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Designing With Communities, Not for Them: A Classroom Approach to Collaborative Advanced Air Mobility Planning

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1 Introduction and Overview of the Literature

Advanced Air Mobility (AAM) is a new and emerging form of aviation for inter and intra-city transport of individuals and cargo using vehicles powered by electric, hybrid electric, and hydrogen sources [1]. Unlike commercial airplanes, AAM vehicles are much smaller and intended to be used for on-demand and scheduled services, such as those offered by Uber and Lyft. Figure 1 showcases a conceptual design for AAM by NASA [2]. Although various factors such as infrastructure, accessibility, security, and environmental impact must be considered in the integration of AAM, public acceptance and adoption have been considered the most important factors in its success and future scalability [3].

Figure 1: NASA Advanced Air Mobility Conceptual Design [2]

AAM is envisioned to increase connectivity between urban and rural areas, reduce ground transportation congestion, aid in emergency relief, enhance access to services, and create new employment opportunities. This vision, however, is contingent on its responsible integration. Noise pollution is a major source of concern that has been associated with increased risk of chronic diseases, disrupted sleep, loss of hearing, increased levels of anxiety, and increased risk of cardiovascular disease for individuals living in proximity to airports [4–6]. Individuals negatively impacted by aviation-induced noise pollution are primarily low-income and members of marginalized communities. This negative impact is expected to persist upon the implementation of AAM unless adequately planned for [7].

To adequately plan and integrate AAM with communities in mind, it is essential to involve community members and stakeholders in the planning and decision-making process. Current involvement thus far has come in the form of public perception studies, in which individuals have expressed concerns over equity, accessibility, environmental impact, and safety – viewing AAM primarily as a means for wealthy individuals to bypass congestion and access specialized services [7–11]. While the public's concerns have been assessed through these studies, the public's involvement in the decision-making process remains mostly superficial. Additionally, most participants often lack background knowledge in AAM if not actively involved in the aviation field, making it difficult for individuals to visualize and quantify potential implications of AAM [8]. While most public perception studies provide individuals with a short description or video on AAM prior to the study, it is arguably not sufficient to make informed decisions. As a result, a pilot AAM class is proposed as a means for students to learn about AAM while actively engaging in discussions used to design a community-centered approach to AAM design.

2 Proposed Classroom Design

To actively engage individuals in the design of AAM planning and integration, it is necessary to have a collaborative process where knowledge is exchanged from multiple parties. As a result, a pilot classroom approach is presented that integrates fundamental AAM concepts while allowing students to actively reflect and discuss the implications of AAM through collaborative design of AAM routes. The following course is proposed and designed for a new freshman seminar course that is open to students of all disciplines at an R1 institution. As part of the course, students will be expected to meet for one hour a week for 10 weeks. The proposed pilot course is intended to better inform the role of education in public perception, provide feedback on AAM educational material, and provide rich insight into the decision-making process.

2.1 Guiding Theoretical Framework

The proposed freshman seminar course is developed using the backwards course design approach established by Wiggins and McTighe [12]. The backwards design process begins with the end goal in mind and aligns subsequent course material to meet the defined objectives through three fundamental steps: 1) defining expected results, 2) identifying assessments used to measure if goals are obtained, and 3) planning course material and activities. The following approach to course design promotes a student-centered approach to deriving course material, ensuring alignment between learning objectives, assessment, and course content [13]. Learning objectives and assessment methods derived using backward course design are discussed in the following sections.

2.1.1 Defined Learning Objectives

The integration of AAM represents a complex engineering problem with no direct solution. As a result, AAM must be viewed holistically, and engineers must consider how this technology may be adapted to embed fairness, accessibility, and safety in its planning. As part of this course, students will be expected to learn to communicate AAM topics with various stakeholders (including non-technical individuals) and actively engage in ethical discussions centered on AAM decision-making. Students are expected to reflect, analyze, and recommend practical steps towards integrating AAM with skills developed throughout the course. The goal of this course is to promote collaboration, discussion, and critical thinking. Table 1 describes the student learning objectives that were formulated using Bloom's Taxonomy. Formulated as a pyramid-tiered framework, Bloom's Taxonomy describes six tiers of critical thinking, ranging from recalling information to creating original work [14]. Bloom's Taxonomy was utilized to construct measurable and actionable student learning objectives that extend beyond remembering information and instead focus on understanding and applying the topics discussed.

The following student learning objectives are designed to facilitate conversations surrounding the broader impacts of engineering design. Studying a complex problem at hand, the proposed course is expected to address Criterion 3.4 of the Accreditation Board for Engineering and Technology (ABET), which outlines the professional and ethical responsibilities of an engineer to make decisions that consider the implications and potential consequences of their design. In doing so, students will need to incorporate the needs and expectations of diverse stakeholders and learn to communicate their findings to a range of audiences – complying with ABET Criterion 3.3. Additionally, students will engage with aviation standards and guidelines set by the Federal Aviation Administration surrounding AAM integration.

Table 1: Student Learning Objectives

1.1	Describe the current state of Advanced Air Mobility in the aerospace industry
1.2	Identify advantages and challenges associated with AAM integration for various stakeholders
1.3	Recognize barriers to accepting and adopting AAM in students' community
1.4	Identify the criteria that make AAM suitable in students' community
1.5	Assess and critique the implications of AAM on communities and the environment
1.6	Evaluate and recommend AAM routes and infrastructure placement through design scenarios
1.7	Design an interview protocol to assess community needs and stakeholder perspectives on AAM
1.8	Recommend strategies for sharing AAM with community stakeholders
1.9	Adapt strategies for sharing AAM for different stakeholders
1.10	Reflect on how learning and actively participating in AAM co-design influences perspective and potential adoption of AAM

2.1.2 Evaluation Metrics

To understand how effectively students accomplish the student learning goals outlined in Table 1, assessment methods were developed. Assessments may be summative or formative. Summative assessments focus on evaluating students' learning, while formative assessments occur during the learning process and are intended to strengthen and improve learning [13]. As shown in Table 1, the course is focused on developing critical thinking, where students demonstrate application and discussion of the topics taught in class. Subsequently, the majority of assessments developed for this course are formative and come in the form of exit tickets, surveys, class discussions, presentations, and Poll Everywhere. A detailed description of the proposed course assessment techniques is outlined in Table 2 in the Appendix.

As part of the course, students will engage in focus group discussions with their peers, in which they will co-design AAM objectives and an implementation plan for their community. The implications of their design will be presented in the form of case scenarios, where students will be able to quantify and visualize the effects of their design on vehicle performance, routing, and potential community impact. Students will be evaluated based on their participation and ability to critique and provide insightful arguments. Additionally, students will design a short protocol to interview community stakeholders and discuss their findings in relation to AAM design and discuss the importance of community-centered design. The findings of these interviews will be presented in a culminating jig-saw activity where their presentation will be catered to a defined target audience. A tentative ten-week course schedule is included in Table 3 in the Appendix.

2.2 Assessing Pilot Study Outcomes

As part of this course, students will participate in focus group discussions guided by a think-aloud protocol in which they will discuss their approach to co-designing an AAM implementation plan for their community. The following discussions will be recorded upon approval of the Institutional Review Board to ensure the confidentiality and safety of the participants. The following focus group interview data will be coded and analyzed via a thematic analysis.

Additionally, it is of interest to not only learn about the outcomes of the design, but also students' positionality throughout the process. When engaging in collaborative design, outcomes are often presented from the researcher's perspective and lack insight from the collaborators [15–17]. As a result, as part of the course, students will submit weekly journal reflections where they will document their perspectives and reflect on their role as decision-makers, observing how knowledge gained of AAM influenced their positionality throughout the course. Journal reflections will be analyzed using a reflexive thematic analysis.

3 Anticipated Implications

The proposed AAM course in this paper is expected to introduce and engage students in the discussion of complex engineering problems, highlighting the importance of designing with and for the people. As part of the course, students will be exposed to discussions about social, environmental, global, and financial implications of engineering designs. The activities and topics discussed in this course align with ABET criteria goals to create critical and ethical engineers capable of communicating with a diverse set of audiences. The findings of this course may be used to inform future adaptations of this course, as well as other courses discussing emerging technologies in other engineering disciplines. Additionally, this course will serve as a primer for informing future collaborative design between community stakeholders and AAM planners, ensuring AAM plans are fair, accessible, and designed to serve all community members.

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Appendix A: Course Schedule

Table 2: Proposed Course Assessment Techniques

Assessment Type	Description	Purpose
Pre-Survey	Canvas survey taken prior to the start of the course.	Assess the student's current knowledge and understanding of AAM.
Poll Everywhere	In-class polling and quizzing system.	Evaluates students' understanding of the content while capturing participation.
Exit Tickets	Short and informal assessment at the end of a lesson that must be submitted prior to leaving class.	Assess students' understanding of the material, effectiveness of the course setup, and identify unanswered questions.
Focus Group Interviews	Small group discussions led by a moderator, guided by a think-aloud protocol	Promote collaboration among students in a structured and safe environment while assessing students' reactions, opinions, and perspectives.
Post-Survey	Canvas survey taken after the end of the course	Evaluate knowledge gained as a result of the course, identifying effective strategies and areas for improvement.
Protocol Quizzes	Canvas Quiz on the focus group interview expectation and think-aloud protocol	Assess students' understanding of the protocol before the focus group interview session, ensuring students are well prepared.

Table 3: Ten Week Tentative Course Schedule

Week	**Learning Objective**	**Class Topic**	**Before Class**	**After Class**
Week 1	1.1	Introduction to Advanced Air Mobility (AAM)	Pre-Survey	Reflection Journal Entry
Week 2	1.1	State of the AAM Industry		Reflection Journal Entry
Week 3	1.2	AAM Concepts and Propulsion Systems	Concept Search	Reflection Journal Entry
Week 4	1.4	Vertiport Infrastructure and Multimodal Integration	Transportation Diary	Reflection Journal entry
Week 5	1.2, 1.3, 1.5	AAM Noise	Reading	Reflection Journal Entry
Week 6	1.5	Social Equity and AAM	Reading	Reflection Journal Entry
Week 7	1.6	AAM Design Scenario Focus Groups	Protocol Quiz	Reflection Journal Entry
Week 8	1.6, 1.7	Policy and the Future of AAM	Policy Search	Reflection Journal Entry
Week 9	1.7, 1.8	Design Scenario Focus Group Outcomes	Protocol Quiz 2	Reflection Journal Entry
Week 10	1.9, 1.10	AAM Jigsaw Activity	Activity Preparation	Post-Survey