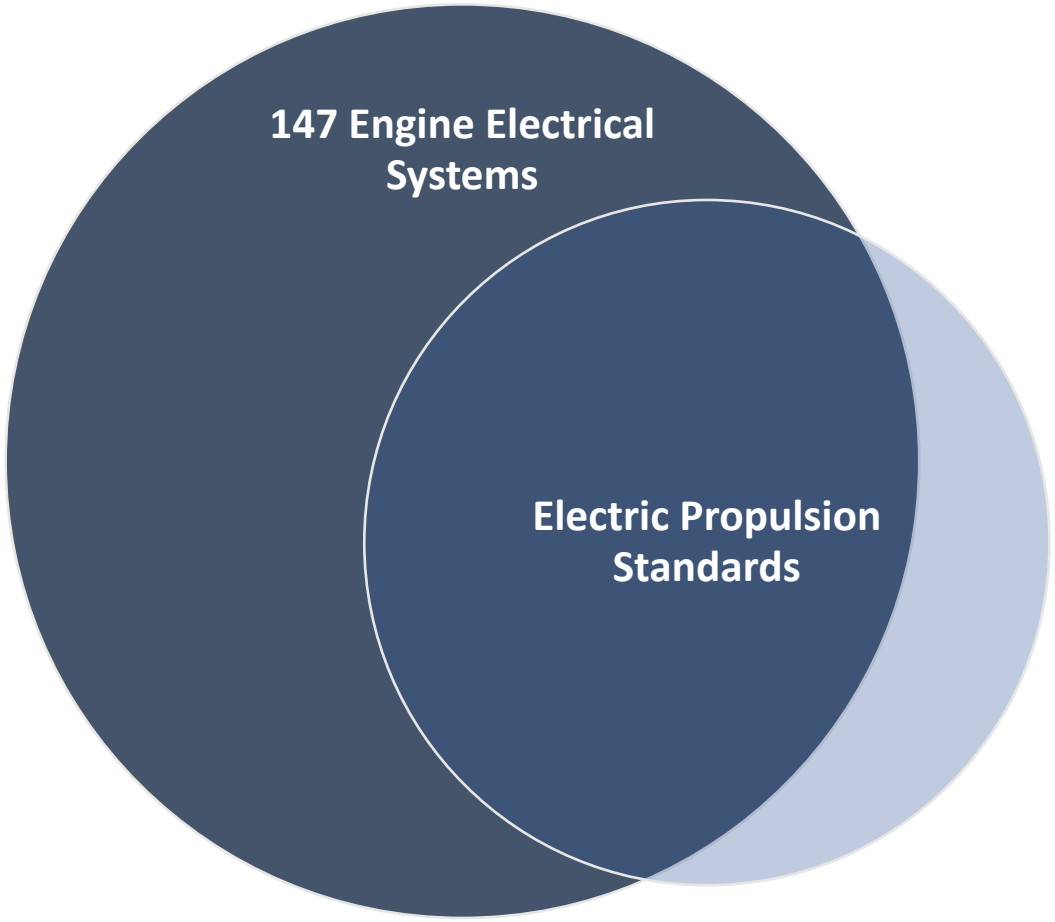
Online Resources

- National Center for Autonomous Technologies
  - https://ncatech.org/
- FAA UAS Collegiate Training Initiative
  - https://www.faa.gov/uas/educational_users/collegiate_training_initiative
- FAA Center of Excellence for UAS Research, Education, and Training
  - Alliance for System Safety of UAS through Research Excellence (ASSURE) https://assureuas.org/
    - UAS Maintenance, Modification, Repair, Inspection, Training, And Certification (2017) https://assureuas.org/projects/uas-maintenance-modification-repair-inspection-training-and-certification/

Example for Electric Propulsion Standards using Integrate Model

ASTM F3239 Specification and ASTM F3338 Design Requirements

Electric Propulsion Using Integrate Model



Research funding through NIST Standards Services Curricula Development Cooperative Agreement Program Award Number 70NANB22H200

Step 1 Curriculum Development

Standards

- Review industry standards and federal regulations.

Organization	Number	Title
ASTM	F3239-22	Standard Specification for Aircraft Electric Propulsion Systems
ASTM	F3338-21	Design of Electric Engines for General Aviation Aircraft
SAE	ARP8676	Nomenclature and Definitions for Electrified Propulsion Aircraft
SAE	AS6502	Aircraft Propulsion System Performance Nomenclature
EASA	NPA 2021-15	New Air Mobility Continuing Airworthiness (CAW) Rules for Electric and Hybrid Propulsion Aircraft and Other Non-Conventional Aircraft (Draft)¶

14 CFR Part 147.17 Training Requirements

§ 147.17 Training requirements.

(a) Each certificated aviation maintenance technician school must:

(1) Establish, maintain, and utilize a curriculum that is designed to continually align with the mechanic airman certification standards referenced in paragraph (b) of this section, as appropriate for the ratings held;

(2) Provide training of a quality that meets the requirements of § 147.25; and

(3) Ensure students have the knowledge and skills necessary to be prepared to test for a mechanic certificate and associated ratings under subpart D of part 65 of this chapter.

(b) FAA-S-ACS-1, Aviation Mechanic General, Airframe, and Powerplant Airman Certification Standards, November 1, 2021, is incorporated by reference into this section with the approval of the Director of the Federal Register under 5 U.S.C. 552(a) and 1 CFR part 51. This material is available for inspection at the Federal Aviation Administration (FAA) and the National Archives and Records Administration (NARA). Contact FAA, Airman Testing Standards Branch/Regulatory Support Division, 405-954-4151, *AFS630Comments@faa.gov.* For information on the availability of this material at NARA, email: *fr.inspection@nara.gov,* or go to *www.archives.gov/federal-register/cfr/ibr-locations.html.* The material may be obtained from FAA, 800 Independence Avenue SW, Washington, DC 20591, 866-835-5322, *www.faa.gov/training_testing.*

Step 2 Workforce Needs

Workforce	• Review industry/workforce needs.

- This is unique to individual schools.

Step 3 Outcomes

Outcomes

- Establish course outcomes.
- Map to ABET/ABBI and ACS.

Alignment with ABET Student Outcomes

Organization	Number	Title	Student Outcomes
ASTM	F3239-22	Standard Specification for Aircraft Electric Propulsion Systems	ETAC Outcome 3 EAC Outcome 2
ASTM	F3338-21	Minimum Design Requirements for Electric Propulsion	ETAC Outcome 2 EAC Outcome 2, 7
SAE	ARP8676	Nomenclature and Definitions for Electrified Propulsion Aircraft	ETAC Outcome 3, Outcome 5 EAC Outcome 7
SAE	AS6502	Aircraft Propulsion System Performance Nomenclature	ETAC Outcome 3, Outcome 5 EAC Outcome 7
EASA	NPA 2021-15	New Air Mobility Continuing Airworthiness (CAW) Rules for Electric and Hybrid Propulsion Aircraft and Other Non-Conventional Aircraft (Draft)	ETAC Outcome 2, Outcome 5 EAC Outcome 7

Course Outcomes Mapped to Part 147 Courses

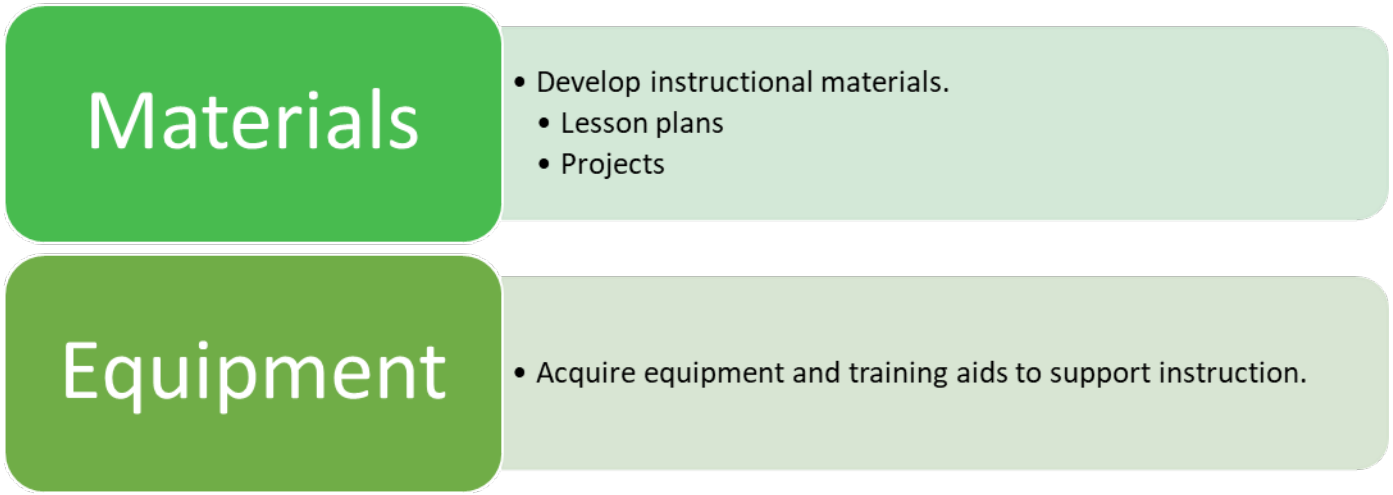
100 Level Course	200 Level Course	300/400 Level Course
The student shall be able to define and distinguish terminology for electric propulsion such as the following: capacity, electric engine, energy distribution system, energy storage system (ESS), usable energy capacity, and electric propulsion system (EPS)	The student shall be able to use electric propulsion terminology in technical communications. The student shall be able to identify two electric propulsion design technical literature and use it appropriately in technical communication.	The student shall be able to identify and use appropriate technical literature related to electric propulsion control and indication for use in technical communication.
The student shall be able to identify and distinguish applicable electric aircraft configurations and operational characteristics.	The student shall be able to describe electric powerplant controls and operational characteristics, and its relationship to energy storage.	The student shall understand energy storage, controls, powerplant operational characteristics, and installation.
The student shall be able to identify and distinguish electric propulsion hazards and mitigation methods.	The student shall be able to use standards to develop plans and procedures for hazard mitigation for at least one known hazard of electric propulsion.	The student shall be to develop plans and procedures for hazard mitigation that includes fire detection, lightning, and high-energy rotors

Course Outcomes Mapped to a Sample of ACS

Course Outcome	Sample of Airman Certification Standards
The student shall be able to define and distinguish terminology for electric propulsion such as the following: capacity, electric engine, energy distribution system, energy storage system (ESS), usable energy capacity, and electric propulsion system (EPS)	AM.I.A.K11 Resistance AM.I.A.K AC/DC Motors
The student shall be to develop plans and procedures for hazard mitigation that includes fire detection, lightning, and high-energy rotors.	AM.III.E.K2 Fire detection warning system operation
The student shall be able to identify and distinguish electric propulsion hazards and mitigation methods.	AM.I.L.K6 Communication/Reporting of hazards AM.I.A.R2 Handling, storage, and inspection of different types of batteries II Airframe Subject K Risk Management

Steps 4 and 5 Materials and Equipment

Future Work



Challenges: access to technical data, new technologies so access to equipment is limited

Related ATEC Presentations

Building and A&P Plus Program: 10:45 to 11:45 Classroom 137

Zackary Nicklin

Co-Principle Investigator, National Center for Autonomous Technologies (NCAT), Northland Community & Technical College

zackary.nicklin@northlandcollege.edu

Stephen Ley

Associate Professor
School of Aviation Sciences
Utah Valley University

sley@uvu.edu

Electronic Propulsion Curriculum 2:30 to 3:30 Classroom 137

Mary Johnson, PhD

Professor
Aviation & Transportation Technology
Purdue University

mejohso22@purdue.edu

Tracy Yother, PhD

Assistant Professor
Aviation & Transportation Technology
Purdue University

tyother@purdue.edu

Aviation and Transportation Technology

Discussion Time

What are your questions, concerns, or ideas?