Memorandum

To: The Faculty of the College of Engineering

From: The School of Aeronautics and Astronautics

Date: January 29, 2025

Re: New Graduate Course, **AAE 57300 Aerospace Human Factors**

The faculty of the School of Aeronautics and Astronautics have approved the following new course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

Course no. **AAE 57300 Aerospace Human Factors**
Spring (offered alternate years), Lecture, Cr. 3

Description: This course addresses human behavior and performance in aerospace environments and task settings, integrating both historical and systems engineering perspectives. This course provides an introduction to, and references for, critical elements of human factors and human-systems integration across multiple eras of human aerospace systems evolution. Historical views of human experience associated with sentinel aerospace vehicles are combined with views of relevant human systems, environmental conditions, human factors risks, and important countermeasures.

Reason: This is the first course offered by AAE in Aerospace Systems with an explicit focus on human factors engineering and human performance. Human factors issues addressed in this course range from aerospace medicine, to decision making in pilot and controller performance, to elements of human-systems integration in aerospace applications. Aerospace engineering designs must crucially address these human factors considerations with appropriate understanding and respect for the relevant systems design constraints and capabilities.

The course is complementary to other graduate-level human factors courses offered in the COE, such as IE 57700 (Human Factors in Engineering) and IE 57800 (Applied Ergonomics). Neither of these classes focus on aerospace systems or vehicles as a major application of human factors principles. The instructor who developed Aerospace Human Factors has a joint appointment with IE, and has ensured that this course is complementary with these IE human factors courses with limited redundancy. The proposed course also fills an important role for the Space Engineering certificate currently being developed for the COE. The course is also being developed with an eye towards

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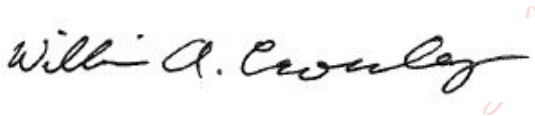
hybrid and online delivery, due to very strong demand among Purdue students, feedback from alumni, and limited competitive offerings at other AAE programs nationally.

In addition to AAE graduate and undergraduate students, this course has been taken by IE graduate and undergraduate students. Demand has exceeded room capacity in both Spring 2023 and Spring 2025 offerings. We expect additional demand with the formalization of the Space Engineering Certificate, with increasing interest from other COE undergraduate and graduate students.



William A. Crossley
Uhrig & Vournas Head of Aeronautics and Astronautics
Professor of Aeronautics and Astronautics

Enrollment History – Previously taught as AAE/IE 590 Aerospace Human Factors

	Level	Major	2023 Spring	2025 Spring	Total
AAE59000 - Aerospace Human Factors	GR - Graduate	ENMG - Engineering Management	2		**2**
		AAEN - Aeronautics & Astronautics	17	18	**35**
		TECH - Technology	1		**1**
		BMEP - Biomedical Engr Program	1		**1**
	ID - School of Interdisciplnry Engr	INTE - Interdisciplnry Engr Study	1		**1**
	AE - School of Aero and Astro Engr	AAE - Aero & Astro Engineering	22	37	**59**
	Totals		**44**	**55**	**99**
	Level	**Major**	**2023 Spring**	**2025 Spring**	**Total**
IE59000 - Aerospace Human Factors	IE - School of Industrial Engr	IE - Industrial Engineering	5	1	**6**
	GR - Graduate	IE - Industrial Engineering	2	3	**5**
		NUR - Nursing		1	**1**
		AVTH - Aviation Technology	1		**1**
	Totals		**8**	**5**	**13**

Course	Level	2023 Spring	2025 Spring	Totals
AAE 59000	Undergraduate	23	37	**60**
	Graduate	21	18	**39**
IE 59000	Undergraduate	5	1	**6**
	Graduate	3	4	**7**
	Grand Total	**52**	**60**	**112**

AAE 57300 Aerospace Human Factors

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AS OF 12 JAN 2025

Spring 2025
TR 16:30 – 17:45
HIKS G980 (with Brightspace Kaltura support)
BSC Office Hours: ARMS 3210 T 14:30 – 16:00
WebEx Personal Room: https://purdue.webex.com/meet/bcaldwel

TAs: Lacey M. Davis (Office Hours M 11:00 – 13:00, TBD) and by appointment
Nicolas A. Morales (Office Hours W 12:00 – 13:00, TBD) and by appointment

Course Overview:

This course addresses human behavior and performance in aerospace environments and task settings, integrating both historical and systems engineering perspectives.

Description:

The history of flight and space travel over the past 250 years (!) are highly coupled to understanding and support for human survival, health, and effective task performance. Aerospace engineering designs must crucially address these human factors considerations with appropriate understanding and respect for the relevant systems design constraints and capabilities. Human subsystems at physiological, cognitive, and functional levels are addressed, as well as human capabilities as components in, and users of, aerospace systems.

This course provides an introduction to, and references for, critical elements of human factors and human-systems integration across multiple eras of human aerospace systems evolution. Historical views of human experience associated with sentinel aerospace vehicles are combined with views of relevant human systems, environmental conditions, human factors risks, and important countermeasures.

Course Outcomes:

Students should demonstrate knowledge of and ability to apply the following topics when designing aircraft, spacecraft, aerospace automation, or aerospace control network engineering systems: Human performance; Systems thinking; Human-Systems Integration; Human Performance in Extreme Environments; Situation Awareness; Human-in-the-Loop Control Dynamics; Engineering System Robustness and Resilience; Distributed Expertise and Team Coordination; Dynamic Autonomy; Human Aspects of Event Response

Topics Covered (partial list):

Human performance; Systems thinking; Human-Systems Integration; Extreme Environments; Situation Awareness; Human-in-the-Loop; Robustness and resilience; Distributed expertise; Dynamic autonomy; Event response

Prerequisites:

Graduate Standing or consent of instructor

Individual Assignments:

Initial "System Definition" exercise, introduced with in-class material (Introduced Jan 23, ***Due Feb 4***), 4% of grade

Two "Reflection-based" position papers based on course material (***Due Feb 13*** + ***Due Apr 17***): 13% of grade each

Individual exam *(take home format)*, ***Mar 4*** (15% of grade)

Additional participation (questions / comments, discussion board, contributed material): 10%

Team Projects:

Discussion-based small group papers based on Case presentations (discussions Feb 7-9), ***due Feb 27*** (15% of grade)

Team-based semester project, with ***project overview*** (***due Mar 9***, 10% of grade) and ***final paper*** (***due May 6***, 20% of grade)

Textbooks and Web Content:

Caldwell, B. S. (2018). Aerospace Human Factors. In *Human Factors and Ergonomics for the Gulf Cooperation Council* (pp. 211-230). CRC Press.

Rippy, L. O. (2021). *NASA Human Systems Integration Handbook* (No. NASA/SP-20210010952).

Optional:
Parker Jr, J. F., & West, V. R. (1973). Bioastronautics Data Book: NASA SP-3006. *NASA Special Publication*, *3006*.

Additional handouts, lecture notes, readings, materials, and discussion will be posted through the Brightspace campus course management system (not all readings are listed below).

Syllabus / Course Schedule

Week	Topics	Readings (as of Jan 12, 2025)
1 (Jan 14,16)	Course Introduction | Humans and Systems (including SoS) Overview	Rippy, 2021: Chapter 2.
2 (Jan 21, 23)	*Jupiter* era: High-Altitude Transitions | Movies and System Definitions	Caldwell, 2018; Parker & West, Ch. 1-2.
3 (Jan 28, 30)	*Flyer* era: Human Control of Vehicles | *Electra* era: Situation Awareness and Controls (Guest Lectures)	Casey, 1993: "Rental Car"; Parker & West, Ch. 12-14, 16. (Movie included)
4 (Feb 4, 6)	*Mercury / Vostok* era: Human capabilities in spaceflight **System Definition 1 due** |	Rippy, 2021: Appendix B. Parker & West, Ch. 3-6.
5 (Feb 11, 13)	Idlewild era: human-systems integration for airspace management | Semester Project Introduction and Group Case Discussion **Individual paper 1 due**	
6 (Feb 18, 20)	Space Center era: human-systems integration for spaceflight missions | **Group Project Discussions (no class Feb 20)**	Rippy, 2021: Chapters 3, 4. (Movie included)
7 (Feb 25, 27)	Space Center era: human-systems integration for spaceflight missions continued | **Case paper (group) due Feb 27**	Caldwell, 2005, 2006; Rippy, 2021: Chapter 5, Appendix A, C, D.2
8 (Mar 4, 6)	**Midterm Exam** | Project team interactions **(no class)**	
9 (Mar 11, 13)	*Apollo* era: planetary and partial gravitational experiences | **Project overview due Mar 13**	Parker & West, Ch. 7-9, 15.

10 (Mar 18, 20)	**SPRING BREAK (no class)**	
11 (Mar 25, 27)	*Skylab / ISS* eras: long-duration human capabilities	Parker & West, Ch. 10-14, 17-20.
12 (Apr 1, 3)	*White Knight* era: advanced aviation and commercial spaceflight	Rippy, 2021: Appendix D.5, D.8
13 (Apr 8, 10)	*Artemis* era: extended human presence	Caldwell, 2015; Hill, et al., 2018. (Movie included)
14 (Apr 15, 17)	Student Request / Review | **Individual paper 2 due**	
15 (Apr 22, 24)	Space Arena era: analog research futures | **Group Discussions (no lecture)**	
16 (Apr 29, May 1)	Where's My Jetpack? Sociotechnical innovation contexts	
17	**Final Paper Due May 6, 12N**	

Additional Syllabus Content

Teaching Philosophy

My teaching philosophy is born of a multicultural, multidisciplinary, multimethod approach to human factors and systems engineering. As an instructor at a leading engineering institution in both Aeronautics & Astronautics, and Industrial Engineering, it is my responsibility to foster a culture of deep inquiry, effective professional collaboration, and functional integration of reference material with varied experience. As a result, the emphasis is on a "growth and gain" model of learning and grading (how much can you develop and improve in your understanding towards a model of professional excellence) rather than a "criterion-matching" model (grading and points assigned based on reproducing a particular set of rules). This model is also reflected in the use of "paragraph-style" lecture notes, with are richer and more complex in information presentation than Powerpoint.

All assignments are graded on an assumption that "standard performance" (i.e., a grade of B) at this level is the ability to analyze, evaluate, and explain material in a reasonable level of standard technical written English. Such performance is expected to achieve a grade in the 83-87 point range (again, expectation of a B); I do not assume that merely standard performance results in 100% of points on any assignment. Insight, integration, and effective extension of references and lecture material which demonstrated creativity and "signs of life," with an absence of technical errors or rule violations, results in scores above this range. As a result, grading curves are only invoked when weighted average scores across the semester fall below the "expected range". Students whose weighted scores exceed 90 should, in almost all cases, obtain an A (unless academic

integrity violations, irreconcilable interpersonal conflicts, or other demonstrations of unprofessional behavior are evident).

This course, as with every course offered at Purdue, plays a part in creating and sustaining a welcoming campus where all students have the opportunity and support to excel. There are many initiatives in the College of Engineering and supported by the university focused on this goal, and this course is designed to take advantage of those resources. Learning experiences and assignments address diversity and inclusion, not because they are "topics," but because they are necessary to prepare students to be successful in a diverse, global environment. Civil as well as military aviation and spaceflight have been international, multicultural, and increasingly inclusive over many decades. This is a global reality, even in settings where modified English is the common operating language.

Student Success Expectations

Although this course is based on decades of research and teaching experience, this course has never been taught in this configuration before Spring 2023. As a result, student feedback and constructive engagement in the course is essential for a successful learning experience. Given Purdue's unmatched history in the aerospace exploration and research domains, including aviation, human spaceflight, and mission operations, student success should be seen in the context of professional readiness for graduating seniors or graduate students to move into positions of responsibility and effectiveness in mission-critical aerospace operations.

Students are expected to complete assigned readings (and review previously recorded Kaltura material) before the specified date of covering that material. Group projects are an important aspect of course learning, and a primary element of semester activity and grading. Ongoing interactions with group members, and active engagement with the instructional team, via electronic media are critical components of successful performance in this class. Individual assignments will also be used as inputs for group assignments, as an additional aspect of course learning and material review. Quality of written communication is seen as an important element of student success. Students are encouraged to utilize the resources of the Purdue Online Writing Laboratory (OWL), well in advance of any assignment due date.

Deadlines are an unavoidable part of being a professional and this course is no exception. Course requirements must be completed and posted or submitted on or before the specified due date and delivery time deadline. Due dates and delivery time deadlines are defined as that used in West Lafayette, Indiana (Eastern Standard / Daylight Time). To encourage you to stay on schedule, due dates have been established for each assignment. Unless otherwise indicated, deadlines for all due dates are 6:00PM Eastern Time on those dates. There will be penalties for assignments delivered after the deadline, unless the student has contacted the instructional team in advance (or in a timely manner for unforeseeable medical or emergency conditions). Deadlines will not be waived or extended for voluntary activities or non-essential travel.

Stay abreast of all updates and materials provided in Brightspace, including additional information regarding University policies, emergency responses, and availability of supplemental materials for success in this course.

Incompletes

According to the Grades and Grade Reports section of Academic Regulations, "A grade of incomplete (I) is a record of work that was interrupted by unavoidable absence or other causes beyond a student's control..." Further details on these circumstances and the process for assigning types of incompletes are outlined in the regulations. Please contact me as soon as you think an incomplete might be needed in this course and before final course grades are due.

Course Evaluation

Toward the end of this semester, you will be provided with an opportunity to give feedback on this course and your instructor. Purdue uses an online course evaluation system. You will receive an official email from evaluation administrators with a link to the online evaluation site and will receive a prompt to complete the survey when you login to Brightspace. Your participation is an integral part of this course, and your feedback is vital to improving education at Purdue University. I strongly urge you to participate in the evaluation system.

This syllabus is subject to change. You will be notified of any changes as far in advance as possible via an announcement on Brightspace. Monitor your Purdue email daily for updates.