JOURNAL OF UNMANNED AERIAL SYSTEMS

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UAS Training and Certification Center

LETTER FROM OUR HOST

Sinclair Community College: Deb Norris

Sinclair College is pleased to be the founder and host of the *Journal of Unmanned Aerial Systems*, a first-of-its-kind publication for Unmanned Aerial Systems (UAS). Recognizing the need for a peer-reviewed publication focused on UAS, Sinclair saw an opportunity to leverage our nationally recognized UAS capabilities and strategic partnerships to create an academically sound and industry relevant resource. The Journal is provided as an online, open-source publication allowing maximum access for students, researchers, and those in industry.

We hope that the Journal will serve as a public forum for sharing new concepts, identifying solutions, and recognizing key strategic thinkers that are addressing the difficult issues facing the UAS industry today as well as in the future. In the best traditions of academia, we welcome differences of opinion, recognizing that sharing ideas, debating the best methods, and confirming results are the most reliable ways to advance a complex technology.

The future of UAS is bright, promising to strengthen economies, add hundreds of thousands of new jobs, and revitalize industries with exciting new applications. Sinclair's role in educating, training, and informing those with an interest in UAS is guided by the vision of our founder, David Sinclair, to "find a need and endeavor to meet it." We invite you to share in this mission through the *Journal of Unmanned Aerial Systems*.

Sincerely,

Deb Norris
Vice President, Workforce Development
Sinclair Community College

ABOUT OUR SPONSOR

Sinclair Community College: National UAS Training & Certification Center

Sinclair Community College's National UAS Training and Certification Center, located in Dayton, Ohio, is a leading national provider of Unmanned Aerial System (UAS) training, certification and education. The Center offers both workforce development training and for-credit education leading to academic credentials. Sinclair's leading portfolio of UAS offerings integrated with traditional aviation capabilities is the most comprehensive in Ohio and matches the best programs nationally. The vision for Sinclair's UAS Center will continue to be advanced by building upon the college's world-class program portfolio and expanding strategic relationships with UAS stakeholders in industry, government, and academia.

In addition to leveraging investments made in Sinclair's present aviation and advanced manufacturing capabilities, the student's learning environment is strengthened through simulation and competency and inquiry learning models built upon Science, Technology, Engineering and Mathematics (STEM) principles. This approach builds on Ohio's strengths in aerospace, data management and analysis, sensor development, and advanced materials and manufacturing, all of which are critical elements to support the UAS and broader aviation markets.

Sinclair's UAS Center provides comprehensive UAS and Aviation Technology offerings driven by a holistic systems approach. In addition to comprehensive traditional aviation programs, two-year degree, one-year certificate, and short-term certificate paths focused on UAS applications in first responder, precision agriculture, and geospatial information are also offered. Additionally, multiple in-person and online non-credit training courses are supported through leading subject-matter expertise and resources. Sinclair operates multiple UAS types through approved Certificates of Authorization, facilitating flights in support of training and research opportunities. Additionally, the total number of UAS supporting student training in labs, indoor environments, and authorized outdoor operations has now expanded to more than 60. Modeling and simulation is an integral part of the UAS programs, supported through an Educational Partnership Agreement with the Air Force Research Laboratory that enhances the Sinclair UAS Simulation Lab while providing notable capabilities for UAS research topics related to human performance and crew training. The College has also committed the capability of its existing Network Operations Center and new task specific hardware and software to support analysis of data collected from UAS flights.

Sinclair has currently invested approximately $7M of internal funding in support of UAS efforts and received additional external state capital totaling over $4M to support the further development of UAS and aviation training and research programs. Enabled through ongoing renovations, the UAS and aviation programs will offer expanded indoor flight testing and training spaces, advanced aerospace and additive manufacturing, modeling and simulation, and multiple labs including maintenance, wind tunnel, avionics, and sensors. Sinclair's partnership driven approach has resulted in the development of nationally leading UAS and aviation programs positioned to support both training requirements and research opportunities with our partners. Through these capabilities, Sinclair will continue to strengthen its national leadership position in UAS and aviation training, education, and certification.

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OVERVIEW OF THE JOURNAL

The *Journal of Unmanned Aerial Systems* provides an interdisciplinary forum for an ongoing scholarly dialogue of original research, articles, books, essays, and commentary by both internationally established and developing experts in the various disciplines constituting the field of UAS. Variety and scientific endeavor are encouraged by bringing together established and developing scholars, from both theoretical and practical perspectives and drawn from national and international communities, university faculties, industry, research institutions, government organizations and non-government organizations (NGOs). The Journal serves the public as an open-access resource and allows users to read, download, copy, distribute, print, search, or link to the full texts of all published material for personal, research or scholarly purposes.

The *Journal of Unmanned Aerial Systems* accepts a variety of content and acknowledges that there are several levels of engagement and contribution that all inform development of UAS within academia, industry and government. The Journal accepts peer-reviewed articles, technical papers, abstracts, book reviews and other content. These submissions are included in each issue and categorized by type. This mixture of peer-reviewed articles along with other sections creates a blended publication that is relevant and interesting to researchers, technical staff and senior managers.

JOURNAL OF UNMANNED AERIAL SYSTEMS

EDITORIAL

From the Managing Editor: Dr. Andrew Shepherd

Welcome to this first edition of the *Journal of Unmanned Aerial Systems*.

The purpose of this inaugural edition is to inform the broader public about the mission, vision, and organizing principles of the Journal. Additionally, it provides an outlet for first articles accepted for publication by the Publishing Board. Some might question if another peer-reviewed journal is needed given the number of quality publications already in existence. However, based on our survey of those publications, their missions, and major areas of focus we felt that there was a gap specifically related to UAS that this Journal can address. Two key attributes of the Journal are that it is, and will remain, an online and open-source resource, meant to provide easy access at no cost to those with an interest in UAS no matter to which stakeholder group they belong.

We have been honored to receive the support of leading experts from academia, industry, and government serving in roles on the Publishing Board, Editorial Board, and as Reviewers. The depth of experience and knowledge offered by these volunteers is astonishing and we are grateful that they freely contribute their time to ensure the quality of the publication. We also continue to accept applications for Reviewer positions from those wishing to share their expertise, talents, and time.

We believe that this Journal will provide a public forum in which new ideas can be shared, concepts tested, and knowledge recorded. Please join us as we launch the Journal by submitting your own work, encouraging peers and students to contribute, and spreading the word about this new resource for the UAS community.

Andrew D. Shepherd, PhD – Managing Editor
Director, Unmanned Aerial Systems, Sinclair Community College

PUBLISHING BOARD

Andrew D. Shepherd, PhD – Managing Editor
Director, Unmanned Aerial Systems, Sinclair Community College
Dr. Andrew Shepherd serves as the Director for Unmanned Aerial Systems at Sinclair Community College in Dayton, Ohio. With more than a decade of experience in the defense industry and academia focused on modeling and simulation, research, course development, accreditation, instruction, and mentorship, Shepherd offers extensive knowledge in many areas of technology, higher education, and workforce training and development. He serves as an Editorial Advisory Board Member for the *Two Cultures Journal* in addition to his role as the Managing Editor for the *Journal of Unmanned Aerial Systems*. Named to both Dayton's top 40 Under 40 and top 100 Defense and Aerospace Professionals by the Dayton Business Journal in 2014, Shepherd is an active member of his community and broader aerospace industry. He earned his Associate of Applied Science degree in Aviation Technology – Professional Pilot and Airway Science Option – from Sinclair Community College. He went on to Embry-Riddle Aeronautical University where he earned both a Bachelor of Science degree in Professional Aeronautics with dual minors in Management and Aviation Safety and a Master of Aeronautical Science with dual specializations of Space Science and Human Factors in Aviation. He most recently earned a Doctor of Philosophy in Business Administration with a specialization in Management of Engineering and Technology from Arizona's Northcentral University.

Matthew J. Hutchinson, PhD – Assistant Managing Editor
Research Scientist, Woolpert, Inc.
Dr. Matt Hutchinson is a Research Scientist and Associate-level shareholder at Woolpert, Inc. in Dayton, Ohio, where he provides consulting services in geomatics. His education at Curtin University in Australia has included a PhD in Spatial Science (2010), a Postgraduate Diploma in Science (2003), and a Bachelor of Science in Geographic Information Science (2002). During his time at Woolpert, Dr. Hutchinson has worked extensively in defense contracting and most recently has led a team at Woolpert exploring the use of UAS for civil mapping and surveying. He has authored peer-reviewed publications, taught university courses and mentored staff and students. His research interests include agent-based software, spatial analysis and change detection from new generation satellites and UAS.

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John B. Bridewell, EdD
Professor of Aviation, University of North Dakota
Dr. John Bridewell is a Professor of Aviation at the University of North Dakota as a part of the UND Center of Excellence for Unmanned Aircraft Systems Research, Education and Training. Present research focuses on refining training technologies to help military warfighters through cooperative efforts with the Air Force Research Laboratory. Additional research efforts center upon the needs of industry partners and governmental agencies. He is an active member of the University Aviation Association and promotes the development of unmanned systems within a collegiate aviation context.

Brent A. Terwilliger, PhD
Program Chair, Master of Science in Unmanned Systems, Embry-Riddle Aeronautical University – Worldwide
Dr. Brent Terwilliger is the Program Chair for the Master of Science in Unmanned Systems degree, the UAS Discipline Chair, and Assistant Professor of Aeronautics at Embry-Riddle Aeronautical University (ERAU)-Worldwide. His past education and experience consists of a PhD in Business Administration from Northcentral University (2012), an MAS from ERAU-Worldwide (2005), a BS in Aerospace Studies from ERAU-Daytona Beach (2000), and more than 10 years working in defense contracting. Dr. Terwilliger has coordinated proposals, led research and development efforts, authored peer reviewed publications, and performed editorial and acceptance review for topics associated with unmanned systems and application of training and simulation. He is currently working on several research publications detailing his work on application of UAS for emergency response, human-machine-interface (HMI), modeling and simulation, and situational awareness.

Benjamin E. Wilkinson, PhD
Assistant Professor, University of Florida
Dr. Ben Wilkinson is an Assistant Professor in the Geomatics Program at the University of Florida. His main interests include photogrammetry, lidar, hydrographic surveying, and UAS. Before joining the UF faculty in 2013, he was a research scientist at Integrity Applications Inc. Prior to that he worked as a research assistant at UF where he earned a PhD in 2011, and as an airborne lidar operator for the National Center for Airborne Laser Mapping. Some of his recent projects include detection of nuisance plant species from UAS imagery and efficient georeferencing processes for UAS data. Dr. Wilkinson teaches introductory and advanced photogrammetry courses at the undergraduate and graduate levels, co-instructs a course on hydrographic surveying, and is currently developing courses on mapping with UAS. He is a coauthor of "Elements of Photogrammetry - With Applications in GIS," 2014.

EDITORIAL BOARD

REVIEWERS

MANUSCRIPT SUBMISSION

The *Journal of Unmanned Aerial Systems* has been established to facilitate the exchange of ideas regarding the development and application of unmanned systems in the context of aeronautics. The use of *Systems* in the title is indicative of the Journal including the entire ecosystem necessary to operate UAS, not just the vehicle itself. For example, this could also include topics relating to the ground control station, communications, security, navigation, human performance, sensors, legislation, training, and operations.

Two defining threads woven throughout the Journal include:

- Domain (e.g. emergency response, agriculture, mapping and surveying)
- Technology (e.g. sensor development, platform development, avionics)

The Journal is specifically tailored to aerial systems, and does not include unmanned vehicles operating on land, in water, or other environments. Aerial vehicles include, but are not limited to, fixed-wing and rotary-wing aircraft plus lighter-than-air platforms such as aerostats. The mission of the Journal shall be to ensure scholarly discussion through the publication of research promoting the use of UAS globally, across domains and for the greater good of society as a whole. The *Journal of Unmanned Aerial Systems* is a peer-reviewed publication typically issued biannually. Manuscripts may be submitted using our contact form, available at: www.uasjournal.org.

Authors will be notified of selection within one month of publication. Unless otherwise noted, selected submissions will appear in the next issue, which will be published online.

Peer-Reviewed Articles

These articles will undergo a blind review process, meeting the standards expected of a peer-reviewed journal. The staff reviewing the content have advanced degrees, many with doctorates, and have backgrounds in UAS and various related fields. Feedback will be provided to the authors at several points in the review process and the final content will be at a standard, both conceptually and grammatically, expected for a peer-reviewed journal.

Technical Papers

The Journal acknowledges that there is interesting and innovative work being done, for example in industry, that may not warrant formal publication as a peer-reviewed article but still has value to the wider UAS community. These technical papers will not be peer-reviewed, in the traditional sense, but will still undergo a vetting and editorial process. Technical papers must show new work being done by the author and must provide an actual contribution, insight, analysis, progress or other experience that has merit and would be of interest to the UAS community.

Book Reviews

Suggestions for book reviews will be considered by the Journal, and both Journal staff and others within the UAS community may be invited to provide the reviews. Book reviews provided by the book's publisher or author will not be used. The review must also meet standards regarding clarity, purpose, grammar and brevity. Any other party, including the book publisher or book author, will provide no payment or other benefit to the reviewer of the book.

AUTHOR GUIDELINES

Contributions and Editorial Correspondence

Send article submissions with cover letters as e-mail attachments.

No hard copy is necessary. Books are not solicited for review from authors or publishers. Those wishing to have books reviewed should send a copy to the editorial office. Unsolicited book reviews will not be accepted for publication. Articles must be based on original research and the careful analysis of archival and other primary source materials. Manuscripts are evaluated with the understanding that they have not been published elsewhere in any language and are not under consideration for publication or part of a book that will be published in the near future. The Journal will consider 500-word commentaries on research in progress for the "In Coming" section.

Hard copy submissions will be accepted only via special arrangement and only to facilitate authors who may not have access to e-mail or the Internet. Arrangements for submission by post should be made directly with the Managing Editor.

Manuscripts must not be under consideration by any other publication or have been published elsewhere. The editors reserve the right to return articles that do not comply with the format outlined in the Manuscript Preparation and Style guidelines.

Publishing Information

The Editors reserve the right to copy edit manuscripts to conform to the *Journal of Unmanned Aerial Systems*' style, which follows the rules found in the Publication Manual of the American Psychological Association, Sixth Edition. Spelling will be edited to conform to American usage. More substantial editing will be returned to the author for approval before publication, at the discretion of the Editors. Only the edited areas in question will be allowed to be re-written; no re-writing will be allowed in the proof stage. Authors must return the article or review to the editors within 72 hours of receipt or approval will be assumed.

When an article is written by multiple authors the lead author will receive one set of proofs prior to publication for the correction of typographical or factual errors only.

Manuscript Preparation and Style

1. General
An article must be in English and should not exceed 10,000 words or thirty-five 8.5-×11-inch double-spaced pages in 12-point font (including main text, notes, tables, and figure captions) with 1-inch margins on all sides. Authors should submit one electronic copy via e-mail attachment in PC format and using a standard word-processing program. Those with no e-mail capability my send disks in PC format and using a standard word-processing program.

The entire manuscript—including notes, tables, and references—must be typed double-spaced and numbered consecutively. Do not use software to mark diacriticals in the original digital text.

AUTHOR GUIDELINES

Do not put names in headers or footers and authors should avoid any references to themselves in the body or the endnotes such as might betray their identity to referees. All submissions must, however, provide a coversheet or letter that includes the author's name, institutional affiliation, land-mail address, telephone and fax numbers, and e-mail address.

The Journal conforms to the Publication Manual of the American Psychological Association, Sixth Edition. The title alones should be centered at the top of the first text page. In the final draft, institutional affiliation and location should appear at the bottom of the first text page. The editor may find it necessary to return manuscripts for reworking or retyping that do not conform to these requirements.

2. Text
Use a five-character paragraph indent. Avoid hyphenating words at the end of lines. Do not use desk top publishing features. Block indents long quotations (more than 50 words). Never cross-reference.

Notes and References: Notes (footnotes) must be numbered consecutively throughout the text, typed double-spaced in paragraph style, and grouped together as a unit at the end of the journal paper, after the references. Footnotes at the bottom of the text page are not permitted. Any acknowledgment of grant support, substantial assistance, and so forth should be typed as an Author's Note above the first note in the final draft. Provide the full name of the author as it appears in the publication. All titles in non-Roman alphabets (Arabic, Cyrillic, etc.) must be transliterated. Foreign titles in Roman alphabets should be capitalized as they would be in that particular language. An English translation of nonstandard language titles should be provided in parentheses after the title. The style of note citations should conform to the following examples:

> *Journal of Unmanned Aerial Systems*: Does not publish bibliographies.
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> Foreign Words and Transliterations: Diacritical marks (macrons and dots) are used in the *Journal of Unmanned Aerial Systems* only on italicized technical terms (see explanation below). Macrons and dots should not be added to personal names, place names, or titles of books. These latter words should generally be spelled without diacritical marks. Place names with accepted English spellings and personal names of prominent political leaders or cultural figures should be spelled in accordance with English norms. No words that appear in an unabridged English dictionary shall be treated as technical terms requiring transliteration. Please see the word list on the *Journal of Unmanned Aerial Systems* editorial office website for exceptions.
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> All technical terms from languages using non-Roman alphabets; must be fully transliterated with diacritics. In addition, personal names, place names, names of organizations, and titles of books should be transliterated but the macrons and dots omitted. Authors are responsible for the consistency and accuracy of their transliteration.
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> Dates: *The Journal of Unmanned Aerial Systems* accepts multiple dating systems. Anno Domini (abbreviated as AD or A.D.), Before Christ (abbreviated as BC or B.C.), Before the Common/Christian/Current Era (abbreviated BCE or B.C.E.) and Common/Christian/Current Era (abbreviated CE or C.E.) are all acceptable. When quoting from an original source with alternate dating systems use the date as quoted (Hijra, solar, etc.) with the chosen Common Era equivalent in parentheses.

AUTHOR GUIDELINES

Photographs, Images, Diagrams and Illustrations: Photographs, images, diagrams and illustrations may be submitted with a manuscript and must be cited in the text, for example, (Figure 1) or (See Image 2). They may be interspersed in the text. Every attempt will be made to include them with the article; however, inclusion will be at the discretion of the Board of Editors. Photographs, images, diagrams and illustrations may be submitted in color or black and white and must be in sufficient detail and contrast to be reproduced electronically and should be large enough to remain eligible reduced to size 10 font. They must be professionally rendered or computer generated. Below standard artwork will be rejected and the author will be notified and given the opportunity to provide a replacement. All Photographs, images, diagrams, illustrations and artwork must be numbered and labeled with the author's name and article title.

Tables, Charts and Figures: Tables, charts and figures must be cited in the text, for example, (Table 1), (See Chart 2) or (Reference Figure 3). They should be numbered consecutively throughout the article in Arabic numbers, captioned, and appear as a unit following the notes section. They may be interspersed in the text. Tables, charts and figures must be professionally rendered or computer generated, details should be large enough to remain legible when reduced to size 10 font. Below standard artwork will be rejected and the author will be notified and given the opportunity to provide a replacement. All tables, charts and figures must be numbered and labeled with the author's name and article title.

Mathematics and other Technical Jargon: Simplify equations as much as possible and avoid unusual symbols or characters. Avoid under-barred symbols, multiple dot accents (more than two) and, in the case of barred variables, use a bar accent (—) for a single variable and a continuous rule (——) for several variables.

Nomenclature: Include a list of all referenced symbology used in the manuscript. Definitions need not be repeated in the text. Acronyms should be defined within the text and not included in the reference list. Sub and super scripts of more than two layers should be avoided.

Vectors: Use boldface type to distinguish between vector and scalar quantities (rather than bars or arrows above the symbol).

Italic vs Roman Characters: Use italic type for variables and constants, with the following exceptions. Set in Roman type: sin, cos, tan,..., and all similar trigonometric and hyperbolic functions: log for base 10 logarithms; qualities such as min, max, opt,..., etc.; "d" for derivative; acronyms such as "AIC" for aerodynamics influence coefficients. The "ln" for natural logarithm will be set in script. Note: When exponential notation is used, the form exyz is preferred.
Use the form exp[x2 + (y – 1) – 3 + Z] when the exponents of the natural base are unusually long or complicated, i.e., containing fractions, integrals, or sigma summations.

Derivatives: Derivatives may be indicated via an over-dot or prime.

Accents: The seven commonalty accepted mathematical accents may be placed above italic Roman or Greek letters. Accents should not be stacked over one another.

AUTHOR GUIDELINES

Fractions: In an effort to render equations as compact as possible, small fractions should be "broken down" in solidus (/) form; especially when the equation does not contain integrals or summations. Do not mix built-up fractions and fractions with a solidus. Fractions with long numerators or denominators (five or more characters) should be left as built-up fractions for readability.

Radical: Radical signs of arbitrary length are available for use over variables (with or without a superscript) and simple fractions. When a radical is needed over an accented or barred variable, a variable with layered superscripts, or a complex fraction (where the numerator or denominator contains a fraction, integral, or sigma summation), the exponential notation ( )1/ 2 should be used.

Multiple-Line Equations: Long equations are broken apart and continued for several lines. The point at which such equations should be broken is best determined by the author so that the breaks fit conveniently with the concept being expressed. A rule of thumb on the amount that will fit on one line in the printed journal is 40 symbols that take horizontal space, counting all regular characters, sub- and superscripts, parentheses, plus and minus signs, etc. Integral and summation signs each count as three symbols.

Authors should format individual lines of equations to be no more than 40 symbols wide to ensure that they "break" logically on the printed page. Short and simple equations should be presented in-line as text. Number each equation consecutively in parentheses to the right of the equation or to the right of the last line of a "broken" equation. Groups of equations that the author wants to identify with one equation number preferably should be individually numbered 1a, 1b, 1c, etc. The exception is a matrix, where the equation number is on the right of the midpoint of the matrix. When numbering equations, the number should appear at the right margin of the page, in parentheses.

Matrices: All matrices should be centered vertically about their "main line" or midpoint. Separate rows in a matrix with a blank line.

AUTHOR GUIDELINES

Book, Article, Film, and New Technology Review

Preparation and Style: The entire manuscript should be in English and should not exceed 1000 words or four 8.5-×11-inch double-spaced pages in 12-point font with1-inch margins on all sides. Authors should submit one electronic copy via e-mail attachment in PC format and using a standard word-processing program. The entire manuscript must be typed double-spaced and numbered consecutively.

Reviews should not require notes. If they must be included use the directions listed above.

The Editors reserve the right to copyedit and proof all reviews accepted for publication.

Publication, Film, Technology Data: Information of the material being reviewed must include the following:

Book Review: First Name Last Name, Title of the Book Italicized, (Place of publication: Publisher, date of publication). Pp.: $price cloth, $price paper.

Eg., Jane Doe, Title, (Chicago: University of Chicago Press, 1999), Pp 265. $45.96 cloth, $27.85 paper.

Article Review: First Name Last Name, "Title of the Article in Quotes", Journal/Publication Italicized, Volume, Issue, (Year): Pp. (web address for electronic journals)

Eg.1.) Jane Doe, "Title," Journal Title (1998): Pp10.

E.g. 2) Jane Doe, "Title," Journal Title 287, no. 5 (2002), Pp 5. http://jama.ama-assn.org/issues/v287n5/rfull/joc10108.html#aainfo.

Film Review: Movie Title, medium (theater, DVD, online), Written by First Name Last Name. Directed by Name Last Name, original publication date if a re-issued, city/state/country of publication: name of studio or Production Company, date of publication. Running time: hours, minutes - Film rating.

E.g. Movie Title, DVD. Written by Jane Doe, Directed by John Doe, Anytown, CA: Movie Entertainment, 2010. 2 hrs 10 min. Rated R.

Reviewer Data: Reviewed by First Name Last Name, School Department/Office Title, University/Organization, address and e-mail address.

E.g. John Doe, Department of Religion, Any University, 1234 First St., Boston, MA 01201; john.doe@emailaddress.edu

Submissions: Reviews are to be sent to the book review editor who commissioned the work. Files are to be sent via e-mail or disk.

JOURNAL OF UNMANNED AERIAL SYSTEMS

TECHNICAL PAPER

SMALL UAS BUSINESS SENTIMENT ON FAA RULES: SURVEY RESULTS

Colin Snow

CEO and Founder of Drone Analyst

Abstract

This paper presents selected results from a survey study performed in April 2014 on business sentiment on FAA rules for the commercial activity of small unmanned aerial systems (sUAS) in the U.S. The study Impact of FAA Rules on sUAS Business examined the effect of FAA policies for operating sUAS in Class G uncontrolled airspace. It evaluated how commercial service providers and operators perceive those rules and assess their importance. The research investigated the potential economic impact of future regulations - including revenue growth forecasts and hiring plans. Participants identified themselves as either current or future providers of commercial activity. They identify the types of FAA regulations that would be both favorable and unfavorable for their current or future business activates, and identify the actions and business outcomes under both conditions.

Introduction

The research study Impact of FAA Rules on sUAS Business looks at the micro-economic impact of FAA rules on small unmanned aerial systems (sUAS) from the perspective of the business owner. We undertook this study to 1) evaluate how commercial service providers and operators perceive current Federal Aviation Administration (FAA) rules for sUAS, 2) determine the micro-economic issues, and 3) assess their importance for future regulations.

Study Demographics

Data collected for this study comes from a survey conducted over the web in March and April 2014. Survey participation was solicited via e-mail invitation, website blog posts, website media article invitations, and online forum posts. A total of 334 web users clicked through to the survey. Of those, 297 answered the qualifying questions and completed the survey. Qualifiers were identified as those who "sell or operate, and intend to sell or operate, sUAS in the U.S. for commercial purposes." Most qualifiers identified themselves as either a principal or employee. These validated respondents represent companies whose annual revenues span from US$100,000 to more than US$10 million. The online survey defined 'commercial service' to mean getting paid for the product or service and 'operate' as flying in uncontrolled Class G airspace. It defined 'sUAS' as remote-control or autonomous unmanned aerial system that weighs fewer than 55 pounds. The survey followed statistical research sample-size best practices with the following results for a worst case percentage (50%) answer against a population of 2,000: Confidence Level 95% and confidence Interval 5.25. The online survey tool reported no sampling bias.

Survey participants were required to identify their primary commercial service offering (Figure 1). Clearly, dominant (41%) service offerings include aerial photography and/or video combined with cinematography / movie/ TV. This combination is logical since aerial photography and video platforms are mostly the same and vary mainly in size and camera-carrying capacity. Sales of sUAS aircraft and technology represents the next largest service offering, at 11%. About eight percent of participants identified themselves as offering agriculture / farming services and another five percent identified their services as mapping / topography / geospatial / photogrammetry.

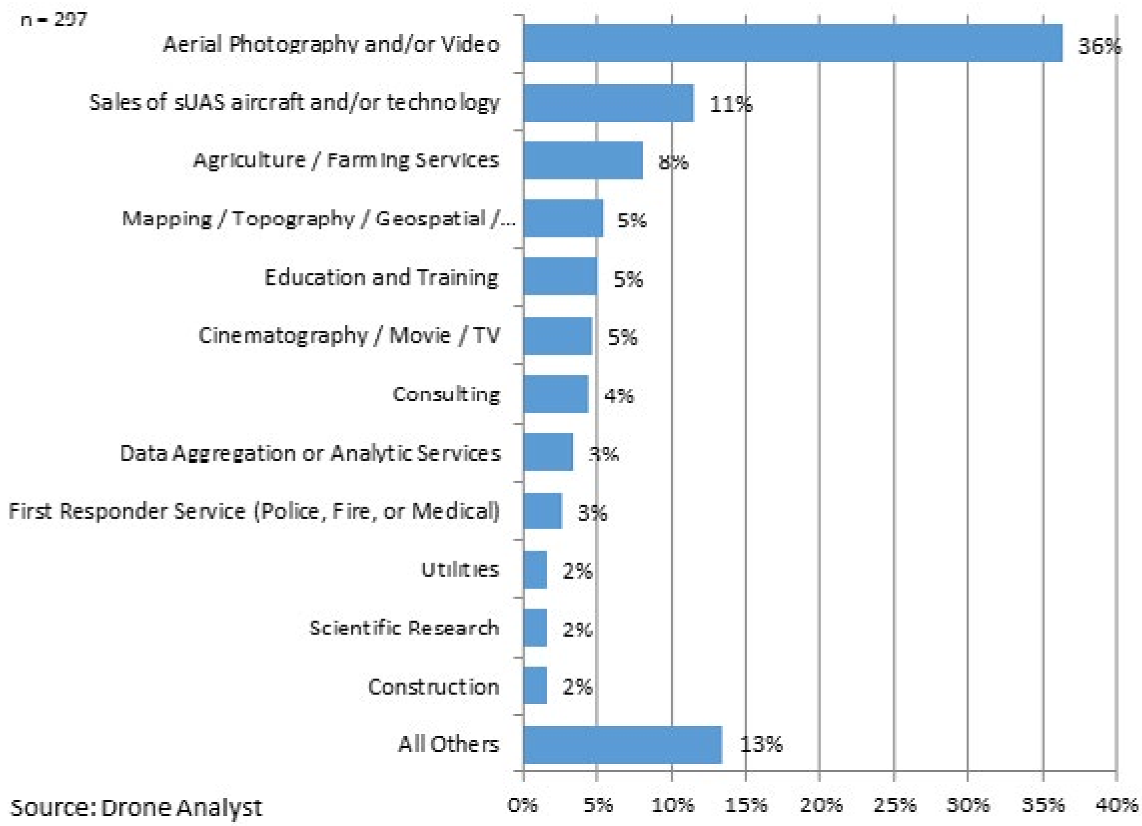

Figure 1. Primary Service or Product

Readiness to Offer Services

When asked about operating and offering commercial services in the U.S., almost half of all respondents (47%) said their company has been doing so already. Of those, almost two-thirds (64%) have been doing so for two or more years, and 34% for more than five years.

We note that two-thirds of those who sell sUAS aircraft and/or technology already do business, and it's this group that has been doing so the longest—with 30% in service for five or more years.

Those who have not begun service were asked when they would like to begin service in the U.S. Almost two-thirds of respondents (64%) said they are ready to begin within the next year.

Revenue from U.S. Operations

We wanted to know company's revenue last year from sUAS commercial services in the U.S. for those who are operating in the U.S. While most (63%) reported revenue last year as less than $100,000, 13% indicated revenue of more than $1,000,000. When viewed through the lens of each service provider type, the data offers some interesting news. For example, last year's revenue from the largest group of service providers—those offering aerial photography and cinematography—is spread across a wide range (from zero to over $1 million). In fact, three respondents reported revenue over $10 million, a figure no other group reported. This indicates revenue is not small and in some cases is in fact quite large.

Comprehension of Current FAA Policies

We asked respondents a direct question about their clarity of FAA regulations for the use and operations of sUAS for commercial purposes. The fact that a combined 71% say it's unclear demonstrates how bad the current regulatory environment is. We went further and asked respondents to identify conditions under which they think it is currently legal to operate sUAS for commercial purposes in the U.S. We offered 12 possible conditions, and respondents could pick as many as they thought applied (Figure 2).

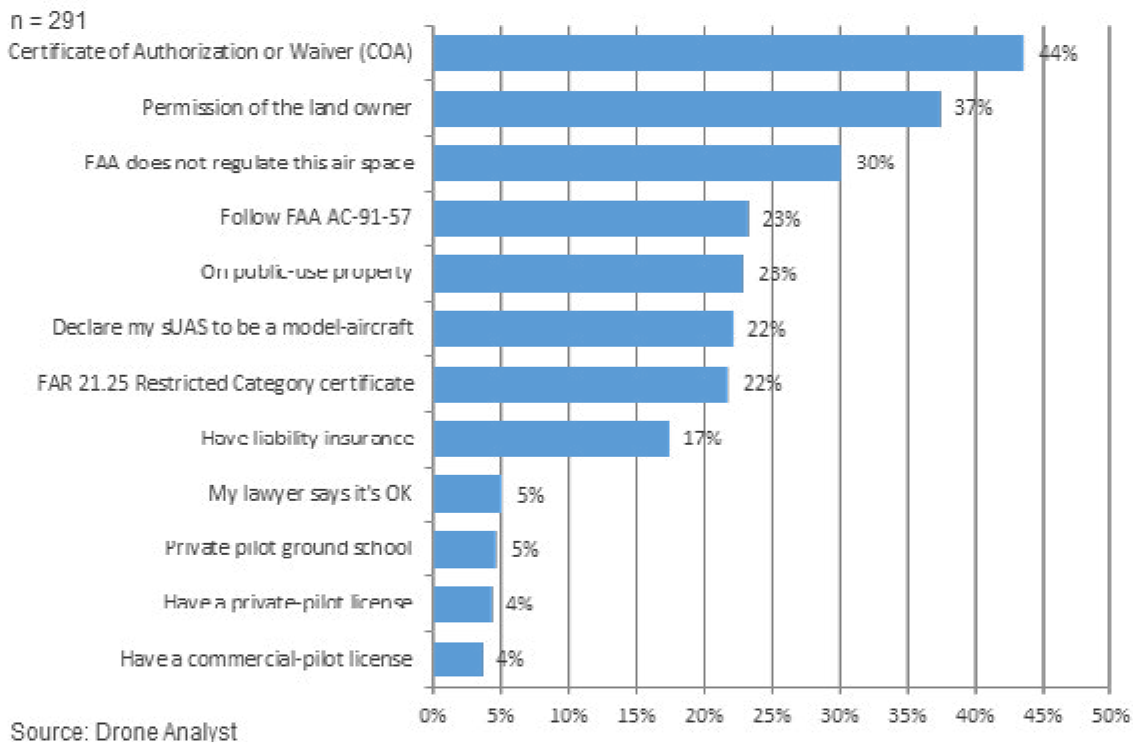

Figure 2. Comprehension of FAA Policies

Responses varied widely, with 44% picking Certificate of Authorization or Waiver (COA) as at least one condition. Permission of the land owner came in second, with 37% of respondents choosing that as condition of legal commercial operation. However, in contrast to these, the third most-checked condition was simply that the FAA does not regulate this air space. The surprising finding with this third answer is that it indicates nearly one-third of surveyed operators think no FAA rules apply to their commercial operations at all.

Business Growth under Favorable Regulations

We wanted to explore what regulations respondents think (as many as apply) the FAA should put in place for commercial sUAS to operate in Class G airspace. The results are shown in Figure 3.

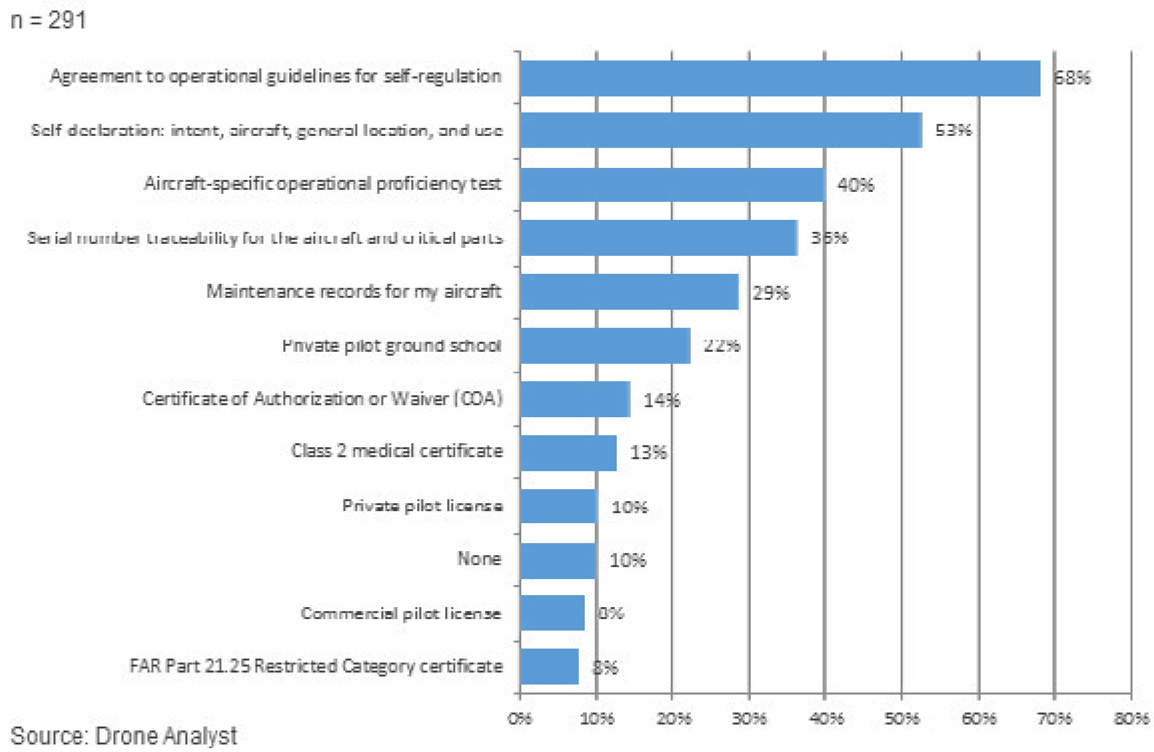

Figure 3. Favorable FAA Regulations

Only 10% said none. The majority (greater than 50% of respondents) picked these two:

1. Agreement to operational guidelines for self-regulation
2. A self-declaration of intent, aircraft, general location, and use

The largest minority (those less than 50%) picked:

1. Aircraft-specific operational proficiency test
2. Serial number traceability for the aircraft and critical parts

In the next series of questions, we wanted to understand the micro-economic implications of the immediate introduction of favorable regulations. To assess commercial readiness, we asked when respondents would begin operations if favorable sUAS regulations were published now. Filtering out those who already have operations in the U.S., we see that almost two-thirds (62%) would start immediately and another 24% within one year. We concluded in the study that 86% or 135 respondents that are not currently operating are being held back by the current policy environment and these respondents can start offering services almost immediately should favorable regulations exist. This fact is underscored by the results of the next question, where we asked about hiring tendency if favorable FAA regulations were published now. This data shows that 42% of respondents would hire two or more full-time employees (FTE) in the next year.

Regulations Considered Unfavorable for Business

In contrast to the questions we asked about favorable regulations and their implications, we wanted to find what respondents thought about unfavorable regulations. We also wanted to know their business impact. We asked respondents to tell us what type of FAA regulations on sUAS commercial operations would be unfavorable for their business using the same options that appear in Figure 3. The majority of respondents picked five unfavorable regulations. These are:

1. Commercial pilot license
2. Private pilot license
3. A Certificate of Authorization or Waiver (COA)
4. A Part 21.25 Restricted Category certificate
5. Class 2 medical certificate

We went on to determine the likelihood of respondents either discontinuing or not starting services if those unfavorable FAA regulations were in place. The results show that 61% would likely not start or shutter their existing business operations. In light of the finding above, which indicates 86% of businesses are being held back by the current rules environment, the study concluded the overall market growth for sUAS would be severely inhibited if unfavorable FAA regulations come into being.

PEER-REVIEWED ARTICLE

FIVE FACTOR MODEL PERSONALITY PROFILES OF UNIVERSITY OF NORTH DAKOTA UNMANNED AIRCRAFT SYSTEMS STUDENTS

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Abstract

Efforts to quantify personality characteristics in the pilots of manned aircraft extend back for decades. For individuals interested in piloting Unmanned Aircraft, similar analysis of normative personality characteristics remains relatively unexplored. This research examined the Five Factor Model (FFM) personality profiles of individuals pursuing Unmanned Aircraft Systems (UAS) studies at the University of North Dakota (UND). Using the Big Five Inventory (BFI) general personality index, the responses of a UAS Student sample (n=65) were compared to a Normative sample (n=248) previously collected by Petros (2013). The sample group, comprised of students with either Pre UAS Operations or UAS Operations declared as a first or second major, scored significantly lower in neuroticism (N) ($p<0.001$), significantly higher in openness (O) ($p<0.01$), and significantly higher in conscientiousness (C) ($p<0.001$) than individuals in the Normative sample. Based on these differences and previous work regarding the personality characteristics of manned aviators, one might hypothesize that relative to their manned counterparts, those students pursuing careers in UAS are similar in their neurotic, interpersonal, and achievement-oriented tendencies, but are distinguishable by their tendency toward introversion and openness to experience. Recommendations for future research encourage application of the Revised NEO Personality Inventory for assessment of facet traits within the FFM domains, and the exploration of these personality traits as they appear within individuals who have completed training for the operation of UAS platforms. The University of North Dakota (UND) offers a wide range of degree programs for manned aircraft, and since 2009 the nation's first major in Unmanned Aircraft Systems (UAS) Operations. Undergraduate students may specialize in majors of commercial aviation, flight education, Air Traffic Control (ATC), aviation management, or UAS Operations for a variety of reasons. As significant investments of time and money are asked of these students in the completion of their degrees, one wonders whether an in depth understanding of their characteristics could enable better academic and career advising for these student pilots.

Statement of the Problem

As the performance of pilots has been construed as "… a product of skill, attitude and personality factors" (Chidester, Helmreich, Gregorich, & Geis, 1991, p. 25), personnel specialists in both military and commercial aviation have worked to identify means to accurately measure the characteristics needed to be a well performing pilot (Carretta & Ree, 2003). A great deal of effort has been made to quantify these characteristics in manned aircraft pilots. However, analysis of similar characteristics of individuals interested in piloting Unmanned Aircraft (UA) remains relatively unexplored.

Contemporary efforts regarding the operations of Unmanned Aircraft Systems have focused on technological advancement and improvement. Searches of the PsycINFO, and ERIC databases, indicate a lack of extant literature regarding the normative personality traits of students pursuing studies in UAS. The results of this study will provide information valuable to interpreting the Five Factor Model (FFM) scores of individuals pioneering this career field, and may stand to further research efforts assessing the relationship between personality traits and aspects of aviation such as pilot selection, training, retention, performance, and crew coordination in UA.

Purpose of the Study

The purpose of this study was to examine the FFM personality profiles of a contemporary sample of UND UAS students. Using the Big Five Inventory (BFI) general personality index, the responses of this group were measured against a normative sample collected previously (Petros, 2013). This comparison allowed for the identification of differences and similarities between the personalities of those students interested in pursuing studies in UAS and the general population. Results of this analysis offer a foundation which may enable future studies to determine whether personality characteristics affect areas such as training success, career persistence, or crew performance for UAS pilots.

Five Factor Model of Personality

Defined by Chidester et al. (1991), personality traits are "stable, deep-seated predispositions to respond in particular ways" (p. 27). Personality is also reflected in behaviors which are relatively stable over time and consistent across situations (Chidester et al., 1991). As some of the personality research below reflects, individual traits have a tendency to vary throughout adult life as a result of maturation and social factors (Conley, 1984). However, research has demonstrated that rank ordering of personality traits remains stable over spans of up to 45 years (Conley, 1984). The history of the BFI, and the widely used Revised NEO Personality Inventory (NEO PI-R), can be traced back through several models of personality, however, both begin in earnest with the identification and development of the FFM of personality.

The FFM of personality is a hierarchical organization of personality traits in terms of five basic dimensions: neuroticism (N), extraversion (E), openness (O) to experience, agreeableness (A), and conscientiousness (C) (McCrae & John, 1992). Development of this model has its origins in lexical theory, or studies of natural language trait terms. As reviewed by McCrae and John (1992), "The lexical hypothesis holds that all important individual differences [in personality] will have been noted by speakers of a natural language at some point in [its] evolution and encoded in trait terms" (p. 186). In more simple terms, personality has been defined by such terms as friendly, high-strung, or punctual. These trait terms are the basic ways in which individuals understand themselves and others (McCrae & John, 1992). It should therefore follow naturally, that, "A complete theory of personality must ultimately explain the phenomena to which these terms refer and the ways in which they are used in everyday life" (McCrae & John, 1992, p. 186). Allport and Odbert (1936) abstracted some 4,500 trait terms from an English dictionary, and

Cattell (1946) formed these into synonym clusters. Cattell (1979) then created rating scales to contrast the different groups of adjectives, and established his 16 Principal Factors model. It was out of this work that the NEO PI-R was subsequently developed by Costa and McCrae (Costa & McCrae, 1992), and the BFI by John, Donahue, and Kentle (1991).

Some research offers there is much important variance in human behavior not accounted for by the FFM (Paunonen & Jackson, 2000). Behavior domains such as religious, manipulative, erotic, and frugal, are lacking in lexical FFM results because they are not well represented in the natural language (Paunonen & Jackson, 2000). Such research contests the lexical hypothesis in that the number of words describing a domain of behavior is not always indicative of its importance. However, even these critics acknowledge that the FFM represents prominent higher-order dimensions of individual difference which have been well encoded in the natural language (Paunonen & Jackson, 2000).

As general personality inventories, the BFI and NEO PI-R focus on identifying personality traits of the FFM (Costa & McCrae, 1992). As opposed to an aviation specific test or an inventory designed to identify pathology, these models allow for direct comparisons to the public. The NEO PI-R has been identified as the predominant measure of the FFM (Widiger & Trull, 1997), and consists of 240 statements in a self-report personality battery. However, due to the number of statements and the cost, the shorter and open source, BFI was used for this study.

In contrast to the NEO PI-R, the BFI has only 44 statements which identify the same five factors of the FFM. Both inventories allow subjects to respond to each statement (e.g. 'I often feel helpless and want someone else to solve my problems', or 'I'm a superior person') on a five point Likert scale ranging from "strongly disagree" to "strongly agree." Each subject's scores are divided into the five basic domains of neuroticism, extraversion, openness, agreeableness, and conscientiousness. The NEO PI-R then further divides each of these factors into six facets through the use of additional facet specific statements. The neuroticism factor is divided into the facets of anxiety (N1), angry hostility (N2), depression (N3), self-consciousness (N4), impulsiveness (N5), and vulnerability (N6). The extraversion factor is divided into the facets of warmth (E1), gregariousness (E2), assertiveness (E3), activity (E4), excitement-seeking (E5), and positive emotions (E6). The openness factor is divided into the factors of fantasy (O1), aesthetics (O2), feelings (O3), actions (O4), ideas (O5), and values (O6). The agreeableness factor is divided into the facets of trust (A1), straightforwardness (A2), altruism (A3), compliance (A4), modesty (A5), and tender-mindedness (A6). Finally, the conscientiousness factor is divided into the facets of competence (C1), order (C2), dutifulness (C3), achievement striving (C4), self-discipline (C5), and deliberation (C6) (Costa & McCrae, 1992; Soto & John, 2008).

As summarized by Grice and Katz (2007) the factors of neuroticism, extraversion, openness, agreeableness, and conscientiousness can be described simply as follows. The factor neuroticism contrasts emotional adjustment and stability with maladjustment such as a frequent depression or anxiety. High scores in this factor indicate maladjustment while low scores indicate emotional adjustment and stability. The factor extraversion contrasts aspects of sociability with a disposition towards introversion and independence. In this factor, higher scores indicate a tendency toward sociability. The openness factor contrasts aspects of imagination and curiosity with conventionality and obeying the rules. High scores in the openness factor indicate a more active imagination and intellectual curiosity. The agreeableness factor contrasts aspects of altruism and compliance with aspects of antagonism and egocentrism. In this factor, high scores indicate increased tendencies toward altruism and a willingness to assist others. Finally, the conscientiousness factor contrasts aspects commonly associated with character such as self-discipline and dependability with impulsivity and disorganization. High scores in consciousness are indicative of individuals who are purposeful, strong-willed, and determined.

The validity of the NEO PI-R is well documented, and its well established norms have led to its application in several studies (Boyd, Patterson, & Thompson, 2005). Briggs (1992) reviews that in the development of the NEO Personality Inventory (NEO PI), Costa and McCrae relied heavily on item and factor analysis to produce an inventory which measured the five factors as cleanly and as faithfully as possible (Briggs, 1992). In validating the NEO PI, Costa and McCrae "produced an impressive series of studies that underscore the ubiquity of the [FFM] in personality measurement" (Briggs, 1992, p. 277). The NEO PI provides a faithful representation of the FFM, along with more precisely identified facets within each factor (Briggs, 1992). Furthermore, its factor scales have proven robust across a variety of settings and have shown evidence of construct validity (Briggs, 1992). Similar reviews of the NEO PI-R reflect the findings of Briggs (1992), and relay that the NEO PI-R demonstrates consistent convergent and discriminant validity with respect to adjective checklist measures of the FFM (Widiger & Trull, 1997).

To address the need for a short instrument measuring FFM components, John, et al. (1991) constructed the BFI. The BFI consists of 44 statements and was developed to create a brief inventory which would allow efficient and flexible assessment of the five factors when there is no need for more differentiated measurement of the facets discussed above. While the BFI scales include only eight or ten items for each factor, "…they do not sacrifice either content coverage or good psychometric properties" (John & Srivastava, 1999, p. 115). In U.S. and Canadian samples, the alpha reliabilities (i.e. measures of internal consistency) of the BFI scales typically range from 0.75 to 0.90 and average above 0.80. Three month test-retest reliabilities of the inventory range from 0.80 to 0.90 and average 0.85 (John & Srivastava, 1999). While no direct comparisons will be made between the NEO PI-R and BFI scales in this study, tests have shown strong cross instrument validity correlations between the BFI and an abbreviated form of the NEO PI-R, the NEO Five Factor Inventory (NEO-FFI). Across all five factors, the convergent validity correlation between these instruments was r=0.73 (John & Srivastava, 1999).

Aviation Related Personality Research

Many exploratory research efforts have addressed the issue of identifying distinguishable personality profiles among pilot populations using the FFM of personality. While reviewing these efforts, it is essential to note that the tables are not the work of the present author, but have rather been adapted from their respective studies into a standardized format to ease comparisons and convenience for the reader.

Regarding civilian pilots.

While the applicable pool of research regarding civilian pilots is dwarfed by the efforts found among military branches, Schutte, Fitzgibbons, and Davis (2004) focused on identifying stable personality characteristics of commercial pilots. NEO PI-R scores of commercial pilots (n=93) (88 male) from 14 different airlines indicated low levels of neuroticism, high levels of extraversion, average levels of openness and agreeableness, and very high levels of conscientiousness relative to the general public (Schutte, et al., 2004). This descriptive profile generally agrees with the more inferentially grounded profiles found among military aviators below.

Regarding military pilots.

United States Navy.

Beginning the review of personality research in the military branches is the work of Campbell, Moore, Poythress, and Kennedy (2009). This study assessed whether a sample of clinically referred military aviators exhibited commonly occurring personality clusters. The NEO PI-R profiles of clinically referred United States Navy (USN) aviators and flight officers (n=956) were analyzed using model-based cluster analysis, and the emergent personality clusters were compared to clinical outcome. Two personality profiles emerged from the model-based cluster analysis, and significant differences ($p< 0.001$) in the factors of neuroticism, extraversion, agreeableness, and conscientiousness were noted. It was found that the first group (n=291) reported significantly higher scores in neuroticism and significantly lower scores in extraversion, agreeableness, and conscientiousness as compared to the second group (n=665). When the clinical outcomes of each group were analyzed, it was found that significantly ($p<0.001$) more members of Group 1 were deemed Not Aeronautically Adaptable (NAA), or not suited for flight duty, than of Group 2 (Campbell et al., 2009).

In 2010, Campbell, Ruiz, and Moore analyzed clinically referred military aviators to determine whether specific NEO PI-R facet differences were consistent with U.S. Navy guidelines concerning Aeronautical Adaptability (AA). The NEO PI-R scores of clinically evaluated USN aviators and flight officers (n=954), who were determined either AA or NAA, were compared. The results, adapted into Table 1 below, indicated significant differences ($p< 0.001$) between the AA and NAA groups for the neuroticism, extraversion, agreeableness, and conscientiousness factors, as well as differences ($p< 0.01$) in the openness factor.

Table 1. NEO PI-R Inferential Results between the Aeronautically Adaptable and Non-Aeronautically Adaptable Groups

		AA (N = 817)		NAA (N = 137)		
Domains/Facets		Mean	SD	Mean	SD	F(1,952)
NEUROTICISM	(N)					
Anxiety	(N1)	49.7	10.6	59.5	13.5	98.82**
Angry Hostility	(N2)	50.0	10.6	55.9	12.4	34.57**
Depression	(N3)	50.1	10.8	61.6	13.9	121.59**
Self-Consciousness	(N4)	50.0	10.2	56.9	11.9	51.56**
Impulsiveness	(N5)	50.1	11.0	55.3	13.5	24.75**
Vulnerability	(N6)	50.7	11.0	63.4	16.5	132.57**
EXTRAVERSION	(E)					
Warmth	(E1)	49.7	10.5	45.3	10.8	20.10**
Gregariousness	(E2)	50.0	10.2	46.3	11.4	15.12**
Assertiveness	(E3)	49.8	10.1	42.7	12.8	53.59**
Activity	(E4)	49.1	10.3	45.5	10.9	14.23**
Excitement-Seeking	(E5)	49.9	9.8	46.8	10.5	11.12**
Positive Emotions	(E6)	49.4	10.8	43.4	12.3	35.04**
OPENNESS	(O)					
Fantasy	(O1)	48.9	9.9	51.5	12.4	7.66**
Aesthetics	(O2)	49.4	9.9	51.1	11.4	3.15
Feelings	(O3)	49.5	9.9	52.0	11.1	7.31**
Actions	(O4)	50.0	9.9	47.9	10.5	5.41**
Ideas	(O5)	49.6	10.0	50.3	11.2	0.64
Values	(O6)	50.0	10.0	49.8	10.5	0.05
AGREEABLENESS	(A)					
Trust	(A1)	50.5	10.0	45.1	12.6	31.04**
Straightforwardness	(A2)	50.5	9.9	49.0	11.4	2.37
Altruism	(A3)	49.9	10.3	47.1	10.9	8.62**
Compliance	(A4)	50.0	10.3	49.8	12.6	0.04
Modesty	(A5)	50.7	10.3	54.2	11.2	13.76**
Tender-Mindedness	(A6)	50.3	9.9	52.0	10.0	3.62
CONSCIENTIOUSNESS	(C)					
Competence	(C1)	49.8	10.2	41.5	13.6	70.93**
Order	(C2)	49.7	10.0	47.0	12.6	7.60**
Dutifulness	(C3)	49.7	10.4	43.7	12.3	36.16**
Achievement Striving	(C4)	49.3	10.4	44.0	12.4	29.56**
Self-Discipline	(C5)	50.0	10.3	42.4	13.5	59.31**
Deliberation	(C6)	49.9	10.2	46.2	11.7	14.86**

** Indicates significance at the 0.01 level

Personality research conducted within the USN has indicated support for the grouping of various personality scales into five-factor models, and furthered a recommendation that such models be central in USN prediction systems (Helton & Street, 1993). Additionally, with respect to identifying personality profiles which may be incompatible with work in stressful occupations, individuals low in the neuroticism factor and high in the factors of extraversion, and conscientiousness appear to be better suited to aeronautical duties (Campbell et al., 2009; Campbell, Ruiz, et al., 2010).

United States Air Force.

Research regarding populations within the United States Air Force (USAF) reach back to 1997 and the work of King, Callister, Retzlaff, and McGlohn. First, the personality traits of male USAF student pilots (n= 103), female USAF pilots (n= 103), and female college students (n= 103) were compared on the NEO PI-R. Then, NEO PI-R scores from 91 of the male and female USAF student pilots were compared to male and female mid-career USAF pilots (n= 64 and n= 48 respectively), as well as male and female college students (n= 58 and n= 103 respectively).

Results of the first study indicated differences ($p < 0.001$) between the NEO PI-R scores of the three groups. All three groups reported significantly different scores in the neuroticism factor, the USAF males being lowest followed by the USAF females. On the openness factor, USAF males were significantly lower than both female groups. Finally, significant differences were found between all groups on the conscientiousness factor. The USAF males scoring highest, followed by USAF females (King, et al., 1997).

Regarding career level differences between both male and female pilots, results illustrated a number of gender and career level differences between subjects (King, et al., 1997). Examining gender, results indicated that female college students scored significantly higher on agreeableness and conscientiousness than their male counterparts. Among USAF student pilots, the USAF female group scored higher on the factors of neuroticism and openness, but no significant differences were found in the extraversion, agreeableness or consciousness factors. Finally, the only difference noted between the mid-career pilots was in the agreeableness factor. Here the USAF female group scored significantly higher than their male counterparts (King, et al., 1997).

In 1999, Callister, King, Retzlaff, and Marsh worked to describe normative personality characteristics of USAF pilots based on the NEO PI-R. The focus of this study was establishing normative personality characteristics to ensure valid clinical assessment. The NEO PI-R test results of USAF student pilots (n= 1,301) were aggregated and compared to both male and female adult norms. Results revealed that as a group, the USAF student pilots' scores were at least 10% higher than the general population norms in extraversion and openness, and at least 10% lower in the agreeableness factor (Callister et al., 1999).

Of the male USAF students' (n= 1,198) factor scores, extraversion was high, with agreeableness low. At the facet level, low scores were found in the vulnerability, values, trust, straightforwardness, compliance, and tender-mindedness facets, with high scores in gregariousness, assertiveness, activity, excitement-seeking, positive emotions, fantasy, feelings, actions, ideas, competence, dutifulness, and achievement striving. In the female USAF students (n= 103), factor level differences were noted in high extraversion and openness scores, and low agreeableness (Callister et al., 1999).

Boyd et al. (2005) also examined personality within the USAF, seeking to determine whether significant psychological differences could predict which USAF student pilots are selected to become fighter pilots, bomber pilots, and airlift/tanker pilots. The study linked the NEO PI-R test results of student pilots (n= 2,105) to the airframe they were later assigned. Results indicated that, in terms of the NEO PI-R, students assigned to fighters reported significantly higher scores in assertiveness, activity, conscientiousness, competence, and achievement seeking than those assigned to airlift/tankers. Students assigned to fighters also reported significantly lower scores in anxiety, self-consciousness, vulnerability, warmth, agreeableness, and tender-mindedness than those assigned to airlift/tankers. Finally, students assigned to bombers reported significantly higher scores in altruism, and tender-mindedness than those assigned to fighters. These results have been summarized in Tables 2 and 3 below, which were adapted from the works of Boyd et al. (2005).

Table 2. NEO PI-R Descriptive Results of USAF Fighter, Bomber and Airlift/Tanker Groups

Domains/Facets		Fighter (N = 870) Mean	Fighter (N = 870) SD	Bomber (N = 159) Mean	Bomber (N = 159) SD	Airlift/Tanker (N = 1076) Mean	Airlift/Tanker (N = 1076) SD
NEUROTICISM	(N)	45.81	9.49	47.16	9.27	46.76	9.32
Anxiety	(N1)	46.34	9.30	46.69	8.72	48.15	9.30
Angry Hostility	(N2)	48.37	10.40	47.63	9.72	48.02	9.72
Depression	(N3)	46.32	7.95	46.18	7.57	46.65	7.95
Self-Consciousness	(N4)	45.73	9.57	46.87	10.04	47.30	9.66
Impulsiveness	(N5)	48.05	11.28	47.80	10.46	48.55	10.81
Vulnerability	(N6)	41.30	8.52	42.08	8.49	43.21	8.42
EXTRAVERSION	(E)	57.27	9.49	58.01	10.56	57.75	9.04
Warmth	(E1)	51.12	9.65	51.04	10.54	52.39	9.25
Gregariousness	(E2)	54.77	10.04	54.57	10.61	55.46	9.86
Assertiveness	(E3)	59.23	9.06	58.02	9.63	57.20	9.03
Activity	(E4)	59.59	8.40	58.78	9.96	57.12	8.89
Excitement-Seeking	(E5)	61.73	8.53	61.51	7.87	61.23	8.21
Positive Emotions	(E6)	55.06	9.61	54.30	10.31	55.13	9.84
OPENNESS	(O)	50.70	10.93	50.67	9.32	51.06	9.90
Fantasy	(O1)	52.61	10.99	52.49	11.01	52.96	10.28
Aesthetics	(O2)	48.86	11.09	48.98	10.22	49.86	10.52
Feelings	(O3)	51.92	11.21	52.49	9.50	53.17	11.26
Actions	(O4)	52.24	10.55	54.36	9.41	52.43	10.39
Ideas	(O5)	54.85	10.71	53.86	10.46	53.85	10.42
Values	(O6)	46.46	10.82	45.10	10.00	47.33	10.37
AGREEABLENESS	(A)	43.45	11.03	44.94	11.07	45.33	10.66
Trust	(A1)	50.48	10.15	49.67	11.08	50.17	10.47
Straightforwardness	(A2)	48.64	10.01	48.53	10.63	48.13	10.33
Altruism	(A3)	51.67	10.14	54.03	9.84	52.80	10.26
Compliance	(A4)	46.01	11.80	46.96	12.02	47.16	10.93
Modesty	(A5)	46.72	10.50	47.13	12.18	47.75	10.66
Tender-Mindedness	(A6)	45.35	10.24	48.01	9.46	46.60	10.05
CONSCIENTIOUSNESS	(C)	55.39	10.20	55.51	9.97	53.83	10.02
Competence	(C1)	56.81	8.86	54.91	8.68	55.06	9.04
Order	(C2)	50.21	10.46	51.57	10.68	50.41	10.87
Dutifulness	(C3)	52.89	8.82	54.14	8.67	52.07	9.19
Achievement Striving	(C4)	60.22	9.15	60.29	9.85	57.95	9.40
Self-Discipline	(C5)	53.07	9.53	53.09	8.08	52.01	9.60
Deliberation	(C6)	50.32	10.35	51.17	9.14	50.47	10.09

Table 3. NEO PI-R Inferential Results between USAF Fighter, Bomber, and Airlift/Tanker Groups

Domains/Facets		Fighter vs Airlift Tanker Mean Difference	P†	Fighter vs Bomber Mean Difference	P†
NEUROTICISM	(N)	0.094	0.083	1.349	0.288
Anxiety	(N1)	1.802	0.000*	0.345	1.000
Angry Hostility	(N2)	0.361	1.000	0.751	1.000
Depression	(N3)	0.329	1.000	0.139	1.000
Self-Consciousness	(N4)	1.569	0.002*	1.145	0.637
Impulsiveness	(N5)	0.497	1.000	0.254	1.000
Vulnerability	(N6)	1.916	0.000*	0.781	0.994
EXTRAVERSION	(E)	0.474	0.798	0.732	1.000
Warmth	(E1)	1.269	0.014*	0.008	1.000
Gregariousness	(E2)	0.688	0.431	0.201	1.000
Assertiveness	(E3)	2.027	0.000*	1.216	0.478
Activity	(E4)	2.472	0.000*	0.814	0.992
Excitement-Seeking	(E5)	0.502	0.601	0.224	1.000
Positive Emotions	(E6)	0.007	1.000	0.769	1.000
OPENNESS	(O)	0.368	1.000	0.003	1.000
Fantasy	(O1)	0.351	1.000	0.117	1.000
Aesthetics	(O2)	1.006	0.139	0.126	1.000
Feelings	(O3)	1.241	0.055	0.568	1.000
Actions	(O4)	0.193	1.000	2.121	0.095
Ideas	(O5)	1.007	0.128	0.991	0.965
Values	(O6)	0.869	0.238	1.365	0.514
AGREEABLENESS	(A)	1.877	0.000*	1.494	0.331
Trust	(A1)	0.307	1.000	0.805	1.000
Straightforwardness	(A2)	0.502	0.897	0.106	1.000
Altruism	(A3)	1.139	0.054	2.365	0.044*
Compliance	(A4)	1.157	0.090	0.956	1.000
Modesty	(A5)	1.033	0.123	0.408	1.000
Tender-Mindedness	(A6)	1.249	0.026*	2.660	0.017*
CONSCIENTIOUSNESS	(C)	1.554	0.002*	0.122	1.000
Competence	(C1)	1.742	0.000*	1.898	0.078
Order	(C2)	0.197	1.000	1.357	0.549
Dutifulness	(C3)	0.819	0.165	1.250	0.437
Achievement Striving	(C4)	2.270	0.000*	0.006	1.000
Self-Discipline	(C5)	1.057	0.055	0.002	1.000
Deliberation	(C6)	0.146	1.000	0.847	1.000

† p-value: Bonferroni α adjustment for multiple comparisons
* Indicates significance at the 0.05 level

Continuing the analysis of personality differences with respect to gender, career, and platform assignment, Chappelle, Novy, Sowin, and Thompson (2010) evaluated the NEO PI-R scores of USAF female pilots, USAF male pilots, and non-pilot females in the civilian population. Data for this study was collected from female and male USAF pilots (n= 512 and n= 9,630 respectively). Within the sample of female USAF pilots, 58 were classified as fighter/bomber pilots, 335 were tanker/transport pilots, 38 were classified as reconnaissance pilots, 12 were helicopter pilots, and 69 were instructor pilots. Results revealed that the NEO PI-R personality profiles of female USAF pilots are closer to those of male USAF pilots than to non-pilot females in the civilian population. With regard to differences in personality according to aircraft assignment, no significant differences were discovered between the personality profiles of female USAF pilots operating different airframes (Chappelle, Novy, et al., 2010).

Also in 2010, Chappelle, McDonald, and King consolidated data from several Subject Matter Experts (SMEs) regarding attributes needed to successfully complete training and adapt to the operational demands of the Sensor Operator (SO) position in the MQ-1 Predator, and MQ-9 Reaper. Data for this study was collected from UAS SMEs (n= 69) including, 47 MQ-1 Predator and MQ-9 Reaper pilots, 16 SOs, and six mission intelligence coordinators. Within the responses of these SMEs, four domains were identified including (1) physical health, (2) cognitive ability, (3) personality traits, and (4) motivation. Within cognitive ability, SMEs perceived that SOs with high levels of the following aptitudes performed well and adapted more readily to the rigors and unique demands of UAS platforms, Cognitive Proficiency, Visual Perception, Attention, Spatial Processing, Memory, and Reasoning. It was perceived that SOs without adequate levels of these aptitudes struggled with timely skills acquisition, task management and prioritization, situational awareness, channelized attention, and general problem solving (Chappelle, McDonald et al., 2010).

With regard to personality traits, the SMEs identified the following non-cognitive capabilities and traits which they perceived affected SO duty performance and adaptation to the unique nature of UAS operations, Composure, Resilience, Self-Certainty, Conscientiousness, Success Orientated, Perseverance, Decisiveness, Humility, Cohesiveness, Assertiveness, and Adaptability (Chappelle, McDonald et al., 2010).

Finally, Barto, Chappelle, King, Ree, & Teachout, (2011) compared NEO PI-R scores of a large USAF pilot sample to those of commercially published norms to support the use of both sets of norms in clinical evaluation. USAF pilot training candidates (n= 12,702) were sampled prior to their admission to Specialized Undergraduate Pilot Training (SUPT). Results indicated substantial mean differences between the pilot sample and the normative data for the neuroticism, extraversion, agreeableness, and consciousness factors. Subjects in the pilot group scored lower on neuroticism and agreeableness, and higher on extraversion, openness and consciousness (Barto et al., 2011). Of particular note was that female pilots scored much higher on extraversion and openness than their normative counterparts, which was consistent with the findings of Chappelle, Novy, et al., (2010). The significant differences between pilots and the normative population suggest that USAF pilots are a highly selected group and "that clinical evaluations might be quite different if only the normative population was used as a comparison group" (Barto et al., 2011, p. 12). Other research has indeed concluded that highly selected and trained aviators should be compared to other aviators rather than the general population (King, 1994).

Studies of personality in the USAF further solidify the concept that significant personality differences can be noted, not only between pilot populations and normative samples, but also across aircraft assignment, gender, and career. Furthermore, highly selected and trained aviators should be clinically assessed against other aviators, rather than the adult norm (King, 1994).

United States Army.

Grice and Katz (2007) examined the NEO PI-R profiles of U.S. Army student aviators awaiting Initial Entry Rotary Wing Training, and compared them to a sample of U.S. Army aviators. With the purpose of identifying personality differences and similarities between the groups, male U.S. Army student aviators (n= 196) and U.S. Army career pilots (n= 75) were compared to one another as well as normative personality scales.

Regarding the personality profiles of the male U.S. Army student aviators, it was found that this group was higher than average in the extraversion factor, average in the neuroticism, openness, and conscientiousness factors, and lower than average in the agreeableness factor as compared to the normative sample (Grice & Katz, 2007). This profile, "… suggests that these student aviators, although outgoing and assertive, are more concerned with individualism and improving individual competence than maintaining social relationships that consume their time and energy" (Grice & Katz, 2007, p. 18).

Methodology

Five Factor Model personality profiles of UND UAS students were examined using the BFI general personality index in the fall semester of 2013. Responses of this group were compared against a normative sample of college students previously collected (Petros, 2013). This comparison allowed for the identification of differences and similarities between those students interested in pursuing studies in UAS and the general population.

Carretta and Ree (2003) caution against several methodological issues associated with studies of personnel measurement and selection. Here, the issues most applicable are those of construct and statistical power. While the alpha reliabilities of the BFI scales are well established (John & Srivastava, 1999), concern for statistical power, or the ability of their tests to detect an effect of a particular size (Field, 2009), in this area of study is well placed. The present study entertained statistical power no less than 0.8, and significance at $p< 0.05$. For these values, a sample of 85 subjects should be sufficient to detect differences with a medium effect size ($r=0.3$), and a sample of 28 subjects should detect differences with a large effect size ($r=0.5$) (Cohen, 1992).

Population

The population for this study consisted of students enrolled as either Pre UAS Operations, or UAS Operations majors at UND (N= 123). Of this population, 42 students (41 males) are Pre UAS Operations, and 81 (75 males) have declared UAS Operations as either their first or second major. (Office of Institutional Research, 2013) Subject responses were not separated by race or gender in this study.

Sample

Of the 123 students with either Pre UAS Operations, or UAS Operations declared as a first or second major, 65 responses were gathered into the UAS Student sample for a 52.84% response rate. The average age of respondents was 22.14, and no responses to the BFI were excluded from analysis. A second sample, collected previously (Petros, 2013), was used as a control group and consisted of BFI responses from 248 individuals. Unlike the UAS Student sample, scores for several FFM factors were excluded from analysis in this group due to incompleteness. Specifically, 237 responses were included in the Normative sample's neuroticism score, 234 were included in the extraversion factor score, 235 were included in the openness factor score, 234 were included in the agreeableness factor score, and 233 were included in the conscientiousness factor score. Given these samples, research results will carry limited generalizability beyond the University of North Dakota.

Data Collection and Analysis

This study was reviewed and approved by the University of North Dakota's Institutional Review Board on August 20th, 2013 as IRB Project IRB-201308-047. Subjects were informed of this study during short presentations to the Aviation 226 Introduction to UAS, Aviation 331 Systems of Unmanned Aircraft, Aviation 332 UAS Ground Control Systems, Aviation 333 UAS Sensor Systems, Aviation 334 UAS Communication and Telemetry Systems, and Aviation 338 UAS Operations classes. Advertisements were also posted throughout the on campus aerospace facilities targeting students enrolled as either a Pre UAS Operations, or UAS Operations major. Subjects were briefed on the purpose and nature of the study both in the classroom presentations and prior to receiving the survey.

The Big Five Inventory (BFI) was made available for completion during class visits as well as during two one hour time slots. The instrument was distributed to and collected from subjects by the author and subject responses were kept anonymous. Because no identifying information was collected, response independence (i.e. the submission of a single response set from each participant) must be assumed. The duration of subject participation did not extend beyond completion of the BFI, and no compensation was provided. Following collection, respondents' scores were aggregated and stored for analysis on a password protected drive, encrypted using Advanced Encryption Standard (AES) algorithms.

Using SPSS 21 statistics software, descriptive and inferential statistics were collected from the data. The means, standard deviations, minimum, maximum, range, and measures of skewness and kurtosis indices were calculated using the raw scores from each of the groups. A one-way Analysis of Variance (ANOVA) assessed potential relationships between the independent variables (sample group) and the dependent variables (BFI factor scores). Significance in all statistical tests were set at a minimum of $p < 0.05$, though significance above $p < 0.01$ and $p < 0.001$ were denoted when necessary.

Results

Comparison of Descriptive Statistics

As illustrated in Table 4, descriptive statistics for the UAS Student sample show mean scores of 2.24 for neuroticism, 3.35 for extraversion, 3.57 for openness, 3.94 for agreeableness, and 4.02 for conscientiousness. Standard deviations for the same sample were 0.61 for neuroticism, 0.76 for extraversion, 0.51 for openness, 0.60 for agreeableness, and 0.46 for conscientiousness.

Also included in Table 4 are z-scores for both the skewness and kurtosis of each factor's score distribution. For these measures, absolute values greater than 1.96 indicate significantly non-normal distributions at $p<0.05$, scores greater than 2.58 are significantly non-normal at $p<0.01$, and absolute values above 3.29 are significantly non-normal at $p<0.001$ (Field, 2009). All factor score distributions for the UAS Student sample failed to differ significantly from a normal distribution in either skewness or kurtosis.

Table 4, BFI Descriptive Results of UAS Student and Normative Sample Groups

Domains/Facets		N	Mean	SD	Minimum	Maximum	Z skewness	Z kurtosis
NEUROTICISM	(N)							
UAS Student Sample		65	2.24	0.61	1.00	3.63	0.13	-0.79
Normative Sample		237	2.89	0.55	1.38	4.25	-1.21	-1.25
EXTRAVERSION	(E)							
UAS Student Sample		65	3.35	0.76	1.88	4.63	-0.88	-1.56
Normative Sample		234	3.34	0.71	1.25	5.00	1.29	-0.10
OPENNESS	(O)							
UAS Student Sample		65	3.57	0.51	2.50	4.70	-0.81	-1.19
Normative Sample		235	3.36	0.53	2.10	4.90	2.42*	-0.56
AGREEABLENESS	(A)							
UAS Student Sample		65	3.94	0.60	2.44	5.00	-1.39	-0.72
Normative Sample		234	3.80	0.60	2.22	5.00	-1.64	-1.62
CONSCIENTIOUSNESS	(C)							
UAS Student Sample		65	4.02	0.46	3.00	4.89	0.52	-1.27
Normative Sample		233	3.65	0.55	2.33	5.00	0.19	-2.20*

* Indicates significance at the 0.05 level

Descriptive statistics for the Normative sample, also illustrated in Table 4, show mean scores of 2.89 for neuroticism, 3.34 for extraversion, 3.36 for openness, 3.80 for agreeableness, and 3.65 for conscientiousness. Standard deviations for the same sample were 0.55 for neuroticism, 0.71 for extraversion, 0.53 for openness, 0.60 for agreeableness, and 0.55 for conscientiousness.

As with the UAS Student sample, z-scores were calculated for the skewness and kurtosis of factor score distributions in the Normative sample. While scores in the openness factor were significantly non-normal with respect to skew at $p<0.05$, it should be noted that large samples (e.g. 200 or more) will often give rise to small standard errors, resulting in significantly non-normal values from even small deviations in normality (Field, 2009). In such cases, a maximum threshold of 3.29 and visual examination of the distribution are considered better criterion (Field, 2009). Visual inspection of this distribution, as well as the significantly ($p<0.05$) non-normal kurtosis score of the conscientiousness factor, did not raise concern for non-normality in the Normative sample.

Comparison of Means

Results of the one way ANOVA comparing the scores of both groups for each factor are illustrated in Table 5. Significant differences were found in three of the FFM factors analyzed, neuroticism, openness, and conscientiousness. The UAS Student sample was found to have scored lower ($p<0.001$) in neuroticism, higher ($p<0.01$) in openness, and higher ($p<0.001$) in conscientiousness than the Normative sample.

Table 5, BFI Inferential Results between UAS Student and Normative Sample Groups

Domains/Facets		UAS Student Sample		Normative Sample		
		Mean	SD	Mean	SD	P
NEUROTICISM	(N)	2.24	0.61	2.89	0.55	0.000***
EXTRAVERSION	(E)	3.35	0.76	3.34	0.71	0.987
OPENNESS	(O)	3.57	0.51	3.36	0.53	0.004**
AGREEABLENESS	(A)	3.94	0.60	3.80	0.60	0.088
CONSCIENTIOUSNESS	(C)	4.02	0.46	3.65	0.55	0.000***

* Indicates significance at the 0.05 level
** Indicates significance at the 0.01 level
*** Indicates significance at the 0.001 level

Discussion

Interpretation of personality results necessitates a familiarity with the basics of psychological testing, what aspects of personality the instrument measures, and the ability to integrate scale score information into a meaningful profile (Costa & McCrae, 1992). The tendency to think in terms of types or categories should be avoided. For example, while it is convenient to think of introverts and extroverts, the FFM extraversion scale represents a continuous dimension and "… most individuals would be best described as 'ambiverts,' that is, showing a combination of introverted and extraverted tendencies" (Costa & McCrae, 1992, p. 13). With these considerations in mind, there is no single cutoff point designating between individuals who have and do not have a given trait. Scoring average on a factor scale can be just as informative as scoring high or low. When cutoff points are needed for a particular application, they should be established empirically and only applied to the specific purpose for which they were intended (Costa & McCrae, 1992).

Given this lack of strict dichotomy, it logically follows that raw FFM score responses carry limited meaning (Costa & McCrae, 1992). Only when compared to the responses of others do scale score responses become valuable. This comparison among personality profiles is what enables meaningful relationships between groups.

Personality Traits of UND UAS Students

The personality traits and tendencies of those individuals pursuing UAS studies at the University of North Dakota are outlined according to each factor below. While primary interest is with respect to the Normative sample (Petros, 2013), these traits are also informally compared with many of the FFM scores of professional aviation groups outlined above.

Neuroticism.

In neuroticism, the most pervasive domain of the FFM scales, the UAS Student sample scored significantly lower than individuals in the Normative sample. Recalling that this factor contrasts emotional stability against maladjustment or the tendency toward negative affects, this score indicates that students pursuing UAS studies are usually calm, even-tempered, and relaxed. They are able to face stressful situations without becoming upset or rattled, and are generally more emotionally stable than members of the Normative sample (Costa & McCrae, 1992).

The UAS Students' relatively low score in neuroticism parallels the majority of findings for that trait among other aviators. Schutte, et al. (2004), found that 60% of the commercial pilots in their study scored low or very low in this factor. In military aviators, model-based cluster analysis discovered two personality profiles among clinically referred aviators. The group scoring significantly lower in neuroticism was found to contain significantly more members deemed Aeronautically Adaptable (Campbell et al., 2009). A second study on naval aviators found that Aeronautically Adaptable individuals scored significantly lower in every facet of neuroticism than individuals deemed Non-Aeronautically Adaptable (Campbell, Ruiz, et al., 2010). In King, et al. (1997) USAF student pilots were found to be significantly less neurotic than a sample of female college students. Again in 2010, USAF female pilots were found to be significantly less neurotic than a normative female sample (Chappelle, Novy, et al., 2010).

Overall, the personality traits of the UAS Student sample display a high degree of congruency with traits documented among other aviation students and professionals. This tendency to be calm, even-tempered, and relaxed, as well as the ability to face stress without becoming upset is also well aligned with the attributes composure and resilience identified by Chappelle, McDonald, et al. (2010) as traits affecting duty performance and adaptation to the unique nature of UAS operations.

Extraversion.

With respect to extraversion, there was a lack of significant difference between individuals of the UAS Student and Normative samples. This would indicate that members of the UAS Student sample display similar tendencies toward assertiveness, activity, and sociability as the Normative sample. As noted above, however, average scores on a factor scale can be just as informative as scoring high or low. This is especially true as this result is considered alongside extraversion scores documented among the majority of aviators reviewed above. With the exception of King, et al. (1997), most studies found their respective aviation samples exhibiting higher degrees of extraversion than their normative or Non-Aeronautically Adaptable samples (Barto et al., 2011; Callister et al., 1999; Campbell et al., 2009; Campbell, Ruiz, et al., 2010; Chappelle, Novy, et al., 2010; Grice & Katz, 2007; Schutte, et al., 2004). The UAS Student results indicate an aviation population exhibiting the same degree of extraversion as their normative sample.

A lack of significant difference between the UAS Student and Normative samples is a noteworthy break from many of the personalities documented among other aviators, both civilian and military. Though an informal comparison in this study, this tendency to display more introverted traits may distinguish individuals interested in UAS from their manned aviation peers.

Openness.

Within the openness scale, the UAS Student sample showed significantly higher scores than the Normative sample. Indicating that, as a group, these individuals display a relatively more active imagination, aesthetic sensitivity, attentiveness to inner feelings, preference for variety, and intellectual curiosity (Costa & McCrae, 1992). Open individuals are willing to entertain novel ideas and unconventional values, and display a willingness to question authority. Openness scores are modestly associated with both educational and measured intelligence, and are especially related to aspects of intelligence which contribute to creativity. The scores of the UAS Student sample in this trait relative to the Normative sample again depart from the relative scores of many other aviation students and professionals. The openness trait of many aviators examined above do not differ from their respective normative or Non-Aeronautically Adaptable samples, (Campbell et al., 2009; Grice & Katz, 2007; Schutte, et al., 2004). Interestingly, Campbell, Ruiz, et al. (2010) found scores of their Non-Aeronautically Adaptable sample to be significantly higher in openness than members of their Aeronautically Adaptable group, while several USAF studies discovered higher openness scores in USAF samples than the normative sample (Barto et al., 2011; Callister et al., 1999; Chappelle, Novy, et al., 2010; King, et al., 1997). Clearly, responses for the openness trait vary throughout the aviation industry and military branches. Explanation for this variety may be revealed within the higher resolution facet scores not examined by the BFI or this study.

The increased tendency of the UAS Student sample toward openness is perhaps not surprising given the emerging nature of the UAS industry. Students pursuing this degree program would be entering into profession teeming not only with novel concepts of aircraft and their capabilities, but also of unconventional modes of compliance with existing regulations both before and after these aircraft are integrated into the National Airspace System (NAS).

Agreeableness.

In agreeableness, the UAS Student sample did not differ significantly from members of the Normative sample. This indicates that members of the UAS Student sample share similar interpersonal tendencies with individuals of the Normative sample. Both are equally altruistic, sympathetic to others, and equally willing to assist with the belief that assistance will be offered in return (Costa & McCrae, 1992). This similarity with the normative sample was shared in the traits of aviators (King, et al., 1997; Schutte, et al., 2004). However, Aeronautically Adaptable USN aviators were found to display higher agreeableness than their NAA counterparts (Campbell, Castaneda, & Pulos, 2010; Campbell et al., 2009), and many USAF and US Army pilots were found to be less agreeable than their normative counterparts (Barto et al., 2011; Callister et al., 1999; Chappelle, Novy, et al., 2010; Grice & Katz, 2007).

While responses of aviators in agreeableness, like openness scores, display a wide variance compared to normative samples, a dichotomy between civil and military operations seems to be present. Indeed, it is noted that while, “It is tempting to see the agreeable side of this domain as both socially preferable and psychologically healthier … [it] is not a virtue on the battlefield or in the courtroom” (Costa & McCrae, 1992, p. 15). Low degrees of agreeableness may be advantageous in single pilot military operations, while more normative degrees may be better suited for the interactions and resource management found in crewed and civil operations. The cohesiveness and humility traits identified as critical to the operational performance of MQ-1 and MQ-9 sensor operators (Chappelle, McDonald et al., 2010), lends support to the concept that higher relative scores in agreeableness may be desirable in crewed UAS environments.

Conscientiousness.

The UAS Student sample exhibited significantly higher scores in conscientiousness, indicating individuals who are purposeful, strong-willed, and determined. These characteristics, coupled with high scores in openness in particular, implicate a tendency toward higher academic and occupational achievement (Costa & McCrae, 1992). Several of the traits found among Chappelle, McDonald, et al. (2010) critical traits for operational performance of MQ-1 and MQ-9 sensor operators, such as self-certainty, consciousness, and success orientated, seem to encourage high degrees of consciousness. Furthermore, relatively high degrees of this trait are also commonplace among other aviators (Barto et al., 2011; Campbell et al., 2009; Campbell, Ruiz, et al., 2010; King, et al., 1997; Schutte, et al., 2004).

Conclusion and Future Studies

The performance of pilots has been construed as the product of skill, attitude and personality factors (Chidester, et al., 1991), personnel specialists in both military and commercial aviation have worked for decades to identify means to accurately measure the characteristics needed to be a well performing pilot (Carretta & Ree, 2003). Extant literature regarding the personality traits of manned pilots generally offers that individuals scoring relatively low in neuroticism and high in the factors of extraversion, and conscientiousness appear to be better suited to aeronautical duties.

The purpose of this study has been to examine these same FFM personality traits in a contemporary sample of students with either Pre UAS Operations, or UAS Operations declared as a first or second major. Using the BFI general personality index, responses of a UAS Student sample (n=65) were compared to a Normative sample (n=248). Results indicated that the UAS Student sample scored significantly lower in neuroticism ($p<0.001$), significantly higher in openness ($p<0.01$), and significantly higher in conscientiousness ($p<0.001$) as compared to individuals in the Normative sample. This UAS student personality profile of relatively low scores in neuroticism, and relatively high openness and conscientiousness scores is similar to the relatively low neuroticism and relatively high extraversion, and conscientiousness profile of individuals previously identified as better suited for aeronautical duties. Differences distinguishing between these generalized profiles are found in the extraversion and openness factors. Based on these differences, one might hypothesize that relative to their manned counterparts, those students pursuing careers in UAS are similar in their neurotic, interpersonal, and achievement-oriented tendencies, but are distinguishable by their tendency toward introversion and openness to experience.

Recommendations for future research include application of the NEO PI-R for assessment of facet traits within the FFM domains. Greater resolution within FFM factor scores may better illuminate commonalities and differences among traits such as the facet scores of openness, which displays mixed results when aggregated at the factor level. As highly selected and trained aviators should be clinically assessed against one another or other aviators (King, 1994), the exploration of FFM personality traits within individuals, both civil and military, who have completed training for the operation of UAS, as well as between those individuals and a contemporary sample of their manned aviation peers, is recommended.

The measurement of personality, particularly instruments measuring FFM traits, has had a small but valid place in the composition of pilot selection methods in the U.S. military. Contemporary works (Carretta, 2011) even vouch for its importance as selection methods are refined for future use. As subtle differences between the personality profiles of manned and unmanned pilots are explored and mapped, a foundation will be provided on which these personnel selection methods can be developed. Furthermore, it will allow for the assessment of relationships between personality and areas such as training success, career persistence, or crew performance within the new and exciting industry of UAS.

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