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Blue Angels at Sun-n-Fun 2014

P-51 Old Crow at Sun-n-Fun 2014 *with matching petal plane*

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The Rising Use of Diesel Engines in the Aviation Industry

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ABSTRACT

Diesel engines have been used within numerous industries since the late 1800s and were initially used in fixed wing aircraft and airships in the 1920s and 1930s. Diesel engines are considered to be more fuel efficient, more reliable and require less maintenance when compared to today's reciprocating and turboshaft engines but are also typically larger and heavier. The technology associated with diesel engines has improved tremendously over the last couple of decades and several of today's aircraft manufacturers are attempting to design an engine that will justify the installation and use of them on a production basis. A couple of fixed wing aircraft manufacturers have already received the necessary FAA approval in order to produce and sell their aircraft with the diesel engine option while other manufacturers are awaiting the FAA's approval.

The purpose of this paper is to educate the reader about the technology and associated designs that are being evaluated by several fixed wing and helicopter manufacturers. Aircraft have begun operating with modern diesel engine technology and it is clear that additional aircraft will soon be approved to operate with the optionally installed diesel engine. In the future, it appears that aviation maintenance technician schools will need to begin incorporating the operation, maintenance, and repair of diesel engines into their curriculum in order to support the advances that are taking place within the aviation industry.

Information will be provided that illustrates the operational differences between the two stroke and four stroke diesel engines. Advantages and disadvantages will be discussed for diesel engine technology when compared to operating smaller fixed wing airplanes and helicopters with reciprocating or turboshaft engines. An overview will be provided for some of the fixed wing airplane and helicopter manufacturers that will include the technology advancements and programs that are being pursued and the resulting impact that it could have within the aviation community.

INTRODUCTION

The diesel engine was invented by Rudolf Diesel who was born in Paris, France in 1858. His first successful engine was operated in 1897 with a diesel engine patent being approved in 1898 for the first engine in history that used a fuel that could be ignited without using a spark. The modern engines in use today for powering submarines, ships, locomotives, electric power plants and large trucks are all based on the original concepts invented by Rudolf Diesel. (Bellis, 2014)

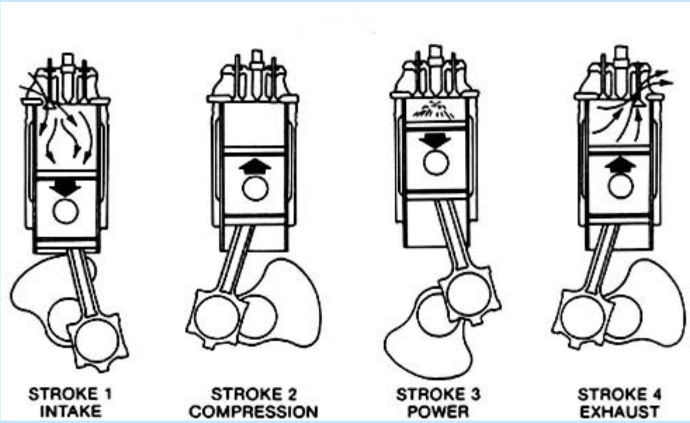
The first aircraft that was powered by a diesel engine was a Stinson aircraft that was modified and flew in 1928. Diesel engines were also installed in airships and some bombers but the earlier versions of the diesel engine stopped being installed due to their increased weight when compared to equally powered reciprocating engines that were operated with gasoline. In the years that followed, diesel engines were primarily used to power heavy ground machines, such as locomotives. (The Economist, 2008)

The majority of all gasoline engines in use today for automobiles and other means of transportation, to include airplanes and helicopters, operate on the principle of four strokes. Some of the diesel engines being developed for use within the aviation industry are two stroke and some are four stroke.

FOUR-STROKE DIESEL ENGINES

Fuel is converted into energy with both the diesel and the gasoline engines by a series of small explosions. The main difference between the two is how the explosions take place. In a gasoline engine, fuel is mixed with air, the mixture is compressed by a piston and the mixture is ignited by the use of a spark plug. In a diesel engine, the air is first compressed, the fuel is injected in the cylinder and then the air/fuel mixture ignites as a result of the heat generated due to being compressed. Thus, the diesel engine does not require the use of spark plugs but in a four stroke diesel engine, the strokes are the same as that of a gasoline engine. The four strokes are intake, compression, combustion and exhaust.

One of the biggest differences between gasoline and diesel engines is the way that the fuel is injected into the cylinders. Most of the older automobiles used a carburetor and the newer fuel vehicles are now using a port injection system. In an engine using the port injection system, fuel is injected into a manifold just prior to the intake stroke and mixed with the intake air before entering the cylinder.



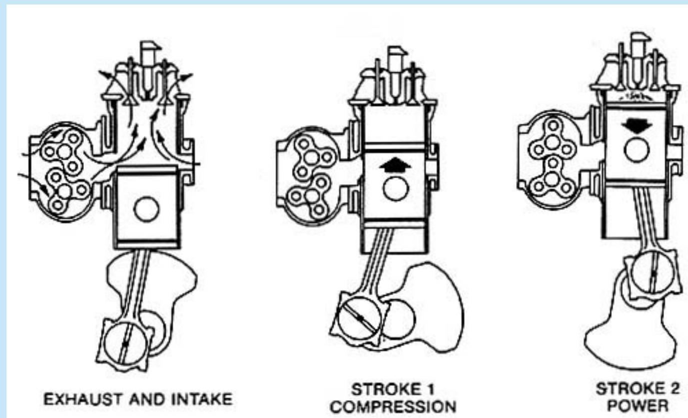
(Retrieved from dieselduck.net)
Figure 1. Four-Stroke Operation

For diesel engines, they use what is referred to as direct fuel injection. As shown in Figure 1, air enters the cylinder on the intake stroke, the piston compresses the air, fuel is injected directly into the cylinder and combustion takes place to produce power. The injectors on a diesel engine are subjected to extreme heat and pressure that take place inside the cylinder and are a component that is a challenge to engineers for making an operationally reliable design. (Brain, 2014)

TWO-STROKE DIESEL ENGINES

One of the advantages of the two-stroke gasoline engine is that the spark plug creates a spark twice as often when compared to the four-stroke engine. This means that a spark is generated once per every revolution of the crankshaft and the engine has the potential to theoretically produce two times the amount of power when compared to a four-stroke engine of the same size. Smaller engines can be produced in order to generate the same power. Common applications for the gasoline two-stroke engine include chain saws, law trimmers and other devices that require a lighter weight for hand held operation. Diesel engine manufacturers commonly use this approach to produce large high powered engines for ships and power generating plants.

With the two-stroke diesel engine, the compression stroke is the same as the four-stroke engine. As the piston compresses the air, fuel is introduced into the cylinder and ignition occurs which forces the piston downward and generates power. As shown in Figure 2, the difference is that as the piston is near to the bottom of the stroke, the exhaust valves open at the top allowing the exhaust gases to escape and relieve the pressure. When the piston is at the bottom of the stroke, ports are uncovered on the side of the cylinder which allows air to enter and assist in the removal of the exhaust gases. The exhaust valves then close and the piston begins to rise, covering the intake ports and then compressing the newly introduced air charge. Two-stroke diesel engines typically use a supercharger to assist in pressurizing the intake air and the removal of exhaust gases and then the rapid replenishment of fresh air for the next cycle of operation. (Brain, 2014)



(Retrieved from dieselduck.net)
Figure 2. Two-Stroke Operation

DIESEL ENGINE MANUFACTURERS

European countries have been the front runners relative to diesel engine technology within the aviation industry and were the first to certify a diesel engine design for production aircraft within the general aviation market. A company by the name of Thielert is one of the companies located in Germany. In 2002 they began producing a four-stroke, liquid cooled, turbo-diesel that can be retrofitted on Cessna 172s and Piper Cherokees. The manufacturer's engines are also installed on the Diamond Aircraft Industries aircraft consisting of a single engine DA40 and the DA42. Thielert went bankrupt in 2008 and then Diamond Aircraft developed their own Austro diesel engine. (Goyer, 2009) Thielert has since recovered from bankruptcy and are producing engines under the company name of Centurion-Thielert.

In France, SMA Engines designed a four-stroke, four cylinder, air-cooled, turbo-diesel which received European certification in 2001 and the FAA certification in 2002. It is certified as a retrofit installation on some Cessna 182 models. (Teissier duCros, 2012) Cessna Aircraft has been flight testing a Jet A-fueled Turbo Skylane JT-A aircraft since May of 2013 with the French SMA SR305-230 engine. Their goal is to market the aircraft primarily in Europe but a strong interest in the aircraft has also been seen within the United States. (Lynch, 2013)

A company located in Racine, Wisconsin called DeltaHawk Diesel Engines has been developing engines for use in the aviation, marine and land based operations. They are currently in the developmental phase and are expecting to produce and receive certification for several diesel engine models to be installed in aircraft ranging from two-seat Light Sport Aircraft up to 12-seat twin engine aircraft and 4-seat helicopters. Their four, six, and eight cylinder engine designs are based on a two-stroke, liquid-cooled design that includes both a turbocharger and a supercharger for operation. (DeltaHawk, 2014)

The helicopter industry is lagging behind the fixed wing community in having a certified diesel engine installation. At this time, there are no helicopters that are flying with a certified diesel engine but the situation could change within the next couple years as a result of research and development taking place in Europe. Later this year, flight testing will take place in Europe with a diesel engine installed on a Eurocopter EC120 as part of the Green Rotorcraft integrated technology demonstrator. It is an initiative within an organization called Clean Sky, which is an aeronautical research program that was launched in Europe. Their mission is to develop advanced technologies that will increase the environment performances of aircraft and result in less noise and better fuel efficiency. (Dubois, 2013)

ADVANTAGES AND DISADVANTAGES

One of the primary reasons that diesel engines have been under utilized within the aviation industry was due to a lower power to weight ratio when compared to similar powered reciprocating engines operating with aviation gasoline (avgas). With a lower power to weight ratio, an aircraft would have to carry more weight in order to operate which typically means that more fuel would have to be carried on board for each flight.

In the past, diesel engines have had the reputation of being noisy, spewing out a thick black stream of exhaust gases and producing higher levels of vibration during operation. In part, these attributes have traditionally been a part of the older diesel engine characteristics, but the newer designs have dramatically improved the operation and efficiency of diesel engines by the incorporation of the latest technology. The cost to produce a diesel engine is more expensive but it could be considered a long term invest due to the fact that it cost less to operate and maintain. They also have a longer service life when compared to reciprocating engines.

Today's diesel engines are now operating with a lower specific fuel consumption and higher power to weight ratios. Within the helicopter industry, one of the goals of the Clean Sky program in Europe is to install a diesel engine in an existing light helicopter for validating the benefits of lower gas emissions and meet their target for a 30% reduction in the fuel consumption. A second goal is to operate an even more advanced diesel engine with an exhaust system manufactured by Austro Engine that will remove additional pollutants. They expect a further reduction in fuel consumption, a 40% reduction of the CO2 emissions and up to a 50% reduction of the NOx emissions. These two goals are scheduled to be completed during the latter part of 2014. (Clean Sky, 2013)

Many of the engines being tested for certification and installation can be operated using either diesel fuel or the various jet fuels used by the commercial airlines and the military operating aircraft with turbine engines. The cost associated with operating aircraft and using avgas in Europe is extremely high when compared to operating with diesel fuel and avgas cannot be obtained in certain areas. More energy can be produced per unit of fuel when using diesel, which means that the engine is more efficient and the aircraft's range can be extended while at the same time producing more power. Another advantage to using diesel fuel is that it does not contain lead which is harmful to the environment when it enters the atmosphere following combustion.

CONCLUSION

In 2009 the National Science Foundation provided a grant to Sinclair Community College in Dayton, Ohio to develop an aviation diesel engine maintenance program. As a result, the grant allowed the college, along with two secondary schools and several industry partners, to expand their Aircraft Maintenance Technician (AMT) programs for the inclusion of aviation diesel engine maintenance, troubleshooting and repair courses. (ATE Central, 2014)

A CFR Part 147 Working Group was created by the Aviation Rulemaking Advisory Committee (ARAC) to recommend changes to the operating rules, curriculum topics and content requirements. The working group submitted their recommendations in December of 2008 and the proposed changes are awaiting the Federal Aviation Administration's approval. One of the recommended topics to be added to the curriculum is that of diesel engines. This provides further proof that diesel engine technology will need to become an integral part of the instruction provided by Part 147 Airframe and Powerplant technician schools.

One thing has become quite clear and that is diesel engines will continue to make their presence known within the aviation industry. They will primarily be installed on home built aircraft, Light Sport Aircraft, smaller fixed wing aircraft and helicopters currently using reciprocating and turboshaft engines as their source of power. As the our technology continues to improve, the weight of the diesel engine will become lighter, it will have a cleaner exhaust and it will also become a more popular choice within the aviation industry.

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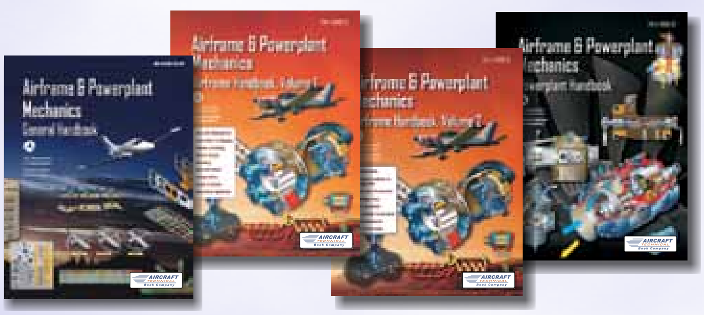


Teaching Introduction to Unmanned Aerial Systems

Mike Leasure
Purdue University

If you are like me, I wondered how to properly teach unmanned aircraft topics. Is flight training a necessary element? What about a COA, and getting approval for flight operations? How do I best cover this broad and diverse emerging discipline? I procrastinated for years as I struggled with the challenges. What I ultimately decided, and how I mixed those decisions with the proper equipment, and facilities, is the substance of this article.

I will begin by saying that during this time of procrastination I was actively flying various camera equipped, fixed wing model aircraft, over rural areas of Indiana. The photographs included row crops, detecting marijuana, creating photos for 3D topographical models, and NDVI images for algae bloom studies. All of these flights were line of sight. We did however, do some testing with automatic flight stabilization (autopilots) and radio modems (telemetry). That being said, I will state that you do not have to be a model aircraft pilot to teach this particular segment of aviation. That barrier has fallen with the latest advances in stabilization technology.

UAS ACROSS THE CURRICULUM?

The first ways we began teaching these topics was not in a specific class, but in using unmanned examples in our regular Part 147 curriculum. A weight and balance calculation exercise, on a Global Hawk unmanned aircraft, is the same as a manned Cessna 172. Paints and finishes are the same, wood, composites, and aluminum structures are all utilized in unmanned aircraft. It is only when you get to the very smallest UAS platforms that they become more like model aircraft. Other subjects such as basic electricity, electronics, avionics, and flight theory are right at home in the unmanned classroom, as well as manned. Where the training needs to be tailored specifically to unmanned platforms is in the areas of launch, recovery, as well as ground based manual and autonomous flight control. Even in those areas I can easily give examples of manned aircraft that are catapult launched, recovered under a parachute, or flown by autopilot.

Small quadrotor with still and video image capability

UAS SPECIFIC CLASSES

The biggest barrier I saw to teaching a comprehensive UAS class was the need for an FAA approved flight area (COA). That barrier was overcome when I saw the latest technology in multi-rotor aircraft. They can be flown <u>indoors</u>, possess cameras for video and still photos, and First Person View (FPV) flight. A series of 3 quadcopters were purchased starting with a beginner type trainer with a simple onboard stabilization system, advancing to a model with two cameras, flight stabilization, and FPV downlink via its own WiFi connection that is flown from an iPad or iPhone. The most advanced model allows the operator to modify the camera options, the degree of stabilization, and a host of other parameters just like a more advanced, longer range, outdoor autonomous system. Total investment for these three aircraft was under $500. The indoor area selected for training was approximately 35x45 feet with a ceiling height of 16 feet. The students begin flight training on a PC based flight simulator. These sims allow changing of flight perspective and are good for orientation training while looking at the aircraft, or from the aircraft, just like outdoor UAS operations are typically done. A manual RC type transmitter is connected via a USB port to better simulate the eye hand coordination needed for manual flight. If GPS guided waypoint and stabilization flight demonstrations are desired, our hangar has good signal reception despite having a metal girder roof structure. The ground based rover is especially suited for this type of indoor operations.

Flight training begins with the simulator and advances through specific tasks as outlined in the laboratory assignments. The student demonstrates the ability to fly a quadcopter manually, fly a mission to identify an object with a video camera, and fly by FPV without looking directly at the quadcopter using only the iPad screen for reference. All accomplished indoors, legally and without weather delays.

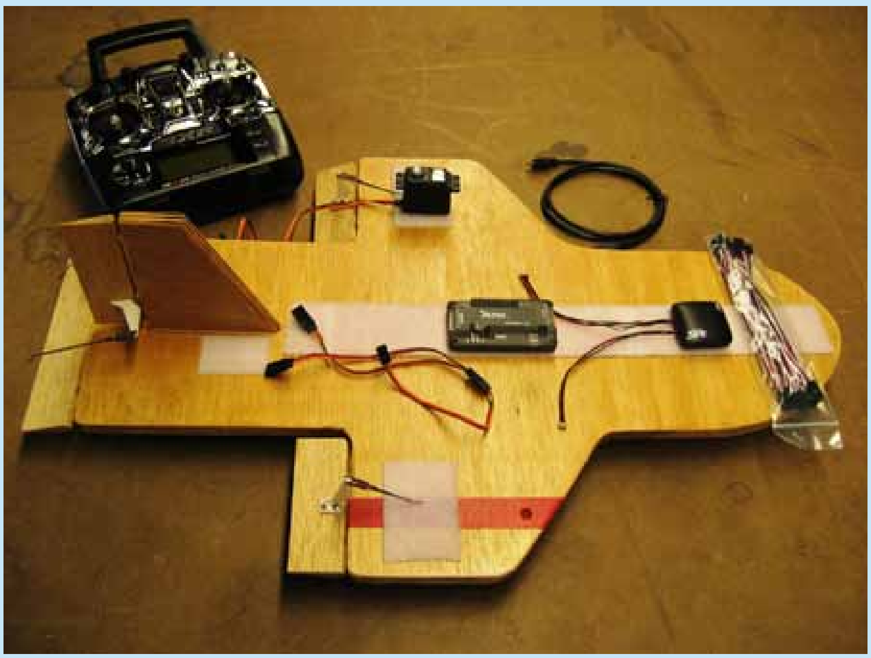
First Person Viewer trainer flown from iPad

SYSTEMS TRAINING

The main difference between model aircraft of years ago and a modern “drone” is the inclusion of GPS guided autopilots with telemetry for ground station use. No UAS training would be complete without training in the installation and use of this technology. What I chose to use was the ARDUpilot, ardruino based autopilot systems. This autopilot utilizes a free downloadable ground station (Mission Planner) that is fantastic for training. The autopilot is around $250 with everything needed to autonomously fly multi-rotors, fixed wing planes, and operate ground based rovers. I will include a list of suppliers at the end of this article.

There is a short classroom training session to introduce the autopilot. After this, the student assembles and tests a live system on a mockup board. This board simulates all aspects of manual radio controlled flight as well as autonomous operations. Radio calibration, stabilization calibration, firmware uploading, and compass calibration, are all demonstrated by the student. A laptop is connected to the autopilot, the ground station is opened, and all autopilot parameters are calibrated and adjusted.

The other laboratory projects include fundamentals such as; soldering, connector identification, battery charging/ discharging, and manual RC transmitter programming.



Mockup board to assemble complete GPS guided autopilot system

Camera of quadrotor with USB adapter for microSD card

Forward camera of AR Drone quadcopter

FUTURE TRAINING OPPORTUNITIES

I am currently working with two companies that have an interest in developing a UAS presence when the FAA allows commercial operations. These relationships have allowed my access to multiple state-of-the-art aerial systems. Students have expressed intense interest in working with these platforms. At this time, the students are limited to creating a proposal, including presentation to the class, of more advanced outdoor missions. The proposal includes a specific mission, airframe required, and data package needed. Having the live airframes on hand that they could study and ask questions has been a real boost to their interest in things unmanned.

CLASSROOM TOPICS

The topics discussed in class, but not necessarily demonstrated in laboratory work, include;

History, airframe options, powerplant options, construction, command and control, launch and recovery, civilian applications, regulations, safety, repair and maintenance, sensor package options, and field deployment experiences.

CONCLUSION

Many of the barriers to efficient training in UAS have been brought down by technology. Even the most basic multi-rotor, readily available at local stores and hobby shops, can be mastered in an hour or two of practice flights. Many students are already flying these in their spare time. The class is the natural next step in the evolution of their interest and involvement. Ready to fly models are now the norms with no building or construction required. As regulations evolve so will the opportunities for real world experience for the student. Get started now, spread the cost over time, and build your confidence with all things unmanned.

SUPPLIER LIST WITH LINKS:

http://ardrone2.parrot.com/
— Quadrotor used for FPV flight with iPad and WiFi

http://diydrones.com/
— online community for technical assistance

http://www.hobbyking.com/hobbyking/store/index.asp
— hobby supplies and ready to fly models

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Current Objective Implementation In Part 147 Aviation Maintenance Technician Schools

Fred D. Dyen
To meet requirements of the Research Residency in Instructional Design & Technology
Old Dominion University
Presented at the Aviation Technician Education Council Annual 2014 Conference
April 7, 2014

ABSTRACT

This paper explores how objectives are being met in five specific subject areas, representative of divergent courses that could be taught via distance, including aircraft drawing, materials and processes, maintenance publications, mechanic privileges and limitations, and maintenance forms and records. This qualitative study analyzed how representative aviation maintenance technician schools drawn from a variety of high school, community college, proprietary school, private, and public university programs are meeting objectives listed in Title 14 CFR Part 147, Appendix B. The study method involved three raters assessing the projects and how each project met the objectives based on qualitative analysis modeled after qualitative framework for program evaluation. The time devoted to each objective, similarities and differences of how each objective is being addressed by the representative schools, were explored, focusing on best practices. Recommendations for the current codified objectives are presented as behavioral, cognitive, and psychomotor objectives as appropriate. Objectives categorized in accordance with recommendations from the aviation maintenance technician schools' curriculum and operating requirements working group final report (ARAC 2008).

INTRODUCTION

Aviation maintenance technology training has been codified in regulatory rigidity most recently defined by the National Study of the Aviation Mechanic Occupation (Allen, 1966). The Federal Aviation Administration (FAA) has traditionally defined flight crew, dispatcher, and aviation maintenance technician ground training in terms of hourly requirements conducted in an instructor–led classroom environment. While education and corporate training have been able to take advantage of technological developments centered on the personal computer, tablets, smart phones and similar devices, computer- based training, and the Internet, the same cannot be said for maintenance training within the FAA's purview. In other segments of maintenance training, including the major airlines, there has been a noticeable shift toward competency-based training throughout this country. This has provided an avenue to offer more relevant and timely training. (Walter 2000, International Air Transport Association, 2011). According to the latest government reports on aviation safety, the FAA needs to update the curriculum and certification requirements for aviation mechanics (Dillingham, 2003), including alternative methods of instructional delivery (Thompson, 2008). Progress has been made on the operations (pilot) venue regarding competency, inherent in the multiple rating system developed in the United States and other countries for pilot certification. However, beyond limited initial attempts competency-based instruction on the maintenance side of the FAA has been stymied. The challenge posed by the anticipated shortage of skilled aviation maintenance professionals has been documented by the Aerospace Industries Association (2008), International Civil Aviation Organization (2011), and the U.S. Department of Labor (2010). Given the high cost of certification; however, new aviation maintenance schools are unlikely to be certificated in the near future, and ramping up the existing schools to meet this anticipated demand is unlikely without incorporating attractive cost-effective measures.

BACKGROUND

sIn the past quarter century we have seen a dramatic increase in sophistication of aviation technology in propulsion, avionics, and composites, as well the as dramatic sophistication of informational technology such as the personal computer, tablets, smart phones, and the Internet. These changes manifest in a disparity between current curriculum at AMTS' and industry needs for highly trained personnel to maintain modern aircraft. The FAA, while responsible for developing minimum curriculum requirements for an aviation maintenance technician school (AMTS) certificated in accordance with Title 14 Code of Regulations Part 147, has failed to make any significant changes to the school's curriculum in the last half century. A recent attempt to rectify this has resulted in no change. An Aviation Rulemaking Advisory Committee

(ARAC) was convened in 2007 on a fast track to address these concerns and a report was issued at the end of 2008 (Thompson, 2008). Due to other pressing matters within the agency, the report will not be issued as a Notice of Proposed Rulemaking (NPRM) until 2014 at the earliest (S. Douglas, personal communication, September 12, 2013), with any curricular change following that process. As aircraft continue to become more sophisticated, the training of technicians to maintain them continues to lag behind.

One of the few changes the FAA granted in the previous 50 years was to allow computer-based training within AMTS, following an NPRM in 1992. While there has been a tremendous increase in competency-based training nationwide, aviation maintenance training has failed to capitalize on this phenomenon. The FAA has remained entrenched in seat time as the educational discriminator of learning defined by a series of convoluted objectives better serving a bygone era of aviation history.

LITERATURE REVIEW

The current objectives found in regulation (Federal Aviation Regulations, 1992) were based upon Bloom's (1956) taxonomy and remain substantially unchanged in the ensuing half century.

Five levels of technical knowledge were assigned to fit the aviation mechanics occupation. These levels were:

1. knowledge (the ability to recall facts and principles, to locate information, and to follow directions;
2. comprehension (the ability to restate knowledge or to interpret information and drawings needed in performing a job);
3. application (the ability to apply principles or transfer learning to new situations);
4. analysis (the ability to reduce problems to their parts and detect relationships between these parts, such as breaking down a malfunction into its fundamental parts in order to troubleshoot); and
5. synthesis (the ability to assemble the knowledge of principles and procedures needed to complete repairs and (to construct new or substitute parts). (Allen, et al. 1966, p. 15.)

Bloom's taxonomy was defined into teaching levels by the FAA in 1970 with minor modifications in 1992 as noted in Title 14 CFR Part 147 Appendix A and codified as:

Level 1 requires:

- i. Knowledge of general principles, but no practical application.
- ii. No development of manipulative skill.
- iii. Instruction by lecture, demonstration, and discussion.

Level 2 requires:

- i. Knowledge of general principles, and limited practical application.
- ii. Development of sufficient manipulative skill to perform basic operations.
- iii. Instruction by lecture, demonstration, discussion, and limited practical application.

Level 3 requires:

- i. Knowledge of general principles, and performance of a high degree of practical application.
- ii. Development of sufficient manipulative skills to simulate return to service.
- iii. Instruction by lecture, demonstration, discussion, and a high degree of practical application. (Federal Aviation Regulations, 1992).

It is interesting to note that only one publisher currently provides a curriculum guide for aviation maintenance technician schools at the current time and the objectives delineated within have not deviated from the FAA objectives codified in regulation. (Crane, D. 1998). Numerous publications have advocated that the FAA curriculum is out of date (Dillingham, 2003, Goldsby and Soulis, 2002, Kroes, White, & Watson, 2001, and Thompson, 2008), although no major changes in curriculum have been implemented since 1970.

Alternate teaching levels were proposed by the aviation rule making advisory committee in 2008, specifically:

- I. Knowledge Levels
  - A. Be Familiar
    - i. Familiar with basic facts, terms / principal elements of the subject.
    - ii. Instruction by classroom, blended, or distance learning as applicable.
  - B. Knows
    - i. General principles, facts, and terms about the subject
    - ii. Can explain the basic operation of component / system / concept of component / system / concept.
    - iii. Instruction by classroom, blended, or distance learning as applicable.
  - C. Understands
    - i. The principles, facts, and terms about the subject.
    - ii. Can apply this understanding to the subject and troubleshoot / analyze / resolve problems.
    - iii. Instruction by classroom, blended, or distance learning as applicable.

II. Skill Levels
   A. No skill demonstration required
   B. Competent
      i. Be able to find and interpret maintenance data and information
      ii. Perform limited practical operations using appropriate data, tools, and equipment.
   C. Proficient
      i. Perform skill operations to a high degree of practical application using appropriate data, tools and equipment.
      ii. Inspections are performed in accordance with acceptable data. (Thompson, 2008).

Since many of the objectives are written in a confusing manner, including multiple verbs with little definable criteria, the purpose of this study is to determine how those current objectives are being met in selected subject areas. At the present time, no FAA document for AMTS program evaluation exists outside of FAA Order 8900.1 Flight Standards Information Management System (FSIMS), Volume 2, Chapter 12 Certification of a Part 147 Aviation Maintenance Technician School. Section 2 of this document provides guidance for evaluation the initial curriculum or any subsequent curriculum revision and Section 3, in addition to providing guidance for initial facilities, equipment, materials and tools evaluation, provides guidance for additional evaluation for the addition of a rating, curriculum change, or change of location. In general, once an AMTS is certificated, the aviation safety inspector (ASI) assigned as the Principal Maintenance Inspector (PMI) or Principal Avionics Inspector (PAI) typically verifies minor curricular, equipment, and instructor changes, as part of routine surveillance, with little attention to a robust program evaluation.

While the FAA has no formal program evaluation criteria or guidelines other than that mentioned above, most educational organizations have formal program reviews mandated by outside accreditation agencies (Southern Association of Colleges and Schools Commission on Colleges, 2011). There are a myriad of terms for evaluation, which vary in scope and detail, including adjudge, assess, appraise, analyze, assess, critique, grade, inspect, judge, rate, review, score, study, test, etc., according to Fitzpatrickick, Sanders, and Worthen, (2010, p. 14), “the purpose of evaluation is to provide both decision making and program improvement.” Tyler (1950) based his approach to evaluation on a series of steps, namely:

1. Establish broad goals or objectives.
2. Classify the goals or objectives.
3. Define objectives in behavior terms.
4. Find situations in which achievement of objectives can be show.
5. Develop or select measurement techniques.
6. Collect performance data.
7. Compare performance data with behaviorally stated objectives.

Modern program evaluation was initiated through government intervention with a series of programs designed to evaluated various federal programs according to Fitzpatrick, et al, (2010), commencing with the Planning, Programming, and Budgeting Systems (PPBS), with its focus on monitoring, outputs and outcomes, followed by the Government Results Act (GPRA) and the Program Assessment Rating Tool (PART). Congress, concerned about accountability, mandated evaluations of the federal juvenile delinquency program (Weiss, 1987) and the manpower development and training program (Wholey, 1986) in the early 1960s. The definitive congressional mark was demonstrated with the adoption of the Elementary and Secondary Education Act of the mid 1960s with the evaluation mandate approved for compensatory education and innovative education projects (Shufflebeam, Madaus, & Kellaghan, 2000).

Shufflebeam (1971) proposed an evaluation method centered on the acronym CIPP – for each type of evaluation method: content, input, process, and product. This was later refined with four additional questions (Shufflebeam, 2003):

1. Is the target group being reached and have they adapted their behavior (impact)/
2. Has the policy issue been resolved (goal attainment)?
3. Are the positive policy results continuing (sustainability)?
4. Are the processes that have contributed to the success of policy readily transferable and adaptable to other contexts (transportability)?

Goal-free evaluation was proposed by Scriven (1972) and required that the evaluator remain uninformed in advance of what the goals were to produce a more objective evaluation. According to Fitzpatrick, et al, (2010)

> The stage for modern program evaluation was set by three factors… a burgeoning economy in the United States after World War II, dramatic growth in the roll of the federal government in education and other policy areas during the 1960s, and finally, an increase in the number of social science graduates with interests in evaluation and policy analysis. (p. 47)

Current program evaluation has expanded beyond governmental oversight and is often conducted by managers and program staff with little or no methodological training in evaluation or social science research methods (Datta, 2006). Correspondingly, school districts faced with budget constraints have shifted evaluation responsibilities from evaluation professionals to teachers and administrators (Fitzpatrick, 2010). Standards, their assessment, and evaluation for accountability has spread beyond education and is exemplified by the Government Performance Results Act (GPRA) which address concerns about accountability (Radin, 2006). The Program Assessment Rating Tool (PART) was developed to replace GPRA and focused on outcomes and results (Gilmour & Davis, 2006).

Another framework for evaluation has been developed by the Center for Disease Control (2011) and focuses on the following steps:

Table 1: CDC's Framework for Program Evaluation

1. Engage stakeholders.
2. Describe the program.
3. Focus the evaluation design.
4. Gather credible evidence.
5. Justify conclusions.
6. Ensure use and share lessons learned.

Evauation Standards

Utility

Feasibility

Propriety

Accuracy

This current framework draws salient elements from many of the previously discussed models and is the one I have chosen to utilize to evaluate the research questions noted below.

RESEARCH QUESTIONS

The study was guided by four specific questions: (1) How can the current objectives found in specific aviation maintenance subject areas, specifically, aircraft drawing, materials and processes, maintenance publications, mechanic privileges and limitations, and maintenance forms and records, be categorized. (2) How a representative sample of top tier aviation maintenance technician schools are meeting Title 14 Code of Federal Regulation (CFR) Part 147 objectives for those subject areas. (3) How much time is allocated to meeting those objectives. (4) What similarities and disparities exist in how these objectives are met by the various aviation maintenance technician schools.

METHODOLOGY

STEP 1: DEFINING THE PURPOSE IN THE PLAN

The stakeholders for this study are twofold and include both aviation maintenance technician schools who are interested in reviewing how objectives are being met by a similar (or different) AMTS and FAA personal including specific aviation safety inspectors assigned as principal maintenance and/or avionics inspectors to a 14 CFR Part 147 AMTS and AFS-300 flight standards district office officials charged with regulatory oversight. By taking a critical look at how regulator objectives are being met, a series of best practices has emerged that have the potential to facilitate improvements at individual AMTS leading to enhanced program development.

While this study was focused on exploring how specific regulatory objectives are currently being met in a limited number of subject areas, it is anticipated that additional studies can expand the subject areas and a follow-up to this study would be the rewriting of the objectives contained in Title 14 CFR Part 147, Appendix B, C, and D.

STEP 2: DESCRIBE THE PROGRAM

The selection of representative top tier schools was referred to the several Aviation Technician Education Council (ATEC) directors to suggest representative schools from the following categories: (1) high school programs, (2) community college programs, (3) proprietary school programs, (4) private university programs, and (5) public university programs. (See Appendix A for the list of specific schools selected). Specific subject areas were selected based upon courses typically taught as "stand alone" subjects representative of the forty-four (44) subjects mandated in 14 CFR Part 147 Appendix B, C, and D. The five subject areas that were selected are detailed in Appendix B.

The analysis consisted of four elements:

1. Each objective in 14 CFR Part 147 Appendix B for the selected subject areas was categorized according to the following groups identified by Marken and Morrison (2013): (1) Tyler-style objective, (2) behavioral objective, (3) cognitive objective, (4) behavioral objectives as cognitive objective, (5) Greeno's cognitive objective, or (6) Gronlund's cognitive objective.
2. Each AMTS was queried regarding how the FAA objectives are being met in their respective courses. The AMTS provided copies of the projects used in the five classes (or portions of classes that cover the subject areas under consideration).

3. The estimated amount of time was entered into a matrix for comparison purposes by the subject matter experts.

4. The projects were compared for similarities, differences, and typical completion times prior to making any determination regarding if there is parity or disparity regarding how objectives are being met among the AMTS in the study.

STEP 3: EVALUATION

The evaluation focused on the following typical course taught in most aviation maintenance technician schools:

1. Federal Aviation Regulations incorporating the following subject areas:
   a. Maintenance Publication
   b. Mechanic Privileges and Limitations
   c. Maintenance Forms and Records

These three subject areas are representative of subject areas that could be taught totally online without additional hardware or software, beyond a standard computer connection with Internet capability. These subject areas are commonly combined into a single class entitled Federal Aviation Regulations (FARs) and representative of type 1 instruction.

2. Aircraft Drawing is a stand-alone subject area representative of a subject area that could be taught online, but would require additional software.

3. Materials and processes is another stand-alone subject area representative of a subject area where lecture material could be taught on line; however, the “hands-on” portion of the class could not be offered except via face-to-face in a properly equipped laboratory.

STEP 4: CREDIBLE EVIDENCE

The representative aviation maintenance technician schools noted in Appendix A were contacted and asked to participate in the study by providing the appropriate project documents that each AMTS uses to meet the objectives listed in Title 14 CFR Part 147, Appendix B, specifically:

Table 2: Subject Area Objectives and References

Objective Reference	Subject Area	Teaching Level	Objective
7	Aircraft Drawing	2	Use aircraft drawings, symbols, and system schematics.
8		3	Draw sketches of repairs and alterations.
9		3	Use blueprint information.
10		3	Use graphs and charts.
14	Materials and Processes	1	Identify and select appropriate nondestructive testing methods.
15		2	Perform dye penetrant, eddy current, ultrasonic, and magnetic particle inspections.
16		1	Perform basic heat-treating processes.
17		3	Identify and select aircraft hardware and materials.
18		3	Inspect and check welds.
19		3	Perform precision measurements.
28	Maintenance Forms & Records	3	Write descriptions of work performed including aircraft discrepancies and corrective actions using typical aircraft maintenance records.
29		3	Complete required maintenance forms, records, and inspection reports.
31	Maintenance Publications	3	Demonstrate ability to read, comprehend, and apply information contained in FAA and manufacturers’ aircraft maintenance specifications, data sheets, manuals, publications, and related Federal Aviation Regulations, Airworthiness Directives, and Advisory material.
32		3	Read technical data.
33	Mechanic Privileges & Limitations	3	Exercise mechanic privileges within the limitations prescribed by part 65 of this chapter.

While each AMTS was asked to provide objective(s) and projects for human factors (if taught within their approved curriculum) this proved to be an unworkable request, given that Title 14 CFR Part 147 does not currently address human factors as a subject area, even though the International Civil Aviation Organization and the FAA mandates testing in that area. Finally, each representative school was asked for an estimate of the time they allot to each subject area noted above.

Raters were trained in accordance with Appendix B in the use of the coding sheets in Appendix C. All of the projects collected from the aviation maintenance technician schools had all identifying marks removed so the anonymity of the programs will be retained. The raters did not have access to information regarding what level of program (high school, community college, proprietary school, private, or public university), or which specific school the projects originated from. For evaluating the objectives, the raters were presented with the explanations noted in Appendix D drawing from Marken and Morrison, 2013 and categorized the objectives independently and met telephonically to resolve ambiguity and differences.

1. A group of three subject matter experts (SMEs) reviewed the projects used in each course, and verified the project's rating on the current FAA Level I, II, or III scale. A value will be assigned to assess how thoroughly the instructional approach meets the objective according to the following Likert scale.

    1. Meets part of the objective.
    2. Minimally meets the objective.
    3. Meets the objective.
    4. Exceeds the objective.

    Example: Objective 28 from 14 CFR Part 147 Appendix B: *Write descriptions of work performed including aircraft discrepancies and corrective actions using typical aircraft maintenance records. Level 3*

    Total Number of Projects for Federal Aviation Regulations (3 subject areas covering objectives # 28, 29, 31, 32, & 33 = *36 Projects*

    Project from Sample School: **Project 13 Federal Aviation Regulations**

    INSTRUCTIONS: Write a logbook entry for the following maintenance and inspections.

Project	Likert
1. Replaced 8.00 x 6 tires and tubes on both main gear with new of identical size and type. Mechanic used the Beech maintenance manual, p/n 18803349, chapter 17, page 17-44 for instructions on how to accomplish the work.	**3**
2. Inspected aircraft engine with total time in service of 758 hours since new in accordance with 100-hour inspection. Mechanic found no discrepancies during the inspection.	**3**
3. Mechanic repaired propeller by filing small nicks from leading edge of both blades in accordance with the Sensenich Propeller Manual 4-88. Nicks were located on the outer 6" on both blades. After filing nicks, the blades were repainted to match original paint.	**3**
4. Piper aircraft, model PA-24-180, N15243, total time in service 3877 hours, inspected in accordance with 100-hour inspection and found to not be airworthy because of unair-worthy brakes on main gear, crack in skin of aileron, broken upper hinge on right cabin door, and corrosion in nose wheelwell on forward bulkhead. Write the inspection entry and the discrepancy list.	**3**
5. Mechanic removed carburetor from engine and then replaced two-piece venturi with new one-piece venturi on Marvel-Schebler MA-3SPA carburetor using new parts, complying with AD93-18-03 and Precision Airmotive Service Bulletin MSA-2, Revision 1, November 11, 1991. Following carburetor assembly, mechanic reinstalled the carburetor onto the engine per Textron Lycoming overhaul manual p/n 2993-4B, date 4/96 and test ran engine.	**3**
6. Mechanic re-timed left magneto to engine per type certificate timing data and Teledyne Continental service instructions in Service Bulletin M77-4 and overhaul manual X3328-8, dated 9/96, chapter 9.	**3**

2. The subject matter experts met several times via an online collaboration platform providing web conferencing, mobile collaboration, instant messaging, and voice authoring to discuss individual differences in ratings and reach consensus. The subject matter experts also looked at the objectives codified in Title 14 CFR Part 147 Appendix B for the specific subject areas. The objectives categories considered were those detailed by Marken and Morrison, (2013) as Tyler-Style, Behavioral (Mager-style), Behavioral as Cognitive, Greeno's Cognitive and Gronlund's Cognitive Objectives. A sixth category was added titled Indistinct Behavioral for those objectives that could not be categorized in one of the previous classifications.

DISCUSSION

A total of 280 projects from nine representative AMTSs were evaluated with the following results: 7 projects failed to meet the objectives in Title 14 CFR Part 147 Appendix B, 215 projects partially meet those objectives, 53 projects actually met the objectives, and 5 projects exceeded the objectives. The reason that so many of the individual projects failed to meet the specific objective found in Title 14 CFR Part

147 Appendix B perhaps has to do more with how the objectives are written than the specific AMTS failure as shown by the following analysis where the objectives for a particular subject area were compared in total. Referring to Table 1, Objectives, the first column represents the individual objectives, whereas the second column represents the collective projects for a given subject area. When looking at individual projects it is not surprising that close to 80% of the individual projects failed to meet or only partially met objectives.

Table 3

Objectives

Criteria	Individual Objective	Combined Objective	% Ind.	% Comb.
Does Not Meet	7	17	2.5	12.8
Partially Meets	215	44	76.8	33.1
Meets	53	67	18.9	50.4
Exceeds	5	5	1.8	3.8

Projects from nine AMTS were evaluated. One AMTS was eliminated because they provided only projects from one class (three subject areas.)

When projects from the participating AMTSs were evaluated individually, only slightly over 20% of projects were deemed to meet or exceed the objectives. However, when re-evaluated as an aggregate well over 50% of the projects met the objectives in Title 14 CFR Part 147 Appendix B. While this is still somewhat disappointing, given that the objectives were not written in accordance with any definable standard, such as the IMS Reusable Definition of Competency or Education Objective – Information Model (IMS Global Learn Consortium, 2002), it is not surprising. Nor should this reflect negatively upon an individual AMTS or any FAA Airworthiness Inspector attempting to assess whether the objective has been met. For example, one particular AMTS had a particular objective, specifically objective 9 "use blueprint information" categorized as only partially meeting the objective, even though the project called for the learner to develop a complete blueprint from specified information. The subject matter experts agreed that while this may to some extent exceed the scope of the objective in terms of the learner's ultimate competency, it did not clearly meet the objective as stated in the rule.

None of the subject matter experts found that any of the objects could be categorized as either Greeno's or Gronlund's Cognitive Objectives and only one objective could be categorized as Behavioral as Cognitive. The subject matter experts struggled with the categorizations because the objectives were not written with adherence to any particular educational philosophy and further complicated by the generic presentation of FAA definition of levels.

Table 4

Objective Categorization

Indistinct Behavioral	Tyler-Style	Behavioral	Behavioral as Cognitive.	Greeno's Objective	Gronlund's Objective
1	3	10	1	-	-

Typical conditions and criteria were drawn from the FAA Levels I, II, and III as defined in Title 14 CFR Part 43, Appendix B.

The next consideration was evaluating the amount of time that each AMTS spend addressing the subject matter. For consistency, Maintenance Publications, Mechanic Privileges and Limitations and Maintenance Forms and Records were considered as one class Federal Aviation Regulations as the majority of programs taught these subject areas in a combined format. Aircraft Drawing was offered by the participating AMTS as a class varying between 20 and 64 hours with an average allotted time of 39.7 hours with over half of the programs wining a few hours of this average. Materials and Processes had the widest distribution, varying between 20 and 144 hours for this subject area with an average of 81.7 hours. The program that noted only 20 hours, failed to indicate projects reflecting several of the objectives. It is entirely possible that these particular objectives were addressed in another subject area, such as a class in structural materials. Without a full evaluation of all of the projects of each AMTS, this could not be determined. The average for Materials and Processes cam to 81.7 hours, again very close to the time that more than half of the AMTSs allocated to this subject area. The last subject area evaluated for time allocation was Federal Aviation Regulations, The range here was between 30 and 120 hours, with the average 62.8 hours. Only one third of the participating AMTS were close to this average with the other two thirds outliers on either side of the average.

BEST PRACTICES

Three best practices emerged from conducting a review of the individual projects, one from each area. While only two of the AMTSs reviewed elected to use computer aided drafting programs, one program integrated an aircraft drawing project (preparing a blueprint of an oil filter cutter) with a materials and processes project (making that oil filter cutter and measuring it to the dimensions in the blueprint). Not only does this enhance student learning by linking the projects from two classes, but it challenges the learner to utilize precision measuring tools throughout the construction process, and rewards the learner with a viable tool worth approximately $200.00 dollars. A second best practice was demonstrated by one of the participating schools that utilized research required by maintenance forms and records to be applied to an aircraft 100-hour inspection. While this is standard practice in an airframe or powerplant inspection class, it is seldom introduced so early in the normal progression of studies in the combined course of Federal Aviation Regulations. The third best practice was demonstrated by only a few participating AMTSs, that was to list the specific objective that the project applies to as well as the performance level of the project. In addition to providing an aid to evaluators, this serves to inform the learner of expectations.

PLANNING FOR DISSEMINATION AND SHARING OF LESSONS LEARNED

An abstract was prepared and presented to the Aviation Technician Education Council (ATEC) for consideration of dissemination at their 2014 Annual Conference. This paper will be presented at the ATEC Conference and the findings will be presented to the ATEC Journal for consideration in a future publication. Additionally, the paper will be sent to Steven Douglas, Senior Executive in charge of Aircraft Maintenance Division, AFS-300 at FAA, with the recommendation that the objectives, currently found in Title 14 CFR Part 147, Appendix B, C, and D be rewritten in accordance with the criteria outlined in Appendix E of this paper for inclusion in the proposed Operations Specification for Part 147 Aviation Technician Maintenance Schools.

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APPENDIX A

REPRESENTATIVE SCHOOLS

High School Programs

Denbigh High School Aviation Academy, Newport News, VA

George T. Bake Aviation School, Miami, FL

Community College Programs

Big Bend community College, Moses Lake, WA

Blue Ridge Community College, Weyers Cave, VA

Sinclair Community College, Dayton, OH

Proprietary School Programs

Hallmark College of Aeronautics, San Antonio, TX

Pittsburg Institute of Aeronautics, West Mifflin, PA

Private University Programs

Liberty University, Lynchburg, VA

Public University Programs

Kansas State University at Salina, Salina, KS

APPENDIX B

RATER TRAINING

Orientation

An orientation to the process of objective analysis and the uses of the data from this process helps the trainees understand the importance of their attention and effort. The training will be conducted via SKYPE.

Controlling for Bias

Observer bias is an important issue that needs to be addressed directly in training. There are two types of bias that are especially important to address: bias due to observer preferences and bias due to observer knowledge of the subject area and typical projects. Bias due to observer tendencies is one preference that thorough training can be expected to remove or at least minimize. It is important that this part of the training gets the trainee to recognize that everyone has biases and preferences. These can be based on a multitude of things: teaching preference, lesson content, etc. The goal of bias training is not to remove these completely, as that is unrealistic, but to make raters aware of their biases and preferences. Then they will be conscious of the consequences for scoring that can result and will make an effort to control them while scoring. Bias due to observer knowledge of the projects being evaluated is far more difficult to address and control. It is virtually impossible to be completely objective and neutral when evaluating projects that someone else has developed in a subject area that the rater is invested in, but that is what each rater will be asked to do.

Applying the Rubric

Each rater was given the coding sheets in Appendix C, the sample projects from each participating AMTS, and asked to code projects 1b, 6a, and 7e prior to meeting as a group. When the group of raters met, consensus was reached regarding the coding of the projects noted above.

APPENDIX C

Coding

Example: nominal variable - objectives

Does not meet the objective.

Minimally meets the objective.

Meets the objective.

Exceeds the objective.

Example: dichotomous variable – whether an individual class meets all FAA objectives

No

Overall the class minimally meets the objective.

Overall the class meets the objective.

Overall the class exceeds the objective.

Example: Time allocated to each class

APPENDIX D

OBJECTIVE CLASSIFICATION CRITERIA

1. **Tyler Style Objectives**
   - Focus specifically on behavior.
   - Craft objective in such a way that solid judgments could be reached.
   - Split objective into two aspects: behavioral aspect and content aspects.
   - Focus on curriculum development.
2. **Behavioral Objectives (Mager-style Objectives)**
   - General start with a condition such as "Given the necessary tools."
   - Followed by a behavioral verb, one that is either directly observed such as removing a spark plug or indirectly observed through the results as in solving a math story problem.
   - Criteria that define the accuracy level such as "within" inch.
3. **Behavioral as Cognitive Objectives**
   - Include the verb (plus content), condition, and criteria of a traditional Mager-style behavioral objective.
   - Focus is generally on behaviors specified in the higher levels (e.g. application and above of Bloom's taxonomy.
     - **Knowledge** "involves the recall of specifics and universals, the recall of methods and processes, or the recall of a pattern, structure, or setting."
     - **Comprehension** "refers to a type of understanding or apprehension such that the individual knows what is being communicated and can make use of the material or idea being communicated without necessarily relating it to other material or seeing its fullest implications."
     - **Application** refers to the "use of abstractions in particular and concrete situations."
     - **Analysis** represents the "breakdown of a communication into its constituent elements or parts such that the relative hierarchy of ideas is made clear and/or the relations between ideas expressed are made explicit."
     - **Synthesis** involves the "putting together of elements and parts so as to form a whole."
     - **Evaluation** engenders "judgments about the value of material and methods for given purposes."
4. **Greeno's Cognitive Objective**
   - Intended to represent the knowledge structures a learner needs to apply the learned material.
   - Thought of as a model.
   - Focus on what a student has to know.
5. **Gronlund's Cognitive Objective**
   - Focus on the wider aim or goal level, rather than on a single, specific, observable behavior.
   - Particularly suited for describing more complex cognitive behavior that are not easily specified using a Mager-style objective.
6. **Indistinct Behavioral Objective**
   - Unable to categorize.
   - Missing major elements, eg. Condition (given the following tools), or criteria (defining accuracy level).

APPENDIX E

OPTIONAL

Each objective will then be rewritten in accordance with the knowledge and skill level proposed by the Aviation Rulemaking Advisory Committee (Thompson, 2008) as illustrated below in accordance with the following guidelines.

a. Only one element will be utilized.

b. There will be a behavioral verb.

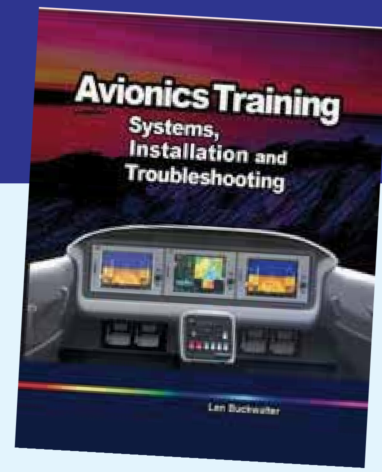
c. Each objective will include a definable measure, eg. condition(s).

d. Each objective will include a performance criteria, such as will 90% accuracy, that is criteria.

Example:
The student will write a description of minor maintenance of an aircraft (or portion thereof) in accordance with 14 CFR Part 43.9 without error. Knowledge C2, Skill C1

1. The student will write a description of a minor alteration to an aircraft or portion thereof in accordance with 14 CFR Part 43.9 without error. Knowledge C2, Skill C1
2. The student will write a description of preventive maintenance to an aircraft in accordance with 14 CFR Part 43.9 without error. Knowledge C2, Skill C1
3. The student will write a description of an airworthy 100-hour inspection in accordance with 14 CFR Part 43.11 without error. Knowledge C2, Skill C1
4. The student will write a description of a 100-hour inspection where the aircraft was not returned to service in accordance with 14 CFR Part 43.11 without error. Knowledge C2, Skill C1
5. The student will write a list of discrepancies and unairworthy items in accordance with 14 CFR Part 43.11 without error. Knowledge C2, Skill C1

A 'Hands-On' Avionics Book for the Aviation Maintenance Technician



This book covers subjects now most in demand; including servicing and troubleshooting on the ramp and flight line.

The text is easy to understand---no electronic knowledge required. Instead of formulas and schematics, the book clearly explains over 30 different systems, then shows how to do an installation, run wires and fix problems. Everything is illustrated in full color for fast comprehension.

Already adopted as a text by A&P schools and other training organizations.

The author, Len Buckwalter, founded Avionics Magazine and has been writing about the subject for 25 years.

Order from www.avionics.com or aviation book distributors.

All images in the book also available on CD for projection.

Published by Avionics Communications Inc.
Leesburg, VA. Tel: 703 -777-9535
E-mail: publisher@avionics.com
Web: www.avionics.com

Avionics Training: Systems, Installation and Troubleshooting.
ISBN 1-88-55544-21-9. Pages: 320
Catalog No. AT-01, Price: $84.00.

To see full Table of Contents and 50-page excerpt from the book, visit ***www.avionics.com***

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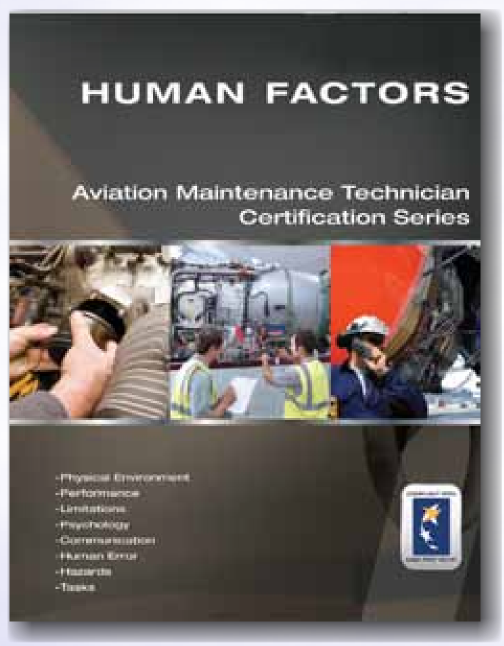
A complete manual covering human factors in the aviation maintenance environment including physiological and psychological aspects, human interaction, communications, risk management, workforce dynamics as well as understanding and managing human related errors.

Emphasis is given to the MEDA model (Maintenance Error Decision Aid) including its philosophy and process, how to develop and implement the program, along with a sample MEDA form with detailed instructions and advice on its use.



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Developing a Feedback System in a FAR 147 Aviation Technologies Program

Allan Kremer
Undergraduate Assistant, Southern Illinois University Carbondale
allanjkremer@siu.edu

Spending a year at Southern Illinois University will introduce many new opportunities to just about anyone. My second semester here, I was approached by my professor with an opportunity to become an undergraduate assistant tasked with aiding to improve our Aviation Technologies program. I accepted with anticipation as to where this would take me. The first week was a bit overwhelming as I didn't have a full grasp as to what was needed to be done at the time. Our final goal with this project is to ensure our graduating students are up to date with the demands of todays' employers. This is essentially accomplished by identifying deficiencies within the classroom that may leave our students unprepared to work within the aviation industry.

In a perfect world, machines would never break meaning mechanics and technicians would never be needed. As we all know, nothing lasts forever so new ideas and techniques are continuously being created. For example, engines are being required to become more efficient for multiple reasons including less abundant fuel sources, and emission regulations becoming stricter. We could also look at the structures of aircraft. To help with weight, fewer metals are being used, being replaced with composites. In conjunction with weight, more and more electrical devices are being used while becoming more advanced at a rapid rate. All of these are coming together, creating complex aircraft in the world of aviation. In order for us to maintain the levels of training to meet the industry standard, direct feedback from the employers is imperative.

A certain pattern must be followed for this program to be successful. First of all, the students need to know about the program and understand how important their feedback is for successful changes to be made to the courses they've completed while in the Aviation Technologies program. Our method to ensuring 100% information dispersion is to gather the graduating students, and give a presentation on the program. This gives a heads up on what will be asked of them. Upon graduation, the students find their dream job while of course continuing to learn from their new job. In this process, the graduate should be able to test their abilities as their direct supervisor should be able to recognize the graduates' strengths and weaknesses. After a few months, an email will be sent to the graduate requesting a short survey be taken to provide feedback on their own interpretation of how well they felt prepared for their employment, along with a request for their direct supervisors contact information, with their consent of course. An email would then be sent to the supervisor with a link and password to a different survey collecting their feedback on their new employees' performance over the past several months.

Collecting the data was an easy task, once we decided on which services to use. Limesurvey.com was chosen to handle the creation and hosting of our surveys for multiple reasons. They offer a completely free service up to twenty five responses each month; if more were needed, the fees were reasonable compared to other sites. This site is free to use and free to host surveys. The only thing that requires payment for using this server is when more than 25 responses are collected per month. Fortunately, Southern Illinois University of Carbondale already maintained an account with additional responses already paid for, which enabled us to create an account under the main account granting us usage of their benefits. With some reading from Limesurveys' extensive support pages, navigating around and learning how to operate their website became very simple in order to complete our tasks. This did not come without trial and error, however there were several times where I had to make changes upon changes to find the layout or style I wanted for each question within the survey. We also enjoyed the branching options that limesurvey.com offered as this automatically tailored the surveys given to the individual taking the survey. Advertisements usually come with free services, but not here. Neither I nor the survey taker will see an advertisement. Another feature that made our progress easier was the option to download the collected data into a Microsoft Excel format.

This entire project utilized free services and simple programs that many have already installed on their personal computer. For starters, Microsoft Excel comes with Microsoft Office; this program quickly tracks and records responses and reports transferred from our survey site. While using Limesurvey.com, one of their features is to download the responses in

Microsoft Excel format. Even our website created for this program through Wordpress, which will be mentioned shortly, is a free service. Aside from the cost of the computer and the Microsoft Office program, this is a free project.

Microsoft Excel was chosen for little to no training is needed. Many schools teach this program, or students will have already used this program at least a few times in their past. I will not watch over this program forever and will eventually have to pass on the responsibilities to another competent individual. Limesurvey.com did offer some easy to use, automated graphs to print off to create reports, but not as many features as what we can use with Microsoft Excel. We have full control over the layout of the reports that get printed off and full control over the graphs that get placed within the reports. Just like we have the surveys tailored to the individual taking the survey, we are able to tailor the report to each instructor for them to see their weak points in getting their students to retain the information learned while in college. An avionics instructor for example, doesn't need to see how the powerplant instructor is performing unless they choose to make public their feedback, this is more of a privacy issue that we have taken care of before any issues arise.

Instructors can then use the reports generated from the surveys to adjust the curriculum in their classes such as adding new subjects, elaborating on existing topics or even adding or changing laboratory projects. Larger implications could even lead to instructors having to obtain more current lab equipment for use in their labs. Regardless, the reports allow the instructor to ensure that their students are getting what they need to be competitive employees in the industry.

We started on this project asking around for guidance. We contacted a wide range of aviation schools within the United States inquiring for similar programs these other schools may already have in place. We were somewhat surprised to find no other school had a program like this already, or were at least unwilling to share it with us. So, since we found no other guidelines to follow, we had to start entirely from scratch.

The first task to be completed was to create a set of questions we needed answered by both graduate and employee. This set ended up being divided into several parts. The first of which is an area where everyone will be able to answer, general aviation questions like safety and what the FAA authorizes for each technician rating. The remaining sections were divided depending on a typical specialization. We divided them into airframe, avionics/electricity, powerplant/propellers, structural, and helicopters.

Once we divided the sections, we were able to focus on each section individually. Before the questions could be created, we needed to know what each area was supposed to be taught in class. We flipped through FAR 147 curriculum requirements to come up with a few questions; we scanned through each class syllabus to cross reference in an attempt to find more comprehensive questions we could ask. Finally, we referenced the FAA questions within our Prepware program to see what the FAA had found to be important for an A&P rated technician to know. With these three sources, we had a very large list of questions to ask, a list that seemed to be a bit overwhelming.

This extensive list of questions needed to be condensed, otherwise the survey would end up taking well over the 15 minutes we had decided should be the maximum time it should take to complete the survey. So, we needed to consolidate. There were issues when it came to deciding which questions to keep, discard, or reword. The idea was to ask as few questions as possible while being able to squeeze all the information possible out of the survey. Many of the questions were condensed into an array style question, see figure 1. For example, "Is your employee able to detect and fix the following issues?" is one of the questions asked. The respondent has the ability to select "yes", "no", or "not applicable" under specific areas being "hydraulic lock", "miss/back/after fire", "over/under speed", "improper oil temp/press", "improper fuel mixture", "any other engine issue" leaving an open ended response box to explain the last option. This effectively asks multiple questions without being too repetitive.

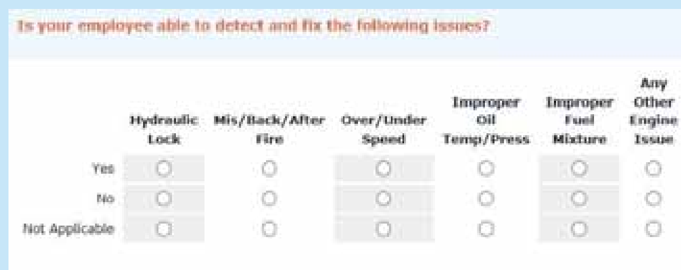

Fig. 1

Some of the questions we discarded were "Does your employee know the difference between a strong repair and a repair made too strong?", "Is your employee able to navigate through standard illustrated parts catalogs?", and "Is your employee able to easily determine the differences between common types of hardware used on the aircraft?". We discarded these, and several others for multiple reasons. They may have already been asked in a similar question; they may have been a question that we found to be insignificant; they could have even been too specific, or vague in which case these would have been reworded rather than removed.

We deleted a lot of questions. We made changes to even more. The best way we found to finalize our surveys was to go through it ourselves with a timer to monitor completion time. We had several other instructors within our aviation program go through the survey providing their input on other ways to reword questions they found to be confusing.

The questions kept are ones that, as mentioned before, would make the most impact while maintaining a short, and easy to understand layout. The best questions applied to both the requirements of part 147 schools, and the course syllabi. See figures 2 through 4 for a few examples of the final project. Figure 2 shows a general question that everyone will be able to answer. The optional text box is very important for more specific feedback, the question itself is more of a hint as to what information we would like to see. Figure 3 more directly focuses on the structures section asking how well the graduate is able to inspect the three structural areas of an aircraft. Notice the difference between figure 2 and 3. Figure 3 doesn't have a comment box inline, this is why an additional question was created to allow for any additional input. Figure 4 shows this.

Fig. 2

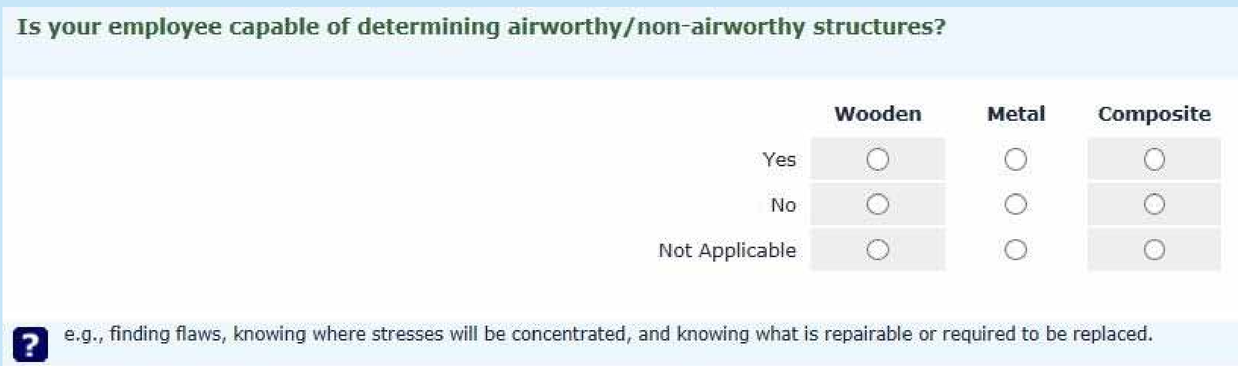

Fig. 3

Fig. 4

Some of these examples may seem too specific for a typical technician. A technician who goes to work primarily for a company working around turbines and new equipment will find questions asking about reciprocating engines and fabric coverings not applicable to them. This is where the branching takes place; see figure 5. After completing the general questions everyone will be answering, one questions was created allowing time to be saved by allowing the user to input a rough estimate of time spent in specific areas while on the clock. From here they will only be asked questions related to that system (airframe, powerplant, avionics, helicopters, structural systems). These areas are also color coordinated, as you will notice, the question in Figure 3 is green matching with structural system option in Figure 5. The same goes for the question in Figure 1, being orange matching with the orange powerplant systems. In the rare event an employer is submitting a survey indicating that every system is minimally maintained or each field is left blank, there will be an open ended question requesting more specific detail of the employees position as no additional questions are asked in this occurrence; see Figure 6. Receiving feedback for only the general section limits the usefulness of the survey, this text box is much larger allowing more character input as we would anticipate anyone answering this question would have more than just a few words to say.

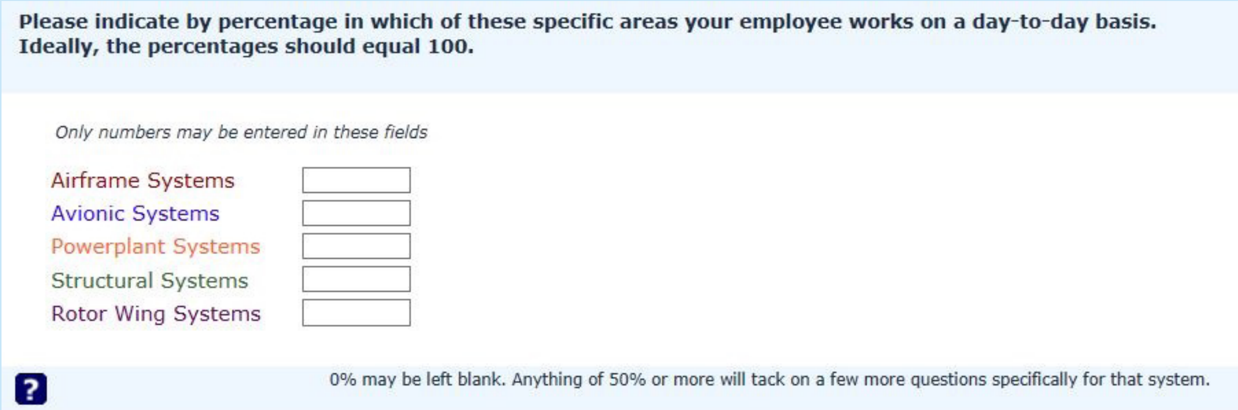

Fig. 5

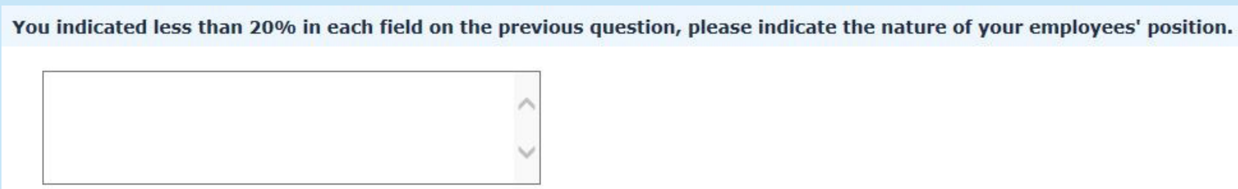

Fig. 6

A question was brought up asking how graduates from years long past would find out about this project dedicated to improving SIUC aviation technologies program if they were not informed about it while they were here. A side project was created; a website to be more precise. We found out that SIUC uses Wordpress.com for sections of their site. A template was created when SIUC started using this service, one in which was given to us and used to match our site to the main home page. Our site can be found at http://avtfeedback.siu.edu/. This premade template made my job much easier as I only had to type in the information about our program and create a few links to different website locations. The one main downfall to using Wordpress is that the site is more of a blogging site rather than a website. Pages on this site are viewed more as a daily social media layout than a standard website.

Even though graduates were previously informed of this program, getting them to actually participate has been no easy task. In the email sent to the graduates, we clearly state that their anonymity is guaranteed so job security will not need to be worried about. We are not allowed to send multiple emails as we had to get our program approved through the Human Subjects Committee. Part of this approval required web based human ethics training and an acknowledgment that sending more than one email for each research request is not allowed. The best thing we can do is to be sure to sit down with this upcoming graduating class and ensure we acquire a good contact list as we explain the program and how their cooperation will help incoming classes receive up-to-date training. We would like, if nothing else, for the graduates to respond to us with their direct supervisors' information so we can send the supervisor an invite to provide us feedback with our graduates' performance. The opinion of the employer is probably the most critical feedback we could receive.

On the plus side, there are a few accomplishments; this project has taken much less time to get set up than originally anticipated. From start to finish took only a couple months at 10 hours a week. The survey itself can be easily modified; the survey may be copied, modified and setup to go live the same time as the old one is active. In the event new surveys needed to be tailored to another group, our international students for example, it would be an easy process that would take no more than a total of a few hours.

Overall, many have expressed their interest in the program as this is expected to be a great tool in future years to come. We have high expectations and plan to continue forward with this program. It is imperative that graduates take the time to provide their employers' contact information to us even if the graduate does not wish to take time to provide their own feedback. Improvements cannot be made if problems are not addressed.

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ATEC Update

Greetings Fellow ATEC Members:

I would like to begin by giving a special thanks to the Conference Committee for putting on an outstanding 2014 conference. The feedback I have received has been overwhelmingly positive. The quality of the speakers and relevancy of topics discussed were exceptional. Kudos for all your hard work and planning.

Our 2014 conference also marked the end of terms for our President Raymond Thompson and Vice President David Jones. I would like to thank them for their vision, passion and commitment to catapulting our organization into a prominent role with the FAA in changing part 147 regulations. I had the pleasure of first meeting Ray and working with him on the ARAC to rewrite part 147 training in 2007. In 2011, I became a Board member with ATEC and have enjoyed working with Ray on these endeavors. I am thankful for his leadership and have gleaned a wealth of knowledge from him.

We have gained momentum as an organization over the past four years. I am committed to continuing that momentum and push for change over the next two years of my presidency. There is much work to be done both in and out of the part 147 arena.

In the coming weeks and months critical decisions will need to me made concerning the business office transition, formulation of new committees, growing industry involvement as well as setting agenda items that will benefit our membership. In accomplishing these tasks it is my goal to remain as transparent as possible about the decisions the Board makes concerning these items. We will continue to keep you up-to-date on these decisions and ensure that your voice is heard.

I am honored to have been elected your new President and am looking forward to working with our new Vice President Amy Kienast and Treasurer Gary Hoyle and the entire Board to forging on a path that positively effects you and your expectations.

Respectfully,

Ryan Goertzen

ATEC CONFERENCE AND MEMBERSHIP

ATEC membership stands at 107 institutional and 22 industry members. 64 schools were represented at the conference. There were 113 registrants. 19 companies exhibited at the 2014 conference.

We would like to especially thank Hallmark College for hosting our tour/dinner.

New Board members and Officers were introduced at the conference.

ELECTION RESULTS:

Four-year Terms:	Andrew Smith – Kansas State University Salina
	Tim Guerrero – Redstone College
	Bill Steinman – Aviation Institute of Maintenance
The new Officers are:	Ryan Goertzen – President
	Amy Kienast – Vice President
	Gary Hoyle – Treasurer

ATEC COMMUNICATIONS COMMITTEE

The Communications Committee of ATEC has been primarily continuing its work to improve the organization's web presence.

TREASURER'S AND FINANCE REPORT

As of November 30, 2013, the close of ATEC's fiscal year, there was a surplus of $8,264. With 107 members in 2014, ATEC should be in a good financial position going forward.

GOVERNMENT RELATIONS

ATEC continues to help schools with local FAA inspector issues. If you need assistance, contact Andrew Smith at atsmith@ksu.edu.

MEMBER RELATIONS

Member Contact Management System – The focus this past year was in the gathering of information to populate the individual schools contact information. A student assistant from MIAT was used to reach out to all of the active member schools to gather this information into a common database file.

Develop 10 New Industry Members and 10 New AMT Members – This continues to be a focus of our committee and much effort has been placed in this area building the relationships that are required for industry to understand the value of being an ATEC member.

4 Membership Webinars – The organization has finally settled on a platform to deliver webinars to our membership. The program called "Start Meeting" allows for the functionality required to conduct webinars and ability to record them and place them on our website for those who were unable to attend. We conducted two webinars in 2013 and will be working on conducting another 2 over the course of this year. Please let us know what webinars you would like to see in 2014.

Enhance the Member Experience – Focus will be on the look and feel of forms used organizationally, methods of payment to the organization, development of ATEC merchandise and outreach.

DID YOU UPDATE YOUR SCHOOL PROFILE?

Be sure your school's information is current on the ATEC Website.

It's easy and electronic.

Go to www.atec-amt.org. Click on "Schools/Members" on the top menu bar. Click on "Member Info Update" in blue. Fill in the information and click "Submit" at the bottom.

We will make the changes on the website once we receive your information.

ATEC WEBSITE PASSWORD (Keep in a Safe Place)

A protected section of the website has been designed for members only. The password is "atecnew" but it will be changed in the coming months.

ON-LINE AD POSTINGS

Don't forget to post your ads, position announcements, swaps and trades on www.atec-amt.org. Click on "Member Services".

INSTRUCTIONAL MATERIALS

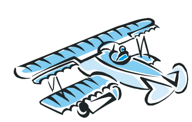
Please submit webinars, shared materials, class presentations for the website. We need input, ideas and new materials.

NORTHROP-RICE FOUNDATION

Please continue to send scholarship applications. The numbers go up every year and more scholarships are being developed each year.

ATEC was thanked for its support of NRF. Unfortunately, only a third of the ATEC member schools are members of the Northrop-Rice Foundation.

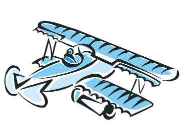
Website: www.northrop-ricefoundation.org



COMING SOON

Watch your email in the next few months for announcements about:

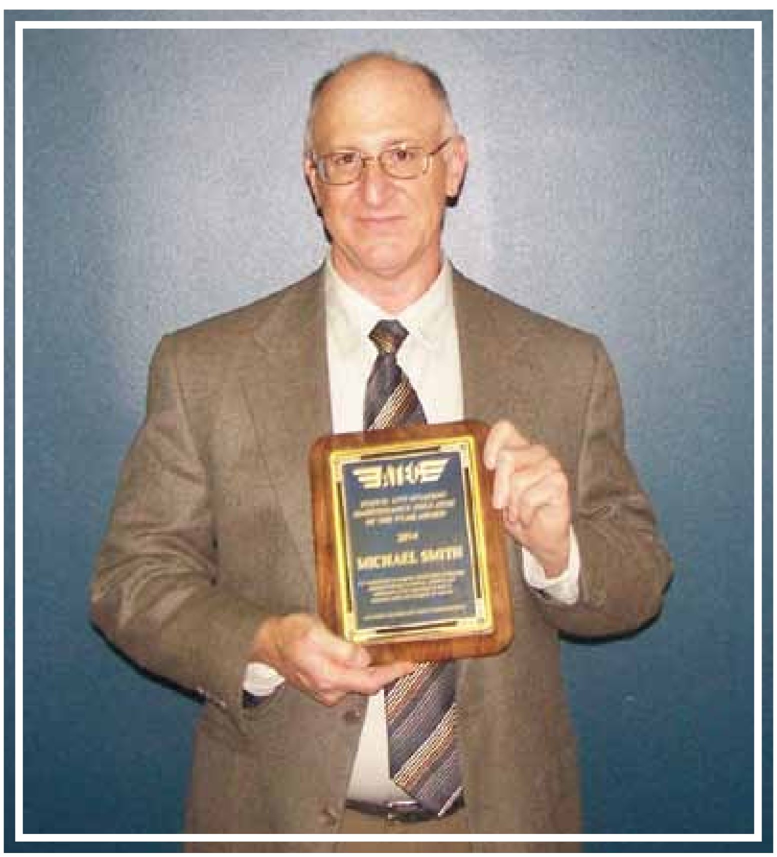
- ATEC's new executive director and bausiness office
- Newly appointed Board members to take the places of our three new Officers
- ATEC's strategic goals for 2015
- ATEC committee restructuring



Student of the Year

Cory R. Marks

Lewis University



Instructor of the Year

Michael Smith

Pittsburgh Institute of Aeronautics

Ray Thompson presents award to Dick Dumaresq after 25 years of service.

Conference attendees 2014

2014 NRF-Administered Awards and Scholarships

STUDENT RECOGNITIONS		
Recognition	Sponsor	2014 Receipent(s)
James Rardon AMT Student of the Year	**Northrop Rice Foundation (NRF) and Aviation Technician Education Council (ATEC)**	**Cody R. Marks** Lewis University
Aviation Maintenance Training Scholarship (Value: $1,000)	**Aeronautical Repair Station Association**	**Jason Bailey** Aviation Institute of Maintenance (VA)
Aviation Maintenance Book Sets (Value: $250 each)	**Avotek LLC**	**Dominic Gonzales** Reedley College **Stephen Michael Lindensmith** Blue Ridge Community College **Theodore Teasmaah Mbetoh** National Aviation Academy (MA) **Jarrid Paul McVicker** Plattsburgh Aeronautical Institute **Larry Palmer Jr.** Aviation Institute of Maintenance (FL)
Aviation Maintenance Training Scholarships (Value: $1,500 each)	**Boeing Flight Services**	**Kenneth Bosic** Pittsburgh Institute of Aeronautics (MD) **Timothy Clague** National Aviation Academy (MA) **Zachary A. Hickey** Chaffey College **Joshua Frederic Knutson** Northland Community & Technical College **Curtis Lee** Aviation Institute of Maintenance (MO) **Geoff Locke** Michigan Institute of Aviation and Technology (MI) **Aaron A. Rogers** Aviation Institute of Maintenance (FL)

2014 NRF-Administered Awards and Scholarships

STUDENT RECOGNITIONS (Continued)		
Recognition	Sponsor	2014 Receipent(s)
Aviation Maintenance Training Scholarships (Value: $1,500 each)	**Boeing Flight Services (Continued)**	**Salem Saoud** Del Mar College **Chase Lee Sizemore** Tarrant County College **David W. Smith** Pittsburgh Institute of Aeronautics (MD)
Aviation Maintenance Training Scholarship (Value: $750)	**Northrop Rice Foundation (NRF)**	**Mason Bradley Beck** Pittsburgh Institute of Aviation (MD) **Daniel C. Suttle** Chaffey College
Snap-On Tool Certificates (Value: $4,000 each)	**Snap-On Incorporated**	**James A. Aperans** National Aviation Academy (FL) **Emily Jo Applegate** Tulsa Technology Center **Kristan E. Kenna** Teterboro School of Aeronautics **Matilda S. McLean** Cincinnati State Technical and Community College **Kyle Zacharias** Pittsburgh Instititue of Aeronautics (PA)
Aviation Maintenance Book Sets (Value: $320 each)	**Wing Aero Products, Inc.**	**Danielle Radyvonyuk** Aviation Institute of Maintenance (FL) **Manuel H. Tongco** Aviation Institute of Maintenance (CA)

VETERAN RECOGNITION		
Recognition	Sponsor	2014 Receipent
Aviation Maintenance Training Scholarship(s) (Value: $500)	**Northrop Rice Foundation (NRF)**	**Joshua Caleb Abbott** National Aviation Academy (MA)

2014 NRF-Administered Awards and Scholarships

INSTRUCTOR RECOGNITIONS		
Recognition	Sponsor	2014 Receipent(s)
Helicopter Maintenance Training Scholarship (Value: Variable)	**American Eurocopter**	**Christopher Whytal** Tulsa Technology Center
Dale Hurst Financial Assistance Scholarship (Value: to $1,500)	**Avotek LLC**	**Fred D. Dyen** Blue Ridge Community College
King Air Maintenance Course Scholarship (Value: $7,200)	**FlightSafety International**	**Paul Eisenhart II** Pittsburgh Institute of Aeronautics (MD)
Aviation Upgrade Training Scholarship(s) (Value: to $1,000)	**Northrop Rice Foundation (NRF)**	**Don Jayatilake** Teterboro School of Aeronautics
Boeing 737-700 Avionics or Systems Training Course Scholarship (Value: Variable)	**Southwest Airlines**	**Joseph David Schmidt** Fox Valley Technical College

SCHOOL RECOGNITIONS		
Recognition	Sponsor	2014 Receipent(s)
Aviation Maintenance Training System (Value: $12,280)	**Nida Corporation**	**Vaughn College of Aeronautics and Technology** Flushing, New York
Model 53025 Start Pac Power Supply (Value: $500)	**Rotorcraft Enterprises**	**Blue Ridge Community College** Weyers Cave, Virginia

ATEC EDUCATOR OF THE YEAR AWARD

Michael Smith
Pittsburgh Institute of Aeronautics

Wing Aero Products, Inc.

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