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Collegiate Pilots' Willingness to Pilot an Aircraft in UAS Integrated Airspace

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Abstract: The integration of Unmanned Aircraft Systems (UAS) into the National Airspace System represents a significant transformation in aviation, highlighting the importance of understanding stakeholder acceptance. Collegiate pilots, as the next generation of aviators, represent an important population for examining attitudes toward UAS integration. This study investigated collegiate pilots' willingness to operate aircraft in airspace shared with UAS, focusing on the effects of UAS operation type (remotely piloted vs. fully autonomous) and FAA pilot rating. A 2 × 5 mixed factorial design was employed, with UAS operation type as the within-subjects factor and FAA pilot rating as the between-subjects factor. Fifty-two collegiate pilots recruited from an FAA Part 141-certificated flight school evaluated two hypothetical airspace scenarios and completed the validated Willingness to Pilot Scale following each scenario. Results of the mixed factorial ANOVA indicated no statistically significant main effect of UAS operation type or FAA pilot rating and no significant interaction between the two factors on willingness to pilot an aircraft.

The results indicate that for this cohort of aviators, the human-in-the-loop element of UAS control is not a primary factor influencing their willingness to share the airspace. This finding suggests that collegiate pilots may base their acceptance more on the overall safety case and regulatory framework for UAS integration rather than the specific control paradigm. The study concludes that aviation training programs should prioritize educating student pilots on UAS capabilities, limitations, and standard procedures, regardless of how the unmanned vehicle is controlled, to prepare them for the inevitable reality of integrated airspace operations.

These findings suggest that collegiate pilots' perceptions of UAS integration are not strongly influenced by their pilot certification level or whether UAS are remotely or autonomously controlled. The results highlight the importance of developing training strategies that normalize UAS integration and prepare pilots for operational complexities regardless of certification stage.

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Introduction

The Unmanned Aviation System (UAS) industry has entered a stage of rapid development and growth. This growth has led to the integration of unmanned aircraft systems into the existing airspace alongside manned aircraft. The safety and acceptance of UAS in the aviation community are crucial for the successful integration of UAS into the national airspace system.

Mohsan et al. (2022) categorize the uses of UAS as military, construction, image and video mapping, medical, search and rescue, parcel delivery, hidden-area exploration, oil rigs and power line monitoring, precision farming, wireless communication, and aerial surveillance. Aydin (2019) conducted extensive research to compile a list of drone applications. The list included sporting events, monitoring nuclear plants, personal event recording, military, search and rescue, home security, firefighting, photogrammetry, wildfire monitoring, disaster relief, construction surveying, traffic patrol, insurance claims, agricultural treatment, transport and cargo delivery, etc.

Unmanned aircraft are classified based on various criteria such as size, range, and capability. The Federal Aviation Administration (FAA) categorizes UAS into three groups: small, medium, and large. According to FAA Part 107 regulations, small UAS weighs less than 55 pounds, including payload, and is typically used for recreational and commercial purposes. Medium UAS, on the other hand, has a maximum takeoff weight between 55 and 1320 pounds and is often employed in surveillance and monitoring missions. Large UAS, the most substantial category, has a maximum takeoff weight exceeding 1320 pounds and is used for military, research, and commercial applications (FAA, 2016). Based on the various FAA Manuals, orders, and advisory circulars, the primary categorization elements are weight, airspeed, altitude, user, and operations.

The U.S. Department of Defense classifies Unmanned Aerial Vehicle platforms as shown in Table 1 (Department of Defense, 2026).

Table 1

UAVs Classification According to the US Department of Defense (DoD)

Category	Size	Maximum Gross Takeoff Weight (MGTW) (lbs)	Normal Operating Altitude (ft)	Airspeed (knots)
Group 1	Small	0-20	<1,200 AGL*	<100
Group 2	Medium	21-55	<3,500	<250
Group 3	Large	<1320	<18,000 MSL**	<250
Group 4	Larger	>1320	<18,000 MSL	Any airspeed
Group 5	Largest	>1320	> 18,000	Any airspeed

*AGL: Above Ground Level
**MSL: Mean Sea Level

Integrating UAS into civilian airspace presents a complex challenge, as current regulations primarily govern manned aircraft operations (Dalamagkidis et al., 2008). UAS integration requires careful consideration of several factors, including airspace design, traffic management, communication protocols, and pilot training. Technology adoption is a complex process related to user attitudes and personality, social influence, trust, and numerous other factors (Sharma & Mishra, 2014). Gollwitzer (1999) suggests that the predictive power of intentions can be increased by making them more concrete, such as defining when, where, and how they will be performed, or implementation intentions.

Vempati (2021) conducted research to determine the effects of UAS integration type and UAS operation type on pilots' willingness to operate an aircraft in UAS-integrated airspace. The study revealed that willingness decreased with airspace complexity, and differences in willingness to pilot an aircraft were based on segregated and integrated operations.

Vempati et al (2022) conducted another study to assess the willingness of manned aircraft pilots to operate in UAM-integrated airspace based on airspace complexity and UAM automation level. The study observed a moderating effect of operation type on automation level and willingness to pilot an aircraft. Professional pilots were more amenable to UAM operations with a pilot on board compared with remotely piloted operations. Narratives indicated that pilots of manned aircraft were more receptive to greater UAS autonomy. This was largely due to concerns about remote pilots' qualifications and experience to operate in the National Airspace System.

According to Comstock (2013), pilots, air traffic controllers, and UAS pilots exhibited notable differences in their perspectives. UAS pilots believed that UASs would not require special accommodations to operate in the National Airspace System and should be held to the same, rather than higher, standards as manned aircraft pilots. In contrast, pilots anticipated more stringent rules and requirements for UAS operations until their safe integration could be reliably demonstrated over time.

Richard's (2017) research examined the perceptions of Air Traffic Control personnel, traditional aircraft pilots, and Unmanned Aerial Vehicle operators regarding crucial human factors inherent in integrating UAVs into the National Airspace System. The findings indicated that manned aircraft pilots generally held less favorable views toward UAVs, while UAV pilots expressed a desire for their roles to be considered equivalent to those of manned aircraft operators.

Understanding the multifaceted challenges surrounding UAS integration requires a holistic approach that acknowledges technological advancements, regulatory frameworks, and human factors (Cooke et al., 2014; Dalamagkidis et al., 2008). The cognitive workload of UAS operators can differ significantly across operational types. It is advantageous to understand how a task's cognitive demands affect flight performance and how to effectively train for those demands. Participants exhibited reduced performance under divided attention, particularly in the combined visual working memory and flight condition. However, participants demonstrated substantial improvement over time, even under high-demand scenarios (Scarince et al., 2024). Resilient operators must be able to handle high workloads, adapt to the limited social capabilities of intelligent machines, and maintain self-confidence despite the superior abilities of certain machine technologies (Matthews et al., 2016).

Sievers (2025) investigated the integration of regional fixed-wing cargo Uncrewed Aircraft Systems into the airspace system, with a focus on underutilized airports. The study compared airports based on certified landing systems and operational factors, revealing that only a small fraction currently has the necessary systems for initial UAS operations, though emerging technologies may improve accessibility.

The integration of Unmanned Aircraft Systems into the national airspace has ushered in a new era of operational complexities, necessitating a comprehensive understanding of how various stakeholders perceive and adapt to this evolving aviation landscape (Gohar et al., 2024). This integration process involves not only technological advancements but also crucial considerations regarding human factors, regulatory frameworks, and risk management strategies (Cooke et al., 2014; Perez-Castan et al., 2021). Successfully navigating these challenges is not merely about overcoming obstacles; it is about proactively shaping the future of air transportation systems to be safer, more efficient, and more resilient amid emerging technologies and operational paradigms. Understanding the perceptions and attitudes of collegiate pilots, who represent the next generation of aviators, is critical to ensure a smooth and effective transition into this integrated airspace (Barnhart et al., 2011). Collegiate pilots' willingness to fly in airspace shared with UAS depends on several factors, including their understanding of UAS technology, their perception of associated risks, and the adequacy of training and regulations governing UAS operations (Torrence et al., 2021).

Previous research on willingness to pilot an aircraft has revealed that perceptions of UAS are still forming, and that as technology advances, acceptance is likely to grow (Cherif et al., 2020). The integration of Unmanned Aircraft Systems into the National Airspace System represents a significant transformation in aviation, presenting both opportunities and challenges for manned aircraft pilots (Telli et al., 2023). Collegiate pilots, who represent the next generation of aviators, will be impacted by this integration, making their perspectives crucial in shaping the future of aviation safety and efficiency. The rapid growth and increasing application of UAS technology across various sectors, including communication, defense, and transportation, underscores the importance of understanding and addressing the concerns and perceptions of these future pilots (Shrestha et al., 2025). Integrating UAS into the airspace introduces complexities related to air traffic management, collision avoidance, and communication protocols, necessitating a comprehensive evaluation of how collegiate pilots perceive these changes and their willingness to adapt to them (Labib et al., 2019).

On the other hand, the UAS training curriculum is not standardized as in manned aviation, and the industry is rapidly evolving, requiring continuous adaptation of training methodologies (Barnhart et al., 2011; Qi et al., 2018). The integration of Unmanned Aircraft Systems into the national airspace necessitates a comprehensive understanding of the perspectives and attitudes held by collegiate pilots, who embody the future of aviation (Gohar et al., 2024). Their acceptance and proficiency in navigating a UAS-integrated airspace are paramount to realizing the full potential of this transformative technology while upholding stringent safety standards.

Literature Review and Research Questions

Existing literature addresses public attitudes toward drone use in package delivery and commercial aviation, encompassing perspectives from air traffic controllers and remote pilots. Although there is research on integrating manned and unmanned operations, the existing literature lacks a clear understanding of collegiate pilots' specific attitudes and concerns regarding the integration of UAS into shared airspace. The purpose of this research was to investigate collegiate pilots' willingness to operate aircraft in UAS-involved airspace. The research questions of this study were:

RQ1: Do collegiate pilots' ratings of willingness to pilot an aircraft vary based on whether the UAS is remotely human-operated or autonomously operated in the airspace?

RQ2: Do collegiate pilots rate different levels of willingness to pilot an aircraft based on pilot rating?

To investigate these questions, the following null and alternative hypotheses are formulated:

H01: Collegiate pilots' willingness to pilot an aircraft does not significantly vary based on the remotely human-operated UAS involved airspace and the autonomously operated UAS involved airspace.

HA1: Collegiate pilots' willingness to pilot an aircraft significantly varies based on the type of UAS operation.

H02: Collegiate pilots' FAA pilot rating does not significantly affect their willingness to pilot an aircraft in UAS-integrated airspace.

HA2: Collegiate pilots' FAA pilot rating significantly affects their willingness to pilot an aircraft in UAS-integrated airspace.

Methodology

Design

A 2 × 5 mixed factorial design was selected as the most appropriate strategy to examine the main effects of, and the interaction between, two independent variables on a single dependent variable. UAS operation type served as the within-subjects factor and comprised two levels: remotely human-piloted and fully autonomous unmanned aircraft, to which every participant responded. FAA pilot rating served as the between-subjects factor and comprised five levels: private pilot license (PPL), instrument rating (IR), commercial pilot license (CPL), certified flight instructor (CFI), and certified flight instructor–instrument (CFII). The dependent variable was willingness to pilot an aircraft.

The dependent variable in this study was willingness to pilot aircraft. The willingness-to-pilot aircraft scale was designed to measure a participant's willingness to operate the aircraft. (Rice et al., 2020). This scale has been used to measure pilots' willingness to pilot attitudes under different hypothetical scenarios, such as in different aircraft sanitization cases (Wheeler, Shacknai, Valluzzi, & Tianhua, 2021), in different airspace classes (Vempati, Myers, & Winter, 2023), in urban air mobility platform-involved airspace (Vempati, Woods, & Winter, 2022).

Measurement Instrument

The Willingness to Pilot Aircraft Scale (Rice et al., 2020) was validated by its developers as a unidimensional measure of willingness. In the present study, the seven items were treated as a single composite and can be understood as reflecting several conceptually related aspects of willingness, safety, and confidence rather than as separately validated subscales. Items 1 and 3 ("I would feel safe piloting an aircraft in this situation"; "I have no fear of piloting an aircraft in this situation") reflect perceived safety and risk appraisal; Items 5 and 6 ("I feel confident piloting an aircraft in this situation"; "I would be confident in piloting an aircraft in this situation") reflect confidence and self-efficacy in the operational environment; and Items 2, 4, and 7 ("I would be willing to pilot"; "I have no problem with piloting"; "I would be happy to pilot") reflect behavioral willingness and affective orientation. These groupings are offered as an interpretive description of item content and were not tested as a formal multidimensional factor structure in the present sample.

Confidence in regulation was not directly measured in the present study. The scenarios did not explicitly state that the operations complied with Part 107; rather, they described civilian, medium-to-large UAS operating below FL180 and segregated from manned operations, with the manned Cessna 172 equipped with Automatic Dependent Surveillance–Broadcast (ADS-B) In. Because regulatory confidence was not operationalized as a measured construct, its influence on willingness cannot be inferred from these data. The role of regulatory confidence should therefore be considered a target for future research that explicitly measures it.

Hypothetical Scenarios

The scenario strategy is consistent with the vignette-based factorial survey methodology (Rossi & Anderson, 1982), in which one dimension is varied systematically while several operational characteristics—here, weather, airspace integration mode, and onboard equipment—are held constant across scenarios to facilitate comparison of willingness across the manipulated dimension. Holding these characteristics constant supports a clearer comparison of the autonomy manipulation but, in an observational survey design, does not permit strong causal inference or rule out all potential confounds.

The choice to use the same scenarios that hold weather, airspace integration mode, and equipment constant across scenarios was motivated by Vempati's (2021) finding that, among the four conditions in the parent dissertation (2 integration types × 2 operation types), the two segregated conditions produced the most uniformly positive pilot sentiment. This indicates that segregated operations with either remotely human-piloted or autonomous UAS represent the "high willingness" region of the experimental space, exactly the conditions under which subtle attitudinal differences between operation types are theoretically most likely to emerge without floor effects suppressing willingness scores.

Isolating this region while varying only the autonomy dimension therefore constitutes a high-sensitivity test of whether the human-in-the-loop distinction matters to collegiate pilots in the most favorable operational context.

Participants and Procedures

Participants were recruited through college outreach emails distributed to students at a college of aviation in southwest Michigan, an FAA Part 141 certified flight school. This outreach procedure produced a voluntary convenience sample rather than a randomly selected sample. After providing informed consent, participants responded to two scenarios corresponding to the within-subjects factor of UAS operation type.

The two scenarios were presented in the same fixed order for all participants—Scenario 1 (remotely human-piloted UAS-involved airspace) followed by Scenario 2 (autonomously piloted UAS-involved airspace); presentation order was not randomized or counterbalanced. FAA pilot rating served as the between-subjects factor, yielding a 2 × 5 mixed factorial design. Following each scenario, participants completed the Willingness to Pilot Scale (Rice et al., 2020). Finally, participants completed a demographic questionnaire assessing age, gender, ethnicity, highest FAA pilot rating, and overall flight hours.

Data were collected via an electronic survey distributed through college outreach emails over five weeks. This research received ethical approval from the Institutional Review Board. The researcher maintained a current CITI certification and declared no conflict of interest.

Data Analysis and Results

Of the 88 responses collected over four weeks, 36 were classified as incomplete and excluded from analysis prior to any inferential testing. A response was operationally defined as incomplete if the participant failed to provide a rating on one or more of the seven Willingness to Pilot Scale items across two scenario conditions. Listwise deletion was applied because the within-subjects design requires complete paired observations for each participant across both measurement occasions. This process yielded a final analytic sample of $N = 52$.

Outlier detection was conducted using boxplots for each scenario condition within each FAA rating group. A data point was classified as an outlier if it fell beyond 1.5 times the interquartile range (IQR) below the first quartile or above the third quartile of the relevant group distribution. Upon examination, no observations in the 52-participant complete-case sample met this criterion.

Accordingly, no additional cases were removed beyond the 36 excluded for incompleteness. The between-subjects error degrees of freedom in the inferential output ($df = 47 = 52 - 5$ groups) corroborate that all 52 complete cases were retained in the analysis.

The survey participant set included 12 female and 40 male student pilots. 78.8% ($n = 41$) participants were white Caucasian, 15.4% ($n = 8$) participants were Asian, 1.9% ($n = 1$) of the participants were Hispanic, 1.9% ($n = 1$) of the participants were Black or African American, and 1.9% ($n = 1$) of the participants were identified as other ethnicities. The mean age of female participants was 21.17 (SD = 1.74) years, and that of male participants was 21.03 ($SD = 1.61$) years. Table 2 indicates the average flight hours of the participants.

Table 2

Average Flight Hours of Participants

	Highest FAA Rating					
Gender	PPL	IR	CPL	CFI	CFII	Total
Female	128.57 (*n*=7, *SD*=36.71)	172 (*n*=2, *SD*=39.60)	281.50 (*n*=2, *SD*=96.87)	-	600 (*n*=1)	200.58 (*n*=12, *SD*=144.47)
Male	112.64 (*n*=18, *SD*=91.77)	157.42 (*n*=18, *SD*=49.49)	270 (*n*=1)	230 (*n*=1)	480 (*n*=2, *SD*=212.13)	158.03 (*n*=40, *SD*=112.31)
Total	117.11 (*n*=25, *SD*=79.72)	158.87 (*n*=20, *SD*=47.89)	277.66 (*n*=3, *SD*=68.82)	230 (*n*=1)	520 (*n*=3, *SD*=165.22)	167.85 (*n*=52, *SD*=120.31)

A 2 × 5 mixed factorial ANOVA was conducted to evaluate the main effects of UAS operation type (within-subjects) and FAA pilot rating (between-subjects), and their interaction, on collegiate pilots' willingness to fly. The internal consistency of the willingness to fly into remotely human-piloted UAS-involved airspace was evaluated using Cronbach's alpha. The resulting $\alpha = 0.95$ suggests excellent reliability. The internal consistency of the willingness to fly into autonomously piloted UAS-involved airspace was evaluated using Cronbach's alpha, yielding $\alpha = 0.96$, indicating excellent reliability.

Before conducting the analysis, the relevant assumptions were examined. Willingness-to-pilot scores were approximately normally distributed within groups. Levene's test of equality of error variances (based on the mean) indicated that the assumption of homogeneity of variance was tenable for both the remotely human-piloted condition, F (4, 47) = 1.81, $p = .142$, and the autonomously piloted condition, F (4, 47) = 0.48, $p = .753$. Because one FAA rating group (CFI) contained a single participant, Box's M test of the equality of covariance matrices could not be reliably estimated; the homogeneity assumption was therefore evaluated using Levene's test. Mauchly's test of sphericity was not required because the within-subjects factor (UAS operation type) comprised only two levels, for which sphericity is necessarily satisfied, and no correction is applicable.

The between-subjects main effect of FAA pilot rating on willingness to pilot was not statistically significant, F (4, 47) = 1.16, $p = .342$, $\eta_p^2 = .090$. The within-subjects main effect of UAS operation type was also nonsignificant, Wilks' $\Lambda = .980$, F (1, 47) = 0.97, $p = .330$, $\eta_p^2 = .020$, as was the UAS Operation Type × FAA Pilot Rating interaction, Wilks' $\Lambda = .984$, F (4, 47) = 0.19, p = .944, $\eta_p^2 = .016$. For a two-level within-subjects factor, the multivariate (Wilks' Λ) and univariate F tests are algebraically identical. The results are summarized in Table 3.

Because several FAA rating groups were very small and unequal in size (e.g., $n = 1$ for CFI; $n = 3$ for CPL and CFII), the between-subjects comparison across pilot ratings is interpreted as preliminary and exploratory rather than as a basis for firm conclusions. Because neither main effect nor the interaction was significant, post hoc tests were not conducted. Figure 1 presents the estimated marginal means of willingness to pilot, which show approximately parallel profiles across the two operation types. Based on these results, the researcher failed to reject either null hypothesis, and both $H0_1$ and $H0_2$ were retained.

Table 3

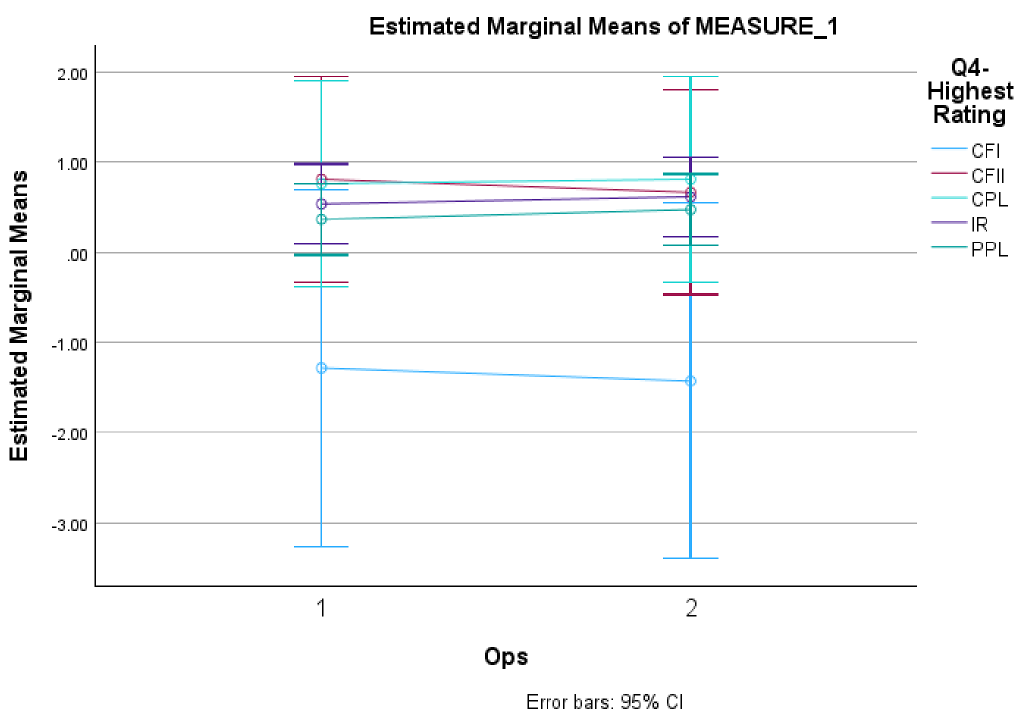
Results of the 2 × 5 Mixed Factorial ANOVA for Willingness to Pilot

Effect	Wilks' *Λ*	*F*	*df*	*p*	η_p^2
FAA pilot rating (between)	—	1.16	4, 47	.342	.090
UAS operation type (within)	.980	0.97	1, 47	.330	.020
Operation Type × Rating	.984	0.19	4, 47	.944	.016

Note. $N = 52$. Willingness to pilot was measured with the Willingness to Pilot Aircraft Scale (Rice et al., 2020). η_p^2 = partial eta squared. The between-subjects comparison across FAA pilot rating groups is exploratory owing to small, unequal group sizes ($n = 1$–25). For the two-level within-subjects factor, the multivariate (Wilks' *Λ*) and univariate *F* tests are equivalent. All *p-values* are exact and two-tailed.

Figure 1

Estimated Marginal Means of Willingness to Fly



Discussion

This study explored collegiate pilots' perceptions, specifically their willingness to fly into UAS platform-involved airspace. It focused on the flight-operations control of a UAS platform to investigate whether there were differences between human- and autonomously piloted unmanned aircraft.

The analysis failed to reject the null hypothesis. No statistically significant difference in willingness was found between the remotely human-piloted and autonomous UAS scenarios (H01 retained), nor was the significant effect of FAA pilot rating detected (H02 retained). It is important to interpret these findings with appropriate epistemic caution. A failure to reject the null hypothesis does not constitute evidence that no difference exists; it indicates only that the observed data were insufficient to detect an effect at the chosen alpha level ($\alpha = .05$) given the achieved statistical power.

The current study was substantially underpowered for between-subjects comparisons: with $N = 52$ distributed across five rating groups, average group sizes of approximately 10-11 participants provide insufficient power (approximately 0.30–0.40 for a medium effect size, $f = 0.25$) to reliably detect moderate between-subjects effects. The nonsignificant findings are therefore more accurately characterized as inconclusive rather than as evidence of equivalence or indifference. Future research should conduct a priori power analyses and recruit adequate samples.

The nonsignificant effect of UAS operation type was nonetheless a theoretically informative preliminary finding. It is consistent with prior work (Qi et al., 2018; Vempati et al., 2021) suggesting that, in segregated operational contexts with adequate regulatory framing, the locus of UAS control (remote human operator vs. autonomous algorithm) may not be the primary driver of manned pilots' willingness. This aligns with the Technology Acceptance Model (Davis, 1989), in which perceived usefulness and system reliability, rather than the mechanics of who or what controls the UAS, may be the dominant drivers of acceptance.

A previous study (Atkins, 2012) on willingness to fly found that more flight hours were associated with a decrease in willingness to fly in UAS-integrated airspace, but this was not the case in this study. Future studies could involve further investigating the specific operational scenarios that lead to pilot concern in the presence of UAS platforms, focusing on factors such as traffic density, weather conditions, and emergency procedures, to gain deeper insight into the underlying concerns and develop targeted mitigation strategies to enhance confidence and safety in the integrated airspace environment.

One important implication of these findings is the role of generational familiarity with automation. While traditional aviation research has often documented pilot skepticism toward autonomous systems (Matthews et al., 2016), the preliminary finding of no significant difference in willingness between remotely human-piloted and autonomously piloted UAS scenarios suggests that collegiate pilots may be more accepting of automation, potentially due to lifelong exposure to autonomous and algorithmic technologies. This shift could represent an emerging cultural change in aviation, in which new entrants are less resistant to technological integration. However, this interpretation should be treated as speculative pending replication with adequate statistical power.

The lack of a statistically significant difference in willingness by UAS operation type (remotely operated vs. autonomously piloted) is an informative preliminary finding. It suggests that for this cohort of next-generation aviators, the presence of a human in the UAS decision-making loop may be less critical than the assurance of the system's safe, predictable behavior. This aligns with the Technology Acceptance Model (TAM), where perceived usefulness and ease of use are primary drivers of adoption, often outweighing the specifics of the underlying technology (Davis, 1989). The collegiate pilots in this study may perceive well-regulated autonomous piloted systems, with their potential for faster-than-human reaction times and adherence to pre-programmed protocols, as equally or even more reliable than remotely human-piloted systems, which are subject to human error, latency, and communication dropouts. This preliminary finding challenges the traditional anthropocentric view of aviation safety and points to a growing acceptance of automated agents as trustworthy partners in the national airspace system (NAS).

The lack of a statistically significant effect of FAA pilot rating on willingness is similarly preliminary. While the data provide no significant support for the hypothesis that higher-rated pilots hold meaningfully different willingness levels, the very small and unequal group sizes across rating categories (e.g., $n = 1$ for CFI) preclude confident generalization. It is theoretically plausible that more experienced pilots would exhibit different risk-appraisal frameworks due to their greater operational exposure; the current study was not powered to reliably detect such differences.

One potentially important moderating variable not captured in the current demographics is the status of the FAA Part 107 Remote Pilot Certificate. Pilots holding a Part 107 certificate have received formal instruction on UAS regulations, operational limitations, airspace authorization procedures, and risk management frameworks specific to unmanned operations. This dual expertise in both manned aircraft operations and UAS regulatory requirements may substantially moderate willingness to operate in UAS-integrated airspace by reducing uncertainty and increasing perceived operational predictability.

Richards and Edgell (2017) demonstrated that UAS pilots exhibited markedly more positive attitudes toward NAS integration than manned aircraft pilots, and Comstock et al. (2014) showed that these two groups differed most sharply on questions of airspace accommodation and regulatory equivalence. If a portion of the collegiate pilot sample in the current study held Part 107 certificates, this would constitute an unmeasured source of between-subjects variance that could have diluted or masked rating-level effects. Future studies should include Part 107 certification status as an explicit between-subjects covariate, enabling analysis of whether dual-certificated pilots exhibit systematically higher willingness, particularly in the autonomous-piloted UAS scenario, where regulatory familiarity and trust in UAS system design may play a stronger role.

Limitations and Recommendations for Future Research

The study's limitations reflect areas for future potential research. First, it focused on 52 student pilots from a university in Southwest Michigan, which may limit generalizability. Although this sample size was adequate for a preliminary investigation, it was insufficient to achieve adequate statistical power for between-subjects comparisons across the five FAA rating groups. Future research should employ an a priori power analysis and recruit at least 85 participants per rating group to enable reliable detection of moderate effects.

A second limitation concerns the structural similarity of the two experimental scenarios. Because both vignettes shared identical peripheral features such as aircraft type, weather conditions, operational rules, UAS integration mode (segregated), and equipment (ADS-B In), the risk profile of the two scenarios may have been perceived as effectively equivalent by some participants, reducing the salience of the autonomy manipulation. This represents a threat to discriminant validity at the scenario level and may have contributed to the nonsignificant effect of UAS operation type on willingness. Future research should introduce additional scenario-differentiating cues specific to the autonomy dimension, such as descriptions of operator location, communication protocols, system redundancy, or fail-safe behavior, to increase vignette distinctiveness while maintaining experimental control. Relatedly, the two scenarios were presented to all participants in the same fixed order-remotely piloted followed by autonomous-rather than in a randomized or counterbalanced sequence; consequently, potential order or carryover effects cannot be ruled out and may have further reduced the observed differentiation between the two conditions.

A third limitation is the omission of Part 107 Remote Pilot Certificate status from the demographics. As discussed in the Discussion section, this dual-certification variable may constitute an important unmeasured moderator of willingness in UAS-integrated airspace contexts. Future studies should explicitly collect and analyze Part 107 status alongside traditional manned aircraft ratings to examine whether UAS operational familiarity moderates the relationship between operation type and willingness.

The hypothetical nature of the survey also lacks the physiological and psychological stress of an actual flight. Future research should employ high-fidelity flight simulation to measure not only stated willingness but also operational performance (e.g., adherence to clearance, workload measures, reaction time to potential conflicts) in dynamic, mixed-traffic environments. This would provide a more holistic and ecologically valid assessment of pilot adaptation to UAS integration.

This research focused exclusively on the perspective of manned aircraft pilots. For successful integration, a holistic understanding of all stakeholders is crucial. A vital direction for future research is to conduct a parallel study with certified UAS pilots and Air Traffic Controllers (ATCs). Investigating their perceptions of mixed airspace, their trust in manned aircraft pilots to adhere to procedures, and their specific concerns would reveal critical systemic interdependencies and potential friction points. Comparing these perspectives would enable the development of integrated training programs and communication protocols that foster mutual trust and shared responsibility among all users of the NAS, ultimately leading to a more cohesive and safer aviation ecosystem.

Finally, the study's observational nature indicates it cannot establish a causal relationship between willingness to fly and UAS control type or current pilot rating. Future research needs to implement more stringent controls, larger sample sizes, and experimental manipulations (including equivalence testing) to isolate the specific factors influencing pilots' willingness to fly in UAS-integrated airspace.

Appendices

Willingness to Pilot Scale

	Strongly Disagree	Disagree	Neither Disagree nor Agree	Agree	Strongly Agree
I would feel safe piloting an aircraft in this situation					
I would be willing to pilot an aircraft in this situation					
I have no fear of piloting an aircraft in this situation					
I have no problem with piloting an aircraft in this situation					
I feel confident piloting an aircraft in this situation					
I would be confident in piloting an aircraft in this situation					
I would be happy to pilot an aircraft in this situation					

Instrument Reference

Rice, S., Winter, S. R., Capps, J., Trombley, J., Robbins, J. Milner, M. N., & Lamb, T. L. (2020). Creation of two valid scales: Willingness to fly in an aircraft and willingness to pilot an aircraft. The International Journal of Aviation, Aeronautics, and Aerospace, 7(1), 1-21.

Scenarios

Scenario 1- Remotely Piloted

Imagine a scenario where you have rented a Cessna 172 equipped with a Garmin G1000 avionics suite. You are conducting your flight under visual meteorological conditions (VMC) and adhering to visual flight rules (VFR). The weather conditions are at least 10 statute miles of visibility, and the sky conditions are clear. On board, you have both paper and electronic navigation charts for the associated portions of your flight route, and the aircraft is equipped with Automatic Dependent Surveillance Broadcast (ADS-B) In. For your route of flight, you learn that civilian, medium- to large-sized unmanned aircraft systems (UAS) will be operating below flight level 180. The UAS operations are remotely piloted and segregated from manned flight operations.

Scenario 2- Autonomous Pilot

Imagine a scenario where you have rented a Cessna 172 equipped with a Garmin G1000 avionics suite. You are conducting your flight under visual meteorological conditions (VMC) and adhering to visual flight rules (VFR). The weather conditions are at least 10 statute miles of visibility, and the sky conditions are clear. On board, you have both paper and electronic navigation charts for the associated portions of your flight route, and the aircraft is equipped with Automatic Dependent Surveillance Broadcast (ADS-B) In. For your route of flight, you learn that civilian, medium- to large-sized unmanned aircraft systems (UAS) will be operating below flight level 180. UAS operations are autonomous and segregated from manned flight operations.

Demographic Questions

1. Age
2. Gender
   Male, female, other
3. Ethnicity
   White or Caucasian, American Indian or Alaska Native, Black or African American, Hispanic or Latino, Asian or Asian American, other
4. Please select the Federal Aviation Administration ratings you hold (select all that apply)
   PPL, IR, CPL, CFI, CFII
5. How many overall flight hours do you have in any aircraft type?

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