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Designing and Implementing a Total Pilot Performance Course for Undergraduate Aviation Students

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ABSTRACT

Collegiate flight students are presented with a unique set of circumstances and challenges during their training. They must negotiate balancing their academic courseload while also completing several pilot certifications, which take hundreds of hours of flying to accomplish. In addition, students are often away from home for the first time and are exploring extracurricular and employment options, while also navigating new social settings. These competing obligations can create a high-stress and fatiguing environment for flight students. Ongoing studies have been evaluating the physical, cognitive, and emotional impacts on collegiate pilots (Henneberry et al., 2026). Metrics being observed before, during, and after training flights include heart rate, heart rate variability (HRV), electrodermal activity (EDA), electrocardiography (ECG), skin temperature, and psychomotor vigilance testing (PVT). Participants in the study have been provided with their results, which can be used to inform their preparation before a flight lesson. Further, this information may provide insight into health implications that can be used throughout the duration of one's aviation career. The results of these studies are being used to design an experimental undergraduate course within a professional flight training program. Topics to be covered in the class include pilot readiness, sustainable health habits, career longevity, wearable technologies, and physiological self-monitoring. Students will be asked to utilize a wearable device throughout the semester and monitor their health and readiness both on the ground and in the air. Learning outcomes include the development of individual and team-based plans that support total pilot performance in collegiate aviation settings.

Keywords: Total pilot performance, Collegiate aviation, Curriculum design, Pilot readiness, Wearable technology, Physiological self-monitoring, Fatigue management, Performance based assessment

INTRODUCTION

Collegiate flight training asks students to carry two demanding programs at once. Alongside a full academic courseload, they pursue several pilot certifications that require hundreds of hours of flight time to complete. Many are living away from home for the first time, exploring extracurricular activities and employment, and navigating new social environments. These competing obligations combine to create a training context that is frequently high-stress and fatiguing (Keller et al., 2022).

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The stakes are not academic alone. Human error contributes to roughly seventy percent of aviation accidents (Helmreich, 2000), and fatigue is implicated in a meaningful share of investigations, on the order of twenty to twenty-three percent (Caldwell, 2012; NTSB, 2016). Yet fatigue management practice has concentrated historically on long-haul commercial operations, leaving general aviation, and collegiate flight training within it, comparatively underserved (Olaganathan et al., 2021; Mendonca et al., 2021). Students therefore face elevated fatigue and stress exposure with relatively little structured preparation for managing it.

THE RESEARCH FOUNDATION

An ongoing research program has been evaluating the physical, cognitive, and emotional impacts of training on collegiate pilots (Henneberry et al., 2026). Working with students across instrument, commercial, and multi-engine stages, the research team observes a set of metrics before, during, and after training flights: heart rate, heart rate variability (HRV), electrodermal activity (EDA), electrocardiography (ECG), skin temperature, and psychomotor vigilance testing (PVT). These measures were selected to capture autonomic regulation, arousal, and sustained attention, the physiological systems most relevant to readiness and fatigue.

Two features of that program directly motivated a course. First, participants have been provided with their own results. Rather than serving only as research data, each student's measurements become information they can use to inform their preparation before a flight lesson and, over a longer horizon, to understand health implications that carry across an aviation career. This feedback loop revealed both the value of the data and the absence of any structured setting in which students learn to interpret and act on it.

Second, the study population illustrated the problem it was measuring. The same students whose fatigue and stress responses were being recorded had received little formal instruction in managing sleep, workload, nutrition, and physical readiness. The research made the performance relevance of these daily-life factors concrete and observable, and in doing so made the case for translating that evidence into instruction. The results of these studies are now being used to design the experimental course described below.

DESIGNING THE COURSE

The course is built on a deliberately narrow claim about its subject matter: the material is readiness, safety, and professional formation rather than general wellness. A single dedicated course is intended to create the depth, repetition, and applied practice that fragmented exposure cannot provide. Positioning the content as safety-relevant professional competency, rather than optional self-care, aligns it with the program's existing accountability for aviation safety and with the evidence generated by the research program.

AT 29000 uses performance-based assessment to help students apply course concepts to realistic aviation readiness problems. Here, performance means the ability to interpret evidence, justify decisions, and develop

practical recommendations, not physiological condition or flying proficiency. The Performance Application Assignments reflect authentic assessment by connecting learning to tasks resembling professional practice. This approach may support engagement, critical thinking, problem-solving, and professional skills (Sokhanvar et al., 2021).

Constructive alignment connects learning outcomes with teaching activities and assessments (Biggs, 1996). An outcome involving data interpretation, for example, requires more than recalling definitions. Students must identify patterns, consider context, and recognize limitations. Similarly, aviation risk management requires students to explain and defend their recommendations. Readings, lectures, and discussions provide the foundation, while assignments and case analyses allow students to demonstrate their understanding.

Self-regulated learning guides the progression from setting goals to evaluating and adjusting strategies (Chen & Bonner, 2020). Students will establish readiness goals, try practical approaches, record observations, and reflect on what worked and what needs to change. Weekly micro-logs will support this process, but collecting data alone will not demonstrate learning. Students must explain what their observations suggest, what remains uncertain, and how that information informs their next decision. Early assignments will offer structured guidance, with later work requiring greater independence.

The sleep and fatigue assignment illustrates this approach. Students might examine personal or instructor-provided sleep records alongside an early flight-training schedule. They would identify a readiness concern, explain its significance, consider alternative explanations, and propose a realistic response. A later scenario could introduce competing academic demands and ask students to revise their plan. Assessment would focus on their reasoning, not on treating a sleep duration or wearable score as proof of fitness to fly.

Formative feedback will connect assignments across the semester. Instructors will identify strengths, gaps in reasoning, and practical next steps. Students will explain how they use this feedback in later work or their final performance plan. Peer review of shared cases or non-sensitive material can provide additional perspectives. Evidence suggests that instructor and peer feedback can support learning, although its value depends on implementation (Morris et al., 2021). The course will therefore require students to act on feedback rather than simply receive it.

Rubrics and examples will clarify expectations for conceptual accuracy, evidence interpretation, aviation risk reasoning, practical recommendations, and revision. Students will not be graded on sleep quality, fitness, physiological values, or successful health changes. A strategy that does not work can still demonstrate learning when the student explains its limitations and proposes a justified adjustment. The final Total Pilot Performance Plan will bring this work together into a practical plan for continued development. Whether the approach improves learning and transfer will require evaluation after implementation.

COURSE CONTENT

AT 29000 is a three-credit course for undergraduate collegiate aviation students. It meets twice weekly in seventy-five-minute sessions across a sixteen-week semester and is built around applied assignments and real-world integration rather than lecture alone. Its topics center on pilot readiness, sustainable health habits, career longevity, wearable technologies, and physiological self-monitoring, and extend to sleep and fatigue management, stress and workload, nutrition and hydration, physical readiness, cognitive readiness and decision-making, human factors, and aviation case studies in health, stress, and performance.

Module Structure

The course is organized into four modules that move deliberately from foundational concepts, through the individual readiness pillars, into data interpretation and decision-making, and finally to synthesis and application.

Table 1: Module structure of AT 29000.

Module	Weeks	Purpose
Module 1: Total Pilot Performance Foundations	1–3	Introduce the model and its safety relevance, establish a baseline self-assessment, set up the wearable device, and conduct first data collection.
Module 2: The Readiness Pillars	4–8	Work through sleep and fatigue, stress and workload, nutrition and hydration, physical readiness, and habit formation, connecting each pillar to data and to aviation performance.
Module 3: Data, Decision-Making, and Human Factors	9–13	Midterm and data checkpoint, wearable data interpretation, cognitive readiness, mental health, decision-making, case studies, and flight-related physiological patterns.
Module 4: Application, Integration, and Professional Performance Plan	14–16	Research and best practices, team presentations, the individual Total Pilot Performance Plan, and final synthesis.

Wearable Integration and Physiological Self-Monitoring

A defining feature of the course is that students use a wearable device throughout the semester, monitoring their health and readiness both on the ground and in the air. The device is introduced early and used across the term to capture indicators of readiness, workload, and recovery. Its role is to support data literacy rather than clinical assessment: students learn to observe patterns, trends, and the practical limitations of physiological data, not to make medical determinations.

Learning Outcomes and Program Alignment

The course specifies five learning outcomes. On completion, students are expected to explain how sleep, nutrition, hydration, physical readiness, stress, and recovery influence pilot performance, safety, and long-term career wellbeing; analyze aviation case studies and research related to fatigue, stress, health, and human performance; interpret basic physiological and self-monitoring data, including patterns, trends, and practical limitations; apply evidence-based strategies to improve personal readiness, resilience, and performance; and develop individual and team-based plans that support total pilot performance in collegiate aviation settings.

These outcomes map to several Aviation Accreditation Board International (AABI) general program outcomes, providing accreditation-relevant justification for the course. Specifically, the course supports the AABI outcomes for analyzing and interpreting data, explaining the value of and need for life-long learning in aviation careers, using the techniques, skills, and modern technology necessary for professional practice, identifying and solving problems, and evaluating aviation safety and the impact of human factors on safety. The alignment is deliberate: it situates a human-performance course within the program's existing accreditation framework rather than treating it as an elective addition.

Assignments

Applied work is the backbone of the course. A sequence of nine Performance Application Assignments runs across the semester, each tied to a pillar or milestone: a readiness baseline and goal statement; wearable setup and baseline protocol; a sleep and fatigue application; stress and workload regulation; a nutrition, hydration, and energy audit; a physical readiness and recovery plan; a mid-semester data checkpoint; targeted performance recording during flight, simulator, or academic activity; and a final performance plan draft. These are complemented by weekly readiness micro-logs that sustain data collection habits, two to three targeted data collection sessions, a team performance presentation, and the culminating individual Total Pilot Performance Plan.

Assessment

Assessment is designed to show how students use readiness concepts, not simply whether they can recall them. Table 2 connects the five course outcomes with the assignments and evidence used to assess learning. Together, these activities ask students to explain concepts, interpret information, evaluate aviation scenarios, and develop practical recommendations.

Table 2: Alignment of course outcomes, assessments, and evidence of learning.

Course Outcome	Principal Assessment Opportunities	Evidence of Learning
Explain factors influencing pilot readiness and performance	Readiness-pillar assignments and midterm	Accurate explanations of relevant concepts and their performance implications
Analyze aviation cases and supporting literature	Aviation case analysis	Evidence-supported explanation of contributing factors, limitations, and possible responses
Interpret physiological and self-monitoring data	Wearable setup, data checkpoint, and targeted recording assignments	Contextualized interpretation of patterns, alternative explanations, and measurement limitations
Apply evidence-based readiness strategies	Sleep, stress, nutrition, and physical-readiness assignments	Justified strategy selection, evaluation of application, and appropriate adjustment
Develop individual and team-based recommendations	Team presentation, performance-plan draft, and final plan	Feasible recommendations, integration of evidence, professional communication, and revision following feedback

The assignments are intended to build on one another rather than function as isolated submissions. Students will draw on earlier observations, analyses, and feedback when developing their final Total Pilot Performance Plan. Assessment will emphasize the accuracy of their explanations, the strength of their evidence, recognition of limitations, and feasibility of their recommendations. A well-reasoned revision can demonstrate learning even when an initial strategy proves unsuccessful. Students' health status and physiological values will not determine their grades.

IMPLEMENTATION

Moving from design to delivery introduced practical considerations. As an experimental course, AT 29000 was proposed to program leadership with a bounded set of requests: approval as a standalone course, funding for a graduate teaching assistant, refinement of the detailed weekly schedule after approval, and a target launch in Spring 2027. Deferring the fine-grained schedule until after in-principle approval keeps the initial decision focused on the course concept rather than on implementation detail.

The relationships needed to run the course were established during the research program. Conducting the underlying study required substantial coordination with flight operations leadership, the chief flight instructor, the safety team, maintenance personnel, the Institutional Review Board, and Federal Aviation Administration representatives. That network, and the credibility built by treating human performance as a measurable operational variable, lowered the barrier to standing up a course grounded in the same evidence base. The required wearable device carries an equipment cost that the program must weigh and, where possible, offset, but it also ensures every student engages directly with their own physiological data across the full semester rather than observing the concept from a distance.

DISCUSSION AND FUTURE DIRECTIONS

The development of AT 29000 illustrates a transferable pattern: field research can function not only as a source of findings but as an engine for curriculum. The instrumentation, target population, demonstrated need, and stakeholder relationships built during a data collection study translated with relatively little friction into a course. Programs contemplating similar offerings may find that grounding a course in an existing measurement effort strengthens both its evidentiary basis and its institutional credibility.

Initial evaluation will focus on feasibility and demonstrated learning. Students will complete comparable aviation-readiness scenarios near the beginning and end of the course, assessed using a shared rubric for conceptual accuracy, evidence interpretation, risk reasoning, and practical recommendations. A second assessor will independently score a subset of responses to examine scoring consistency. Assignment completion, student-reported burden, wearable-data availability, and documented use of feedback will provide implementation evidence. Findings will be interpreted cautiously because a single-cohort design cannot isolate the course's effects from other learning experiences. Physiological outcomes and longer-term behavior maintenance will remain questions for subsequent evaluation.

CONCLUSION

AT 29000: Total Pilot Performance brings pilot-readiness research into the classroom through a three-credit course focused on practical application, self-monitoring, aviation case studies, and individual performance planning. The course is designed to help students make sense of readiness data, think through aviation-related decisions, use feedback, and adjust their approach over time. The first offering is planned for Spring 2027, so its educational impact has not yet been evaluated. Future assessment will examine how well the course works in practice, what students learn, and how effectively they apply readiness concepts to aviation scenarios. The course provides a practical model for programs that want to move beyond isolated advice and give pilot readiness sustained attention throughout the semester.

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