Fall 2015, Volume 37, Issue No. 2 • ISSN 1068 5901

ATEC JOURNAL

ABOUT THE ATEC JOURNAL

The ATEC Journal (ISSN 1068-5901) is a peer-reviewed publication published twice a year by ATEC. The Journal provides an opportunity for educators, administrators, students and industry personnel to share teaching techniques and research. Authors are encouraged to submit their articles for publication consideration, whether scholarly, research, application, or opinion.

Submission deadlines are as follows:

- Spring Issue Closing Date: April 1
- Fall Issue Closing Date: October 1

ATEC JOURNAL PEER REVIEW POLICY

The ATEC Journal is a scholarly peer-reviewed/refereed publication targeted at the aviation maintenance industry. The Journal is focused on assessing developments in the areas of aviation maintenance education, curriculum, pedagogy, FAA certification and technological innovations affecting the maintenance industry. The Journal welcomes submissions reflecting the latest industry and academic thought in these areas. As a refereed publication, submissions will be subjected to a single-blind review by members of the editorial board and a limited number of professionals with expertise in the relevant field. The guidelines below describe the criteria for publication, explain the review process, and detail how to submit an article for review.

CRITERIA FOR PUBLICATION

To be published in the ATEC Journal the article must:

- Provide strong evidence for its conclusions,
- Be of interest to educators, researchers and/or those in the aviation maintenance industry,
- Assess unique or novel issues in a way that is likely to influence thinking in the field, and/or
- Introduce innovations in teaching or practical project application.

REVIEW PROCESS

The editorial board evaluates submissions to determine whether the general criteria for publication are satisfied and whether an article warrants formal review and publication. The process consists of a single-blind peer review by members of the editorial board and professionals possessing the requisite education and experience in the relevant field. Each article will be reviewed by at least two editorial board members. The author's identity will be known to the editor but will remain anonymous to other board member referees to ensure an impartial assessment. The referees will evaluate the strengths and weaknesses of a submission and provide those to the editor. On the basis of those comments, the editor will accept or reject a submission, or request that the author make revisions before publication. All papers that are reviewed and approved for presentation at the ATEC annual meeting will be published in the journal.

EDITORIAL BOARD

HOW TO SUBMIT AN ARTICLE FOR REVIEW

Authors should upload their submission by utilizing the online submission form. Submissions shall include the following:

- Cover letter identifying the author(s), contact information, institutional affiliation and a brief description of the author(s) education and experience.
- Abstract of the article.
- Article.
- Data and supporting materials.

Authors are responsible for anonymizing their article by removing all personally identifiable information from the abstract, article and supporting documents. To facilitate electronic review of the submission, all documents should be uploaded in a single combined PDF.

ADVERTISING OPPORTUNITIES

For each semi-annual ATEC Journal distribution:

- Half page: $125
- One page: $250
- Two pages: $350

Combo Package

Includes ad inclusion in 12 monthly distributions of ATEC News, the council's monthly e-newsletter, and two semi-annual ATEC Journal distributions, price varies based on Journal ad size selection:

- Half page: $750
- One page: $800
- Two pages: $1000

To advertise, submit the online advertising plan purchase form.

ABOUT ATEC

The Aviation Technician Education Council (ATEC) was founded in 1961 to further the standing of FAA approved schools with education and industry, and to promote mutually beneficial relations with all industry and government agencies. The Council's mission is to advocate for aviation maintenance schools in the areas of curriculum improvement, technical and financial support, while promoting mutually beneficial relations with related government and industry groups.

BUSINESS OFFICE STAFF

Crystal Maguire, Business Manager
Brett Levanto, Communications Manager
Daniel Fisher, Legislative Affairs Manager
Jennifer Kitching, Finance Manager
Eleesha Jackson, Senior Administrative Specialist
Sarah Hartley, Communications Coordinator

117 North Henry Street, Alexandria VA 22314-2903

atec@atec-amt.org, 703-548-2030

More than an A&P: Aviation Related Courses that Exceed the Regulatory Requirements

Terry Michmerhuizen,
College of Aviation, Western Michigan University

Abstract

Anyone desiring to become an aviation technician has various paths by which he/she can acquire the necessary skills to obtain FAA certification as an Airframe and Powerplant mechanic. The first decision that must be made is whether to choose formal training from a Part 147 approved school, or informal "on the job" (OJT) training working under the guidance of a certificated mechanic. (Reference 14 CFR 65.77) After that decision is made, more choices follow. If the choice is OJT, do they want only an Airframe or Powerplant certificate? Either one requires 18 months of verifiable work under approved oversight. If the goal is to obtain both certificates, then the total documented work time required is 30 months. On the other hand, if the choice is made to attend a more formal training classroom environment, there are at least three options for the candidate to consider. (Attachment 1)

- Certificate only school (typically 12-16 months)
- Certificate plus an associate degree (typically 24 months)
- Certificate plus a bachelor's degree (typically 48 months)

Any educational institution has the responsibility of assisting any prospective student to understand the benefits and the limitations of these options. Some of these variables would be:

- Cost of education
- Length of education
- Probable initial employment positions
- Possible subsequent employment positions

Although the first two of these are pretty straight forward and objective, they will vary significantly based upon what type of educational institution the aspiring technician has chosen. The third bullet point regarding probable positions for initial employment is more subjective, and can vary depending on student GPA, regional hiring demand, and internship opportunities. In spite of these variables, most traditional age students will graduate from any one of the three bulleted school options listed above, and enter the aviation maintenance workforce as an entry level technician.

It is the fourth bullet that identifies the possible subsequent employment positions that has the greatest variation. Although specific employment requirements will vary depending on the actual company involved, it is generally accepted that a maintenance technician who also has a bachelor degree will have greater potential for movement within a company than one without a four year degree. This paper will identify four aviation related courses in our curriculum that exceed the requirements set by the FAA in Part 147, and will focus solely on the course requirements and learning outcomes of AVS 4900 (Senior Project I) and 4910 (Senior Project II).

AVS Course numbers, names, credit hours and catalog descriptions of the additional courses

AVS 3190 - Aviation Law (3 credit hours)
Legal principles governing the aviation industry. Historical precedents, regulatory statutes, standards, contracts, liability and insurance, current developments and court decisions.

AVS 4620 - Reliability, Maintainability and Supportability (3 credit hours)
Aircraft reliability, maintainability and supportability (RMS) are examined. Methods of incorporating reliability and maintainability into aircraft design are discussed. Support requirements and the economic impact of maintenance on life cycle costs are covered.

AVS 4900 - Senior Project I – Planning (1 credit hour)
First course of a two-semester sequence. Students work in teams on approved projects. Class discussion will include problem definition, project planning, task scheduling, ethics, and decision impact analysis. Use of case studies will add to the students' understanding of real world situations.

AVS 4910 - Senior Project II – Analysis (2 credit hours)
Second course in the two-course senior project. Solutions proposed for the problem identified in Senior Project I will be fully researched by the same team. This investigation will include ethical, financial, legal and environmental concerns. Written and oral status reports are required along with a formal report and professional presentation. Interaction with faculty and industry mentors is also necessary.

Overview of Senior Projects I & II

This is a series of two courses in which the student is required to develop, plan, manage, conduct and document a project of his/her design. The project may involve physically constructing a training aid, conducting a research project, or doing a practical project for an outside company or intra-college entity such as aircraft fleet maintenance, flight line operations etc.

The combination of classes provides an opportunity for students to showcase the knowledge and skills they have gained in the College of Aviation Maintenance program and their University experience. Planning and management of the project are key elements of the course and are as important as producing the deliverable project. As such, a portion of the grade is based on how well they communicate and document their project.

Senior Project I is the course in which a project is developed and a formal plan written which describes and details the project.

Senior Project II is the course in which the project is conducted in accordance with the plan and a final report written and formal presentation given.

These two courses together fulfill the Proficiency 2, Baccalaureate Level Writing requirement* so significant emphasis is placed on proper writing technique, form, and mechanics.

The learning outcomes of these two Senior Project courses are that a student:

- can develop a realistic plan for a complex project which defines the tasks, resources and time required for completion.
- can coordinate with others and effectively work in a team environment to complete a complex task.
- can manage time and resources to complete a project within the natural constraints of the environment.
- can conduct a project in accordance with a prescribed plan.
- can demonstrate the use of proper technical writing skills to document activities, outcomes, and lessons learned in the conduct of a project.
- can handle changes in job scope and complexity

Student Requirements for Senior Project I

Team Size and Project Definition

Students form their own teams of two or three individuals, usually based upon their existing friendship, or a common interest in a particular project area. On occasion a student may be allowed to work solo, but the preference, based upon the team concept prevalent in industry is for a multi-person team. Once formed, the team must identify a problem that exists, and provide three options as possible solutions. They are then required to select one of their three choices as the optimal solution and it becomes the basis for their project.

*** Writing Courses (Proficiencies 1 & 2)**

Writing courses which satisfy proficiency requirements should work to develop students' ability to express themselves effectively in writing. Baccalaureate-level, advanced, or writing-intensive courses should reinforce the skills acquired in college-level courses and should promote maturity as a writer. They should further the ability to analyze and evaluate writing, the ability to construct and develop a point or idea, the ability to develop organized paragraphs and use appropriate transition devices, and the ability to employ the grammatical and mechanical conventions of standard written English. Instructors and departments will be responsible for determining the format, modes of presentation, technical vocabulary, and research or bibliographic conventions appropriate for writing in their respective disciplines. (WMU General Education Policy, Revised Fall 2012)

Project Proposal

The team will develop a project and submit a formal written proposal for the project. The proposal must include the following:

- A description of the project with enough detail so it can be evaluated for feasibility, complexity, and appropriateness.
- Rationale for why the project was chosen, and what they hope to learn from it.
- A list of the students who will work on the project.

After review, the proposal will either be approved or it may be returned to them for additional information, clarification or correction as necessary. When the proposal is finally approved the next step is to begin developing the Project Plan.

Project Plan

The plan must include at least the following information.

- Project Description: A detailed description of the project. This should include a narrative description as well as any drawings, pictures or anything else that helps to clearly define the project.
- Bill of Materials with Budget estimate: A bill of materials will include the things that are needed to make or complete the project. It may be raw material (steel tubing, sheet metal, wire etc.), parts (purchased from a vendor), consumables (welding gas, paint, etc.) or any other materials needed. An itemized cost estimate for these materials must also be provided. This should be as accurate as possible, and therefore the student may have to contact suppliers, research catalogs, or go to local supply houses to get real information. If estimates are necessary, they should be based on some realistic data and it should be clearly indicated that they are estimates. A total budget for the project will be calculated.
- Labor: This is an estimate (in man hours) for completion of the project and must be broken down by the major tasks as shown on a Gantt chart.
- Schedule: A Gantt chart will be used for scheduling major activities of the project and completion dates of these activities and the entire project. Each activity in the Gantt chart should be reflected in the labor estimate.

- Control Method: This will pertain to projects that are being conducted by teams. When multiple people are working on a single project there must be a method of controlling the activities so that each person knows what to do and that progress is being made. The team must establish how this will be accomplished and include this in the plan. Suggested techniques include; selecting a manager, having regular meetings and recording minutes, keeping a journal, assigning specific tasks, establish a "suspense file" system of tasks assigned but yet to be completed.

Presentations

The team will do a very brief (3-5 minute presentation) to the class when the proposal is submitted. This allows the instructor and the class to ask questions about the project and often adds valuable insight to the project complexity that was not initially considered by the team.

A more detailed presentation will be given later in the semester when the team presents the details of their project plan. This will be a formal presentation including visual, graphic aids/charts showing work breakdown structure (WBS) and the expected chronology of the project.

Review of Case Study

Early in the semester the students are provided a copy of The Aircraft Brake Scandal case study, as documented in 1972 by Kermit T. VanDiveer of the B.F. Goodrich Company. This is read outside of class and subsequent classroom discussion alerts them to some of the subtle (or not so subtle) issues that exist in corporations. Topics include respect for authority, social pressures (both individual and corporate) truth telling (both individual and corporate) and whistleblowing.

Student Requirements for Senior Project II

Weekly Status Report

During the accomplishment of the project, a weekly status report (Attachment 2) is required to monitor the teams' progress. This is intended to prevent ignoring a problem that develops and instead address it early in the semester when they still have time to react. This is very similar to industry reporting requirements, and after reviewing the Goodrich Brake Scandal case study in Senior Project I they understand the benefit of such regular documentation to upper management.

Final Report

A final written report will be completed which summarizes the project. It will be due at the time of the class presentation. The report should include:

- Executive Summary: A single page that captures the essence of the project. It identifies what the goal of the project was, what the results were, and any other significant information.
- Detailed Documentation of the Project: A narrative description of the project and a hard copy of the presentation (power point), photos taken at various stages, drawings, diagrams, operating instructions, and any other documentation.
- Expenses: A table that shows the actual cost and material used compared to the estimated costs and material from the plan.
- Actual Labor: A table that shows the actual labor (in man hours) used in the project compared to the estimated labor from the plan.
- Lessons Learned: This section of the report provides an opportunity to highlight any specific problems that were exceptionally challenging that the team had to resolve. It is an opportunity to report on the persistence, ingenuity, and resourcefulness of the team and to call attention to things that they are most proud of in the completion of the project. Areas often included in the section are project management, resource constraints, and material acquisition.

Presentations

A "dry run" of the final presentation will be given in which the team presents the details of their projects activity and completion to the instructor and the other Senior Project teams. Valuable feedback is again obtained as the team explains their project and questions are asked.

A formal presentation is given to faculty, staff and interested students and must be professionally conducted (ie appropriate attire and overhead projection are required). If possible a demonstration of the completed project is encouraged.

Peer Evaluations

Each team member will evaluate the other members for participation. A peer evaluation form (Attachment 3) is provided to each student near the end of the semester and is used to rate the level of participation of the members of their team. These peer evaluations are considered in the final grade and therefore each member may not receive the same final grade. Although this is the only course in the curriculum that has this component in grading, it represents another avenue of preparing the student for life after college. It is very consistent with the industry concept of "360 degree employee reviews" where a supervisor solicits input from the coworkers of an employee he/she is conducting a yearly review for.

Conclusion

I have had the privilege of teaching this class for the last three years. In that time there have been 30 projects involving a total of 55 students. The project diversity has been extremely wide ranging and has challenged me as the instructor as well as the students in the class. I learned to check with other faculty to assure that all instructors are "in the loop" for whatever project is being considered. (See Attachment 4, Instructor Concurrence Sheet) When a project involves an area of maintenance actions outside of my knowledge and comfort level, I enlist the services of one of the other maintenance faculty. All instructors in the maintenance training program have been involved to some degree regarding these student projects. Sometimes the biggest challenge I have had was reining in the students' enthusiasm and helping them obtain a realistic focus for what could be accomplished in 14 weeks! For example, the team that conducted the unleaded fuel testing listed below initially had the desire to develop their own unleaded fuel!!

The following is a brief list of some of the more significant projects undertaken by the students.

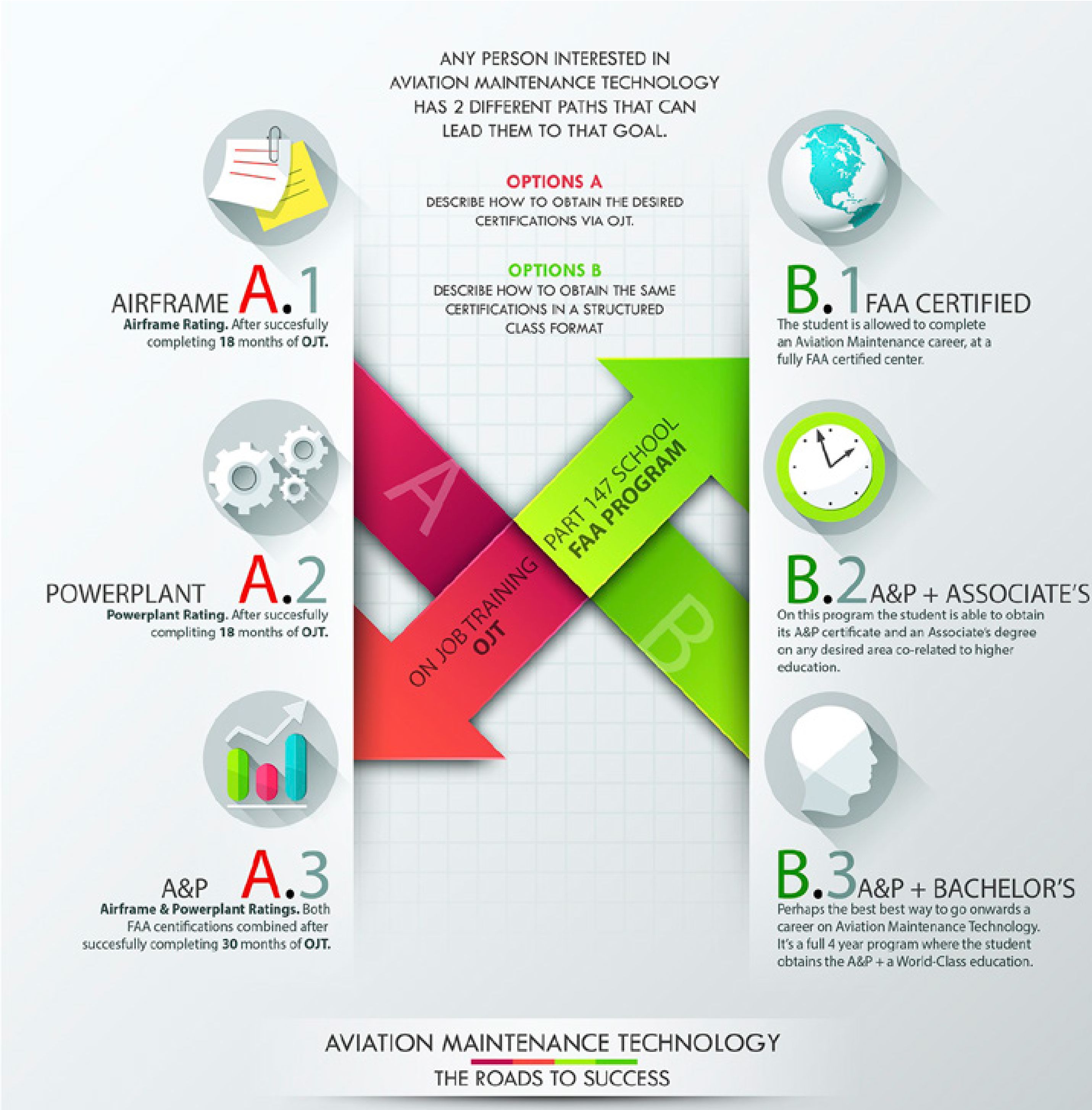
- Allison 250 water brake dyno test cell enhancements
- Cirrus fuselage mobile storage stand
- Composite airfoil inspection samples
- Continental C-85 magneto training aid
- Establishment of a tool control program
- 500 hour magneto inspection training video
- Operational testing of a Lycoming IO-360 engine with unleaded fuel

When students make their final presentation of their project, they are required to include a section called "Lessons Learned" This portion is always of great interest to me as many times lessons learned by one team may be repeated by another team. An example would be "We didn't realize how long it would actually take to do __XXX___. We had no idea!!" Other times they come up with unique observations that reflect a growing awareness of the complexities of the "real world" that exists beyond the structure of the academic institution. A few examples of these comments, often sprinkled with a bit of college age humor are:

- We learned not to assume responsibility for something we can't control (vendor callbacks)
- We found a couple of ways not to build it (paraphrasing Thomas Edison's comment about developing light bulbs)
- When I started this project I didn't know what I didn't know, and now that it's over I know that I originally didn't want to learn this much!! (that is my favorite quote)

During the first meeting of the class, I tell them that this may be the hardest course they take in the aviation maintenance training program, exceeding the mental challenge of AVS 2610 (Maintenance Regulations) and the technical challenge of AVS 4600 (Inspection and Airworthiness Certification) both of which they have already taken. Many students find my comments hard to believe, but I go on to explain that I make that comment because the courses combine planning, communicating and doing a task, and most of the semester it will be self directed. (Note: The weekly status report provides a good method for them to keep track of their project, and report any "challenges" to me so we resolve them quickly and efficiently. I reinforce the importance of honesty on that weekly summary by reminding them they better not have a glowing summary without problems for 12 weeks, and then tell me in the final week they are not ready to present!) Upon completion of the class, most students find themselves not only agreeing with my day one comments, but also experiencing the personal satisfaction that comes from developing and completing a project from start to finish. In addition to that satisfaction, they have also exercised and improved their communication skills, both written and oral. These two characteristics, proper task management and effective communication, are important transferable skills that can be used by them in any job, any company, and any career position. And that, to me, is what our teaching is all about!

Attachment 1



Attachment 2

WEEKLY STATUS REPORT

Project Lead_________________ Project Name__________________________ Date______

Overall status: On track? Yes No Scope Creep? Yes No

Comments____

____

Problems? ____

____

Plan content: Revision needed? Yes No

Comments____

____

____

Bill of Materials: Per Plan? Yes No Revised

Comments____

____

____

Budget Estimate: Per Plan? Over Under Revised

Comments____

____

____

Manpower: Per plan? Over Under Revised

Comments____

____

____

Final Presentation: Not Started Started In Work Completed

Comments____

____

____

Attachment 3

AVS 4910

PEER EVALUATION

Semester: Fall 2015

Instructions: Rate your teammate(s) as a percent of participation where 100% means that the member fully participated in all activities such as meetings, work time, research, parts chasing, etc. Do not rate yourself. These evaluations will be kept confidential and will not be shown to any team members.

Name of person evaluating ___________________________

Team Member Name ______________________

Percent participation__________%

Comments (optional)

Team Member Name ______________________

Percent participation__________%

Comments (optional)

Team Member Name ______________________

Percent participation__________%

Comments (optional)

Attachment 4

AVS 4900 Senior Project Instructor Concurrence Sheet

The following project is being considered for a senior project.

Student Team members are: ____ _______________________________

Brief Project Description: ____

____

Please indicate below your concurrence with or objection to this project.

Instructor 1_________________________ Date________Agree?______________

Comments:____

____

Instructor 2_________________________ Date ________ Agree?_____________

Comments:____

____

Instructor 3__________________________ Date_________ Agree?_____________

Comments:____

____

Instructor 4__________________________ Date_________ Agree?_____________

Comments:____

____

Instructor 5__________________________ Date _________ Agree?_____________

Comments:____

____

Instructor 6__________________________ Date_________ Agree?______________

Comments:____

____

Author

Terry Michmerhuizen is an Assistant Professor in the College of Aviation at Western Michigan University. He has been involved with aviation manufacturing, maintenance and training since graduating from LeTourneau College in 1975 with a BS in Mechanical Engineering Technology. He obtained a Master's Degree in Management in 1992. He holds an FAA Airframe and Powerplant technician certificate, with Inspection Authorization privileges. He is an FAA Designated Airworthiness Representative, in both manufacturing and maintenance. He is also a contract ODA Inspection Unit Member at the Duncan facility located in Battle Creek Michigan. Terry has his own personal consulting business conducting aircraft conformity inspections and providing FAA related industry training.

Safety Behaviors in Collegiate Maintenance Students

Beth M. Beaudin-Seiler, PhD, Western Michigan University
Jeremy Hierholzer, Western Michigan University

Abstract

This study examined the safety behaviors demonstrated by students in a high level aviation maintenance technology course at a mid-western collegiate program. Two sections of the same course were observed, one experimental group was given opportunity to outline the personal protection equipment needed to conduct that day's activities, and the instructor demonstrated by wearing the personal protection equipment. The control group was not given any information on personal protection equipment and the instructor did not demonstrate wearing any personal protection equipment. Findings show that students will engage in safety behaviors wearing personal protection equipment, but do not maintain this behavior. This indicates that the behavior is not habitual, and emphasis on safety should be a part of the program from the beginning.

Introduction

Life as an aviation mechanic is regulated and regimented. There are certain ways to fix parts, wings, and fuselages and cutting corners can result in an unacceptable cost. As any real aviation mechanic will testify to, the moment you step on to the "shop floor" rules apply. Personal protection rules apply and often times the violation of these rules can be unforgiving. Yet, anecdotally it seems as though students in an aviation maintenance technology program were not adhering to the personal protection equipment rules that would be mandatory in an employment setting, and quite frankly common sense in an educational setting.

With this in mind, the authors wanted to better understand the culture of safety that existed (or did not) within a collegiate aviation maintenance program. Students studying aviation maintenance will enter a career field in which personal protection equipment is mandatory and following safety protocols are a must. Understanding if students followed personal protection equipment protocols in university lab courses was the main objective of this study.

Method

Students in an advanced aviation maintenance technology course, at a large mid-western aviation program, were observed for two weeks in April, 2013. The course was an aircraft systems laboratory, lasting 4 hours, which required students to conduct hands on activities on various sections of airplanes and systems boards. Two sections of this same course, taught by the same instructor, one occurring on Mondays, and the other occurring on Wednesdays, were the target groups for this study. Each section was observed twice.

These students were junior status in college with a number of aviation maintenance technology courses completed. Both males and females were included in the observations. Participants were given lab instruction sheets at the beginning of each class period. This outlined the activity that was to be accomplished for the day (see Appendix A). The difference between the two groups was as follows. The Monday participants had a lab sheet that asked the students to discuss possible hazards, outcomes and outline the personal protection equipment that would be needed in order to complete each of the activities for the day (see Appendix B).

The students and instructor discussed each of them prior to being released into the lab to conduct the activity.

The Wednesday participant's lab sheet did not have the personal protection equipment outlined and no discussion on which, if any, personal protection equipment made sense to utilize. Additionally, the instructor at the Monday course wore the appropriate personal protection equipment that was previously discussed with the students; during the Wednesday course, he did not.

Results

During each of the observational sessions, hands on lab activities that should require personal protection equipment, specifically eye protection and latex gloves, to complete were given as assignments. Data from the observations were as follows:

Monday's Experimental Group	Wednesday's Control Group
Day 1 – 16 students, all male 13 used eye protection 3 used gloves	Day 1 – 16 students, 4 female, 12 male 0 used eye protection 0 used gloves
Day 2 – 15 students, all male 12 used eye protection 8 used gloves	Day 2* – 15 students, 4 female, 11 male 2 used eye protection 4 used gloves

*Instructor wore latex gloves for this activity in this group.

Discussion

Results of this study were very interesting to the investigators. First even though the experimental group were able to identify the personal protection equipment needed in each activity, and had an instructor demonstrate the behavior, not all students did it. Those that did engage in the safety behavior however, only did so for the first hour of the 4 hour session. Even though the instructor consistently used the personal protection equipment, the students fell back into their habits of not wearing them.

Second, it became clear to the investigators that the students will emulate the behavior (just not for long) if they see their instructors doing it. On Day 2 of the Control Group's session, the activity was one in which the instructor did not feel comfortable not wearing latex gloves, therefore he wore them. No other prior discussion took place on personal protection equipment, and no outline was given to the students for this activity. In this group we observed some students engaging in the safety behavior, not for the entire session, but they at least started that way.

Research shows us that not just children, but adults as well will imitate what they feel to be credible models (McGuigan, Makinson & Whiten, 2011). This means that students will imitate their credible instructors on safety behaviors. However, it will not instantly become habit, and will not transfer necessarily to other situations. Research on how habits are formed suggests forming a new habit can range between 18-254 days (Lally, Van Jaarsveld, Potts, & Wardle, 2010). This means that if we want students to demonstrate safety behaviors in aviation maintenance technology courses, we must engage them early in the program and as instructors demonstrate the behavior consistently. Continued research in the safety behaviors and attitudes of aviation maintenance technology students is important for both the student and the industry.

References

Lally, P., Van Jaarsveld, C., Potts, H., & Wardle J. (2010). How are habits formed: Modelling habit formation in the real world. Eur. J. Soc. Psychol, 40, 998-1009. Doi: 10.1002/ejsp.674

McGuigan, N., Makinson, J., Whiten, A. (2011). From over-imitation to super-copying: Adults imitate causally irrelevant aspects of tool use with higher fidelity than young children. British Journal of Psychology, 102, 1-18. Doi: 10.1348./000712610X493115

Appendix A

Lab Sheet Without Personal Protection Outline

Project #11 Landing Gear Retraction Systems

Purpose:

Operate landing gear retraction systems. Inspect, check, service, and repair landing gear retraction systems and landing gear position and warning systems.

Reference:

ASA Airframe Structures Text pp. 433-438

High-Quality Lecture Materials

Piper Arrow Handout

Activities:

Part 1: Beechcraft Baron Landing Gear

1. Perform a landing gear retraction and extension test on the Baron.

Appendix B

Lab Sheet With Personal Protection Outline

Project #11 Landing Gear Retraction Systems

Purpose:

Operate landing gear retraction systems. Inspect, check, service, and repair landing gear retraction systems and landing gear position and warning systems.

Reference:

ASA Airframe Structures Text pp. 433-438

High-Quality Lecture Materials

Piper Arrow Handout

Safety:

Activity	Possible Risk	Risk Mitigation

Activities:

Part 1: Beechcraft Baron Landing Gear

1. Perform a landing gear retraction and extension test on the Baron.

Authors

Co-Author: Beth M. Beaudin-Seiler, PhD

Contact: beth.seiler@wmich.edu

Affiliation: Western Michigan University

Education: Bachelor of Arts in Communication and Criminal Justice; Masters in Public Affairs and Administration; PhD in Public Affairs and Administration

Co-Author: Jeremy Hierholzer, Faculty Specialist II

Contact: jeremy.hierholzer@wmich.edu

Affiliation: Western Michigan University

Education: Bachelor of Science in Maintenance Technology; Masters in Career and Technical Education

---

Inspection, Maintenance and Repair Training for Civilian Unmanned Aircraft

Mike Leasure, Associate Professor - Aeronautical Engineering Technology, Purdue University
Timothy D. Ropp, Associate Professor - Aeronautical Engineering Technology, Purdue University
Joelle Chia - Junior, Aeronautical Engineering Technology, Purdue University
Evan Appold - Junior, Aviation Management, Purdue University

Authors' Note: Reference to Unmanned Aerial Vehicle (UAV), Unmanned Aerial Systems (UAS) and Drone, are considered synonymous terms for the purpose of this report. The authors will use UAS to imply all three.

Abstract

Flight regulations for safe operation of unmanned aerial systems (UAS) in civilian airspace are among top items of discussion by U.S. national airspace regulating agencies. However, as UAS missions and payloads grow, little attention has been placed on other equally critical aspects of UAS operations such as maintenance and airworthiness assurance. As the use of unmanned aircraft rapidly evolves from a small niche market to more widespread civilian market within the National Airspace System (NAS), a more robust approach to maintaining UAS airworthiness, safety, and operational reliability is required to accommodate their unique structures and systems. Researchers at Purdue University's Department of Aviation Technology are developing a user friendly, assistive inspection and maintenance system tailored to civilian operator field use that can help ensure safer and more reliable UAS operations as these remarkable vehicles become a routine addition to the National Airspace System.

Introduction

The increase in civilian UAS payload and uses is driving an urgent need for more training in standardized inspection, maintenance and repair approaches to maintain airworthiness assurance and safety. We know from years of experience in manned flight that all air vehicle systems degrade, break, and require continuous, well planned servicing and maintenance. While many commonalties between manned and unmanned aircraft exist, there are also significant differences in maintenance and repair civilian operators must be aware of and perform to ensure operational safety and reliability. This is especially critical as missions and payloads carried increase throughout the U.S. National Airspace System (NAS) and FAA races to set standards ensuring their safe operation within it (FAA, 2014; FAA, 2012).

Few UAS operators have experience repairing UAS air vehicle structures and systems to a level of airworthiness achieved by human operated aircraft. UAS vehicles are not simply a miniaturization of their human inhabited counterparts. Additionally, it is proposed that few UAS operators have experience in scaled aluminum, balsa, plastic or composite structural repairs and their impact on flight characteristics on UAS airframes. As the UAS age rushes in, it is believed emerging regulations will be adaptations from existing piloted air vehicle maintenance requirements. The FAA has set that precedent already with document wording suggesting unmanned aircraft to be maintained and repaired in a similar fashion to manned aircraft. This in turn will place an upstream demand on UAS manufacturers for more robust procedures and recommendations for their particular UAS vehicle, similar to a manned aircraft Structural Repair Manual, (SRM) Type Certificate Data Sheet, (TCDS) or Pilots operating Handbook, (POH). All of these documents are as important to the user of unmanned as they are to manned aircraft.

UAS Micro-Maintenance Strategy

To meet this challenge, research faculty are challenging and training the next generation of aviation graduates to integrate UAS operations into their research and industry skills sets. A student team, working through Purdue's Hangar of the Future Research Laboratory, (HOF) have developed an initial strategy for UAS field maintenance and repair. They have tailored robust Maintenance, Repair and Overhaul (MRO) system concepts and fully integrated maintenance data delivery systems to offer one solution to more reliable UAS maintenance and operations. Utilizing tablets, smart phones and scannable Near Field Communication (NFC) chip technologies, they have created and tested a beta version of an easily accessible field maintenance and repair strategy for UAS operators using these common personal computing devices. The system uses hyperlink manuals, repair and service information, safety notes that can be accessed in the field.

Building a Maintenance Plan from the Ground Up

To understand the structural peculiarities and differences of a UAS vehicle, the Hangar of the Future team built, programmed, and successfully test flew a quadcopter under direction of faculty with expertise in UAS operations and large aircraft maintenance. The quadcopter was a commercially available kit with high performance capability with onboard flight stabilization avionics. The aircraft represented a more complex build than most lower-end hobby store models.

Using similar airworthiness framework approaches (keeping in mind there is not a one for one exact crossover between human operated and UAS vehicles), they created a beta version of an Operations Manual (OM) for testing on the UAS as they constructed it. This guide would serve as a starting point with further revisions to come as flight and maintenance testing continues. Accessible by a radio frequency identification Near Field Communication tag, scanned with an NFC enabled smart phone, the user is able to bring up a hyperlinked layout of routine inspection and maintenance data. This framework was evaluated and vetted by the Department's leading experts on UAS builds and operations. It was approved and deemed appropriate to build upon for further testing.

The Manual (Figure 2) is divided into different sections based upon current mission activity. These sections include the following:

- User (human operator) - for assembly and flight
- Technical Specifications - for operating limitations, inspections and components of the quad
- Operations Log - to track maintenance and flight records
- Support section – for miscellaneous technical support section

Figure 1 – UAS Operations Manual

UAS Operations Guide

Table of Contents

I. User Section:

1. Assembly/ Disassembly
   - 1.1. Refer to Technical Specifications 1.1.1
2. Setup for First Flight
   - 2.1. Battery
   - 2.2. Flight Configurations
3. Flying
   - 3.1. Pre Flight Inspection
   - 3.2. Take off/ Landing
   - 3.3. Controlling UAS
   - 3.4. Flight Modes
4. Post Flight
   - 4.1. Post Flight Inspections
   - 4.2. Record Information in Logs

II. Technical Specifications:

1. General Information
   - 1.1. Assembly/ Disassembly
     - 1.1.1. Instructions
     - 1.1.2. List of Parts
   - 1.2. Parts Replacement
   - 1.3. General Safety Information
2. Type Certificate Data Sheet
   - 2.1. Operating Limitations
     - 2.1.1. Weight and Balance
     - 2.1.2. Range
     - 2.1.3. Speed Limitations
     - 2.1.4. Weather Conditions
   - 2.2. Flight Modes
3. Inspections
   - 3.1. Pre-flight Inspection
   - 3.2. Post-flight Inspection
   - 3.3. Visual Inspection
   - 3.4. 100-hour Inspection
4. Structures
   - 4.1. Propellers
   - 4.2. Legs
   - 4.3. Housing
5. Electrical Systems
   - 5.1. Battery
   - 5.2. Motors
     - 5.2.1. Brushless Motor Speed Controller
   - 5.3. Voltage Regulator
6. Avionics
   - 6.1. Autopilot
   - 6.2. Arduino Duemilanore
   - 6.3. Power Distribution Board
   - 6.4. Multi-Rotor Control Board

III. Log Section:

1. Log Sheet
   - 1.1. Flight Log
   - 1.2. Maintenance/Repair Log

IV. Support Help

1. Online Tech Support
2. Phone Support

The team plans to add a TCDS section as well. This OM would be ideally tailored to each UAS operator in the near future, providing on-demand information for supporting and sustaining UAS field operations.

Incorporating 3D Printing for Field Repairs

The team's work also includes development of 3D printing capabilities. They experimented with the ability to produce, in a very short period of time, 3D printed repair parts, and successfully printed selected replacement test parts.

Conclusion

As the FAA involvement in unmanned systems repair and maintenance increases, this UAS maintenance system can offer a significant step in fulfilling airworthiness, safety and reliability concerns emerging as the use of unmanned platforms continues to expand across civilian airspace.

Looking to the future, researchers plan to develop and add a flight risk assessment application for UAS pilots to assess mission readiness and safety. On the maintenance side, development of a 3D printable CAD replacement parts library continues. This will allow the user to simply pick the required part and using a touch of the screen on a smart phone remotely initiate the production of the part, using predesigned measurements and specifications to a connected 3D printer. This system will be most useful for commonly broken parts such as landing gear and motor support arms on multi-copters.

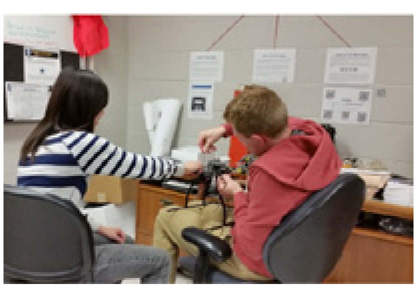
For unique parts, or innovative repairs, a 3D printed part can still be used but will require slightly more time for custom design and fitting. Additional parts manufacturing authorizations at both the FAA and company levels must be taken into consideration as well. Approval documentation, specifications, form 337's, logbook entries and other required documentation will be seamlessly linked into the system as required by potential regulations.

References:

Federal Aviation Adminsitration (FAA, 2014). Unmanned aircraft systems. Retrieved Sept. 10, 2014 from FAA Website: https://www.faa.gov/uas/

Federal Aviation Administration (FAA, 2012). Section 333 of the FAA Modernization and Reform Act of 2012, "Special Rules for Certain Unmanned Aircraft Systems," Commercial operations in low-risk, controlled environments.

CATIA CAD design and test prints of UAS center control mount (hub) left, and motor mount plate, right



Students assembling quadrotor while developing maintenance support.

Flight stabilization board (avionics) with manual flight control receiver mounting to airframe hub.

The structural frame is completed with electronics and power system installation pending.