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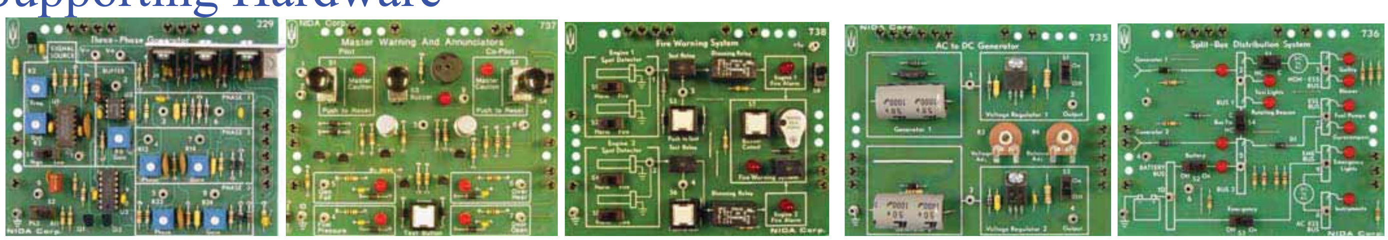

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Preparing Aviation Maintenance Personnel for the Support of Next Generation Composite Aircraft

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ABSTRACT

As the cost of jet fuel continues to rise and the global economy weakens, the airline industry anxiously awaits the delivery of the new composite structure Boeing B787 and Airbus A350. While the 20% reduction in fuel consumption these aircraft promise may be critical for long term survival of the industry, the new structural materials will present significant challenges for maintenance personnel. For aviation maintenance schools the challenges will include the initial acquisition of the required equipment, the ongoing costs of composite repair and processing materials, and the incorporation of the new technology into the curriculum. Faculty members in Aeronautical Engineering Technology have introduced new coursework in this area. Students in these courses use autoclaves, curing ovens, heat bonders, and CNC equipment in the manufacture of five laboratory projects. Realistic repairs to honeycomb and solid laminate structure are accomplished, as well. A new advanced tool and mold design course is under development that will prepare students for the design and manufacture of tooling for complex aircraft parts.

INTRODUCTION

Over the past 100 years, the materials for aircraft design have changed. First aircraft designs were made of wood structures and fabric covering, airframes made of steel tubing replaced the wood aircraft, and during the 1930s the first aluminum aircraft were introduced. WW II introduced rapid advances in technology, and this was particularly so in aviation where aluminum was increasingly used as the primary structural material to produce lighter and faster aircraft.

Advanced composite materials for aircraft construction have been used since the 1960s. Initially, secondary structures such as wing to fuselage fairings, radomes, floor boards, and flight and ground spoilers were made from fiberglass or Kevlar. Later aircraft developments introduced carbon fiber materials for horizontal and vertical stabilizers and flight control surfaces. In the 1980s composite materials were introduced as the primary structural material for military aircraft, and it soon became clear that virtually all aluminum would eventually be replaced by these materials in military applications due to their strength and weight savings advantages.

The military were the first to introduce complete carbon fiber fuselage and wings for aircraft such as the B2 bomber, the F22, and F35 aircraft. The knowledge base that was developed during these programs is now being used to design a new generation of aircraft. The Beechcraft Starship was one of the first commercial all composite aircraft, but unfortunately the aircraft was a commercial failure, and only 53 were build. Ironically, one of the main reasons for the commercial failure of this aircraft was the fact that it was overweight. This airframe is no longer manufactured or supported anymore and most of the airframes have been ground up and incinerated. The B787 will be the first main stream airliner developed from primarily carbon fiber materials. The program has suffered some major delays and setbacks but the first flight is expected to be near. Boeing has already sold 878 aircraft to 57 customers. The A350 is the Airbus answer to the B787; the design phase is completed and the first aircraft is expected to fly in 2013. Airbus has already sold 483 of these aircraft. Given the many advantages of composite materials, it is very likely that future aircraft will be designed around these materials.

ADVANTAGES AND DISADVANTAGES OF COMPOSITE MATERIALS

Composite structures made from carbon fiber materials are 20% lighter than comparable aluminum structures. Composite structures also consist of fewer parts and labor costs can be reduced. Lighter aircraft will burn less fuel, which is one of the major operating costs of airline operation. The primary advantages of composite materials are their high strength, relatively low weight, and corrosion and fatigue resistance. Some of the disadvantages of composite materials are susceptibility to UV light, high material cost, and repair requirements, which include, in some cases, temperature controlled facilities and expensive equipment.

COMPOSITE MATERIALS TRAINING

The current FAR 147 curriculum still places a large emphasis on wood, fabric, and welding topics, although most technicians will probably not inspect or repair an aircraft with a wood structure and dope and fabric covering or weld an airworthy cluster. There will always be a need for technicians with the capabilities to inspect and repair older general aviation aircraft, but this is a limited number of airplanes. The attention paid to composite aircraft repair is very limited under FAR Part 147, and is confined mostly to the repair of fiberglass honey comb sandwich structure. Even the AC43.13-1B which was revised in 2001 has a very limited scope on the repair of advanced composite materials such as pre-pregs or VARTM. Given the increased application of these new materials, the authors of this paper believe that composite structures should be taught at the same high level as aluminum structures. Aluminum structural repair will remain very important with so many aluminum airframes still being manufactured and flying, and it is expected that for the next 30 years aluminum repair will remain very important. However, future technicians need to have a good understanding of composite structures. Repair to composite structures is very critical and requires a different approach than aluminum structural repair. It is often difficult to determine, after the repair is made, if all procedures were followed correctly. For instance, choice of material, ply orientation, stacking sequence, and the number of plies greatly affect the strength of the repair and small mistakes could reduce the strength of the repair substantially and could, in fact, render the repair and the aircraft un-airworthy. Composite repairs are more sensitive to environmental factors such as temperature and moisture, and often become more a process of remanufacturing than repair, due to the fact that the same materials and cure cycles used in the original fabrication process must be duplicated for the repair. On the other hand, the repair has the potential, at least, to return the composite component and the airplane to the same aerodynamic finish and performance it possessed prior to the damage. This is generally NOT the case when rivet repairs are required to aluminum structures, for instance.

A new FAR 147 is under development and hopefully the manufacturing, repair, and inspection techniques required to determine the airworthy condition of the structure of composite aircraft will be addressed in this new document. We would suggest that the new FAR 147 will address the manufacturing, repair, and inspection of composite material structures and components. In order to support these new materials in the field, students must learn how to repair composite structures, in particular those newer and thicker solid laminate structures made from pre-preg carbon fiber tape or fabric. In order for students to be able to identify and carry out the proper repair techniques, they will also need a firm foundation in the manufacturing processes utilized for materials. Effective study of such studies should include both lecture on the concepts involved, and practical applications of the concepts in the laboratory where hands-on skills are developed.

The need for advanced nondestructive testing methods for composite materials is very important, and is substantially different from current methods used for metal aircraft. The coin tap test and visual inspection method have been widely utilized for years to locate flaws in composite structures. These methods work satisfactory for thin laminates with no more than four plies but newer structural solid laminate composite parts have sometimes over a 100 plies. These parts require a more sophisticated method of inspection and the future technicians need to be aware of and proficient in these techniques. Some of the newer techniques to find defects in composite materials are: phase array inspection, bond tester, and thermography.

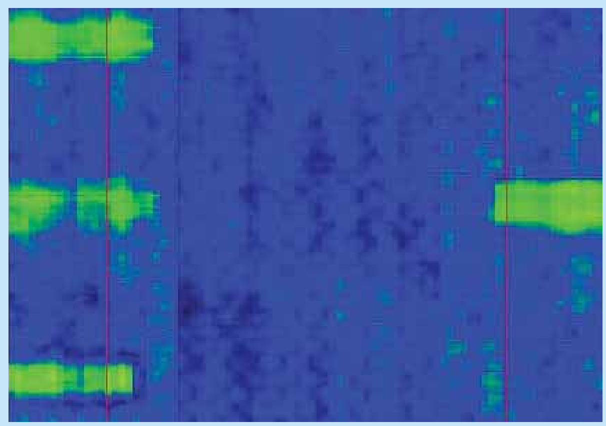

Figure 1. Phase array testing.

STRATEGY FOR COMPOSITE MATERIALS TRAINING

The authors have developed a strategy to achieve the composite materials training needs for the next five years. This strategy has four focus points:

Update existing composite materials course work (AT272) with new topics that will address advanced aircraft composite material requirements.

Develop interdisciplinary coursework with the College of Engineering (AT490/MSE597) to develop a design for manufacturing, experimental testing, and repair knowledge base.

Expand and update the composite laboratory to become a research facility where faculty, graduate students, and undergraduate students can pursue research. In this day and age, as the financial resources lag far behind the demands of these programs, the development of funded research activities is paramount to the success of the composite training effort. The model of building a state of the art laboratory will rely increasingly on external grants and funded research to purchase and support expensive equipment, including autoclaves, curing ovens, hot bonders, and machining centers for tooling fabrication. Funding generated by tuition and state support cannot be expected to meet the needs of these programs in the future.

Increase the number of undergraduate and graduate students performing research in the laboratory. This strategy supports the goal of achieving a self-supporting revenue stream for the composite laboratory, while also expanding the opportunities for faculty and students to work closely together in an advanced learning environment. Student feedback from involvement in research is very positive and experience in this program indicates that a significant number of these students then enroll in graduate school to further their educational and research careers. At the current time the composite laboratory receives funding from a Raisbeck endowment and a grant by the USMC for the development of field repairs for helicopters with a composite structure.

NEW COURSE WORK DEVELOPMENTS

For many years, the AT Department has offered composite education and training for Aviation technology engineering students. Faculty developed several composite courses and established an advanced composite laboratory with equipment required for the repair of modern composites. The emphasis of the course work was to introduce students to fundamental manufacturing and repair principles. The content of the AT272 Advance Composite Materials Course has been updated to reflect new manufacturing and repair techniques required for next generation aircraft. For example, pre-preg materials have become the major type of materials for high strength aircraft structural applications, and therefore several projects have been developed to give the students an opportunity to use pre-preg tape and fabric. In these projects, they will use an autoclave, curing oven, and hot bonder to cure their products.

Faculty prepared a new course training manual that is used to provide the students the necessary composite manufacturing and repair theory. New projects were developed to give the students a chance to practice and demonstrate their knowledge.

PROJECT 1 CLIPBOARD

This project prepares the students for a typical wet lay-up fiberglass repair. Similar to repairs made to fiberglass radomes or fairings. Students will cut several layers of fiberglass and impregnate the fiberglass fabric with a room temperature cure epoxy resin. A total of 8 layers of fiberglass are used in a 0° and 90° orientation. The fiberglass plies are laid up on a glass plate and cured at room temperature. After the cure is completed the laminate is cut and trimmed to size and clip board parts are attached to finish the project.

Figure 2. Clipboard fabrication.

PROJECT 2 CURVED HONEYCOMB PANEL MANUFACTURING AND SCARF TYPE REPAIR.

This project will introduce students to carbon fiber and Kevlar pre-preg materials and three typical curing methods: autoclave, oven, and hot bonder. Students will cut the material to the size specified in the engineering drawings and create two symmetrical and balanced 4 ply lay-ups. The parts are laid up on a curved aluminum tool, vacuum bagged, and cured in the autoclave. After the cure the two parts are bonded to the honeycomb core with film adhesive and cured in the curing oven. After the manufacturing of the part is complete, damage is caused to the carbon fiber laminate. Students will map out the damage using a tap test or other suitable NDI test and prepare a scarf type repair to restore the structural strength of the part. The repair is vacuum bagged and cured with a hot bonder.

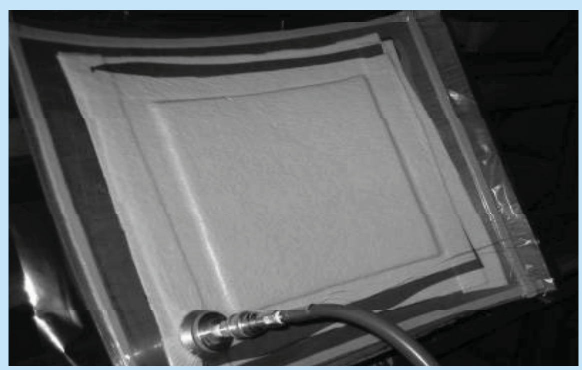

Figure 3. Curved panel fabrication.

PROJECT 3 STRENGTH TESTING

This project will enforce the importance of material properties, ply orientation, and stacking order. Students will make test specimen from fiberglass, Kevlar, and Carbon fiber i.a.w an ASTM standard. Several different ply orientations and stacking orders are used so that the students can compare them and see what will happen if an unsymmetrical and or unbalanced lay-up is used. Several plates are manufactured and cured in the autoclave. After the cure the plates are cut to the correct specimen size, and the parts are tested with a tensile tester and the data is recorded and interpreted.

PROJECT 4 SOLID LAMINATE FUSELAGE PANEL WITH STRINGERS

Students will prepare an 8 ply laminate of carbon fiber tape. An aluminum tool is used for the lay-up. The laminate is vacuum bagged and cured in the autoclave and after the cure the panel is trimmed to the correct dimensions. Two stringers are made of 8 plies of carbon fiber tape, laid-up on a tool, vacuum bagged, and cured in the oven. The two stringers are secondary bonded to the skin panel with a film adhesive and cured in the oven. After the part manufacturing process is completed students drill a one-inch hole in the skin panel and then secondary bond a prefabricated carbon fiber repair patch to the skin panel with a paste adhesive. A hot bonder and heat blanket is used to cure the repair patch to the skin panel.

Figure 4. Solid laminate panel

PROJECT 5 NACA DUCT

Students will first design a solid model in CATIA of a NACA duct, and then they will use a CAM program to generate a post file that will run the 5 axis CNC Motionmaster. The students will make a tool from tooling board using the CNC equipment, and the carbon fiber fabric will be laid-up on the tool, vacuum bagged, and cured in the oven at 250 °F. After the curing cycle, the NACA duct will be removed from the tool and trimmed to size.

Figure 5. Solid Model of NACA duct.

ADVANCED COMPOSITE COURSE WORK AT490/ MSE597

The second course under development is an advanced composite materials course AT490/MSE597. Students of the Aviation Department will work closely together with students from the College of Engineering. They will attend different lectures but share a three hour laboratory session. The idea is not to teach them the same material but to support and compliment each other. The engineering lectures are focused on material properties, part design, and the predication of strength and shape. The focus for the Aeronautical Engineering Technology students will be to "design for manufacturing". The students will further enhance their CAD/CAM skills and manufacture tooling and parts for the engineering experiments. The two student groups will meet in the laboratory and work together in the design, manufacturing, and testing of several experiments. We believe that this interdisciplinary effort will help students from different majors to understand the constraints of their work, and the relationship that exists between the other disciplines involved from the design stages, through manufacturing, to support of the vehicle in the field.

TOOLING FABRICATION FOR THE MANUFACTURING OF ADVANCED COMPOSITE PARTS

The old way of making molds and tooling using plaster, clay, or hand fabrication will become less important by the introduction of advanced CNC machining centers that can quickly make most shapes based on a solid model. CATIA V5 and Surfcam or Mastercam are the software packages to generate a post file that will control the machining center.

Figure 6. Wing rib tooling.

FACULTY TRAINING REQUIREMENTS

It will be very important for faculty members who teach advanced composite materials that they stay abreast of the technology. Most faculty members did not have Composite materials courses and CAD and CAM software when they went to school, and they will have to educate themselves to learn these new tools that are so important in the design and manufacturing of tooling required for repairs. One way faculty members can stay in touch with technology is to establish a close relationship with a company that manufactures and repairs advanced composite structures. To promote such a relationship successfully, both the faculty members and the company in question must perceive a benefit from the ongoing activities. If the company understands that the program may be able to provide significant feedback for improved processes, for instance, as well as a supply of highly skilled graduates, the relationship may prove productive for all concerned. The faculty members in question may find it necessary to volunteer some learning effort on the front side in order to kick start these opportunities.

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APPENDIX A

Proposed new curriculum for AT272 Composite Materials

- Wet lay-up part manufacturing
- Pre-preg part manufacturing
- Wet lay-up repair of fiberglass part
- Oven cure repair pre-preg material
- Hot bonder repair for pre-preg part
- Autoclave repair
- Curing cycles
- Bolted repairs
- Honey comb sandwich panel repairs
- Solid laminate part manufacturing and repair
- Basic tooling fabrication using CNC
- CAD/CAM introduction

PROPOSED NEW CURRICULUM FOR AT490 DESIGN FOR MANUFACTURING

- Catia V5 part design workbench
- Catia V5 composite materials workbench
- Introduction to Surfcam or similar Computer Aided Manufacturing (CAM) package.
- Tooling fabrication using 3 axis and 5 axis CNC equipment
- Pre-preg part fabrication for complex shapes
- Curing techniques, including autoclave and curing oven.
- Wet lay-up part fabrication for complex shapes
- Tolerances
- Tooling fabrication for VARTM process
- Part fabrication using VARTM.
- Advantages of different manufacturing process.

The Intersection of New Aviation Fuels and Powerplant Development

Implications for aviation maintenance training and support personnel

David L. Stanley & Thomas W. Wild
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ABSTRACT
Several factors have combined over the last decade to encourage development of new powerplant technology for light aircraft, foremost among which are concerns over continued availability and the increasing cost of fuel. The recent ruling by the EPA that reduces allowable lead emissions by an order of magnitude increases the importance and urgency of finding a replacement for 100LL aviation gasoline in the very near future. These efforts, as they relate to piston engine applications, are focused on both the aircraft powerplant and new fuels. Diesel engine technology, which side steps the lead problem by simply shifting over to Jet-A and similar fuels, is facing a rough start but holds great promise in the long run. For existing spark ignition engines, the development work is focused on new fuels to replace 100LL, as well as the incorporation of advanced ignition and fuel metering systems to allow the use of lower octane aviation fuels that already exist. For aviation personnel supporting these new technologies in the field, questions concerning adequate and appropriate training have been raised. How should aviation maintenance training prepare to meet these challenges? What background and specific information is important for the technician and for other aviation support personnel? Is there an overall strategy that Part 147 schools may follow to prepare for these changes, and to acquire the necessary equipment and training? Answers to these and related questions as addressed by this paper are critical for Part 147 schools, and for continued safe aviation operations, as well.

INTRODUCTION
A sea change is coming in general aviation, and the impact will be far reaching. Fuels, powerplant technology, airframes, and the support of these will all be affected. Combining to force these changes in the short term are environmental concerns and the skyrocketing cost of fuel. Longer range issues related to the high cost of overhaul and operation are also providing an impetus for powerplant improvement and change. Piston engine aircraft, particularly those used in revenue producing transportation, have relied on 100LL aviation gasoline (avgas) for many years. This fuel contains a significant amount of tetra ethyl lead (TEL), which is used to increase the octane rating and prevent detonation. TEL has come under increasing scrutiny for its detrimental impact on the environment, and recent events related to this make it clear that aviation must quickly find its way to a different fuel formulation for piston engine applications. This is, very simply, the one short term factor that may lead to an abrupt change with sobering consequences for the industry. In addition to the environmental concerns, small quantity production costs and special transportation requirements also drive the cost of avgas well beyond that of other fuels. New fuels are under development with the goal of serving as a direct “drop-in”, while new powerplant technology is also coming to the forefront that may enable the use of existing turbine fuels. For the technician and other personnel in aviation, it will become increasingly important to stay abreast of these changes, understand the implications for the aircraft, and be ready to support the new technology as it arrives.

FUELS CURRENTLY APPROVED FOR PISTON ENGINE AIRCRAFT
Aircraft engine development and aviation fuel research are very much interdependent. New engine technology is clearly reliant on the availability of approved fuel that meets the demands of the engine under development and is affordable. The work going on today with respect to engine research is driven at least in part by the belief that 100LL avgas will soon become a thing of the past. Currently, however, it continues to be the dominant fuel for aircraft powered by spark ignition engines in the United States. While 100LL is widely available at the present, both environmental concerns and refining costs are factors that may well lead to the need for a new fuel in the very near future. Although research has been underway for a number of years to find a replacement for this fuel, no direct, drop-in equivalent has been approved. This effort has been

driven largely by the fact that 100LL is the only commonly-used fuel today that contains tetra ethyl lead (TEL), an additive that increases octane of gasoline. Aircraft engines with high compression ratios, turbocharging or supercharging were originally certificated with this fuel, and must use it to avoid detonation. Only a handful of refineries produce 100LL avgas, and that effort is extremely expensive in that lead is considered a contaminant in other fuels, which makes it necessary to flush the system entirely prior to returning to the production of other fuels. Further aggravating the situation for 100LL is the fact that, due to the lead content of this aviation gasoline, it may not be pipelined, and, therefore, delivery to airports must generally be accomplished by truck (Epi Inc., 2009). While the aforementioned are significant drivers of the cost of 100LL, they are not new factors in the price equation. What is new in this arena is the recent EPA mandate to reduce lead in the environment, a decision which came about as a result of a petition filed by the Friends of the Earth with the EPA in 2007 (Wikipedia, 2009). The EPA responded with the following notice of petition for rulemaking:

> "Friends of the Earth has filed a petition with EPA, requesting that EPA find pursuant to section 231 of the Clean Air Act that lead emissions from general aviation aircraft cause or contribute to air pollution that may reasonably be anticipated to endanger public health or welfare and that EPA propose emissions standards for lead from general aviation aircraft. Alternatively, Friends of the Earth requests that EPA commence a study and investigation of the health and environmental impacts of lead emissions from general aviation aircraft, if EPA believes that insufficient information exists to make such a finding. The petition submitted by Friends of the Earth explains their view that lead emissions from general aviation aircraft endanger the public health and welfare, creating a duty for the EPA to propose emission standards."

Subsequently, in response to a federal court order, the EPA reduced the acceptable limits for lead in the atmosphere by an order of magnitude, from 1.5 microgram/m3 to 0.15 microgram/m3, the first regulatory reduction in airborne lead levels in over 30 years. Although the overall implications of this regulatory change for general aviation are not yet completely clear, the handwriting does appear to be on the wall for leaded avgas.

80 octane is an approved aviation gasoline that was widely available for lower compression applications until it fell out of production in the 1990s due to low demand (Wikipedia, 2009). It contains only a small amount of TEL in comparison with 100LL and remains the fuel of choice for those aircraft with lower-compression engines approved to use it. Many of the aircraft that were originally certified for operation on 80 octane may also be approved to use autogas through a supplemental type certificate process; most autogas these days, unfortunately, no longer meets the requirements of these STCs. 82 UL (unleaded), an aviation gasoline that was developed to work around these autogas issues, never came into production due to low demand.

Mogas or autogas, short for automobile gasoline, is approved for use in a number of specific airplanes through a supplemental type certificate (STC) process. However, none of these STCs, which were developed by either the Experimental Aircraft Association (EAA) or Peterson Aviation, allow for the addition of ethanol to the gasoline (Wikipedia, 2009). This is problematical due to the fact that ethanol, which is produced from corn in this country, is increasingly used as an oxygenate additive for gasoline to reduce exhaust emissions and boost the octane of the fuel in the absence of lead. Given the positive impact this has had on agricultural markets for farmers who supply the feedstock of corn used to create ethanol, its use as an additive is unlikely to change in the near future. Autogas, as a result, is not a part of the aviation fuel picture, at least under the current STCs developed for this purpose. In short, for piston engines that require gasoline, at least, pilots these days generally have no choice but to fuel their aircraft with 100LL, the continued availability of which is very much in question.

One bright spot in the current fuel situation is the development and certification of diesel engines for light airplanes. These engines may, at least in some cases, be certified to burn readily available and generally cheaper Jet-A turbine fuel. Although this is promising and exciting, several problems and challenges complicate this approach, not the least of which is the reluctance of one oil company to sell Jet-A for other than turbine engine applications. ExxonMobil recently told their fuel supplies that Jet-A should not be sold for diesel engine aircraft applications due to concerns with freeze point, cetane number, and lubricity issues (AllBusiness, 2009). Their position is that those customers intent on purchasing Jet-A for their diesel engine aircraft must sign an indemnity agreement before fueling can take place, thereby relieving ExxonMobil of any liability in the event of a fuel-related accident. According to AllBusiness, both Diamond Aircraft and DeltaHawk, maker or diesel aircraft engines, have expressed consternation at this action taken by Exxon Mobil. Diamond responded that all of the issues raised by ExxonMobil were addressed as part of the normal engine and aircraft certification process, DeltaHawk specifically addressed the lubricity question, saying that their fuel pumps do not rely on the fuel for lubrication. The cetane matter is one that may affect starting of the engine under cold conditions, but according to DeltaHawk, does not represent a safety of flight issue. Jet-A is a kerosene-based fuel that specifically designed to meet the continuous combustion requirements of turbine engines. In a diesel engine, fuel is injected into the cylinder under high pressure as the piston approaches top dead center. As a result of compression, the temperature of the air in the combustion chamber at that point is sufficiently high to cause ignition of the fuel-air mixture. The duration of the combustion event and the associated pressure rise that takes place is a function of the cetane number of the fuel, a characteristic that is controlled and specified for diesel fuel. High cetane values lead to shorter ignition delays between the time the fuel is injected and the time initial ignition occurs. If the cetane number of the fuel is too low, then the fuel and air may have sufficient time to mix thoroughly, in which case the somewhat delayed ignition event may cause the entire mixture to light off at once, resulting in an excessively rapid rise in pressure. In order to match combustion characteristics to engine requirements, the cetane number of diesel fuels is generally specified in a range, while jet fuel, on the other hand, is NOT controlled for cetane number. As state before, this is considered by some to be a significant issue for its use in aviation diesel engines, and FAA is looking into the issues surrounding this controversy.

FUELS IN DEVELOPMENT

Teledyne Continental Motors (TCM) has been testing 94UL, which is basically 100LL without the TEL added in the refining process (Wikipedia, 2009). As indicated by its name, this test fuel has lower octane than 100LL and, therefore, provides reduced protection against detonation. While the reduced octane may limit the use of the fuel to only aircraft with compression values below a certain value, it does have the advantage of meeting the other specifications required for avgas, including vapor pressure and BTU value. The latter is a factor of significance in that it generally determines the fuel duration and, therefore, the range of the aircraft.

Ethanol, a fuel that has been used to power millions of cars in Brazil for many years, now, has a much lower BTU content for unit mass or volume than does gasoline. A few airplanes have been approved through the supplemental type certificate process to use neat (100%) ethanol, including the C-152 (Shauck & Zanin, 1996). The range limitations and other issues associated with this fuel, however, appear to work against expanding its use in aviation applications. According to South Dakota State University, AGE-85 (Aviation Grade Ethanol) is an ethanol-based fuel with the potential to be used in any piston engine aircraft (AGE 85, 2009). It is made up of approximately 85% ethanol, along with light hydrocarbons and biodiesel fuel. Supplemental type certificates allowing its use as either a neat fuel or in any combination with 100LL are available for the Cessna 180 and 182 model airplanes. As was mentioned before for pure ethanol, the lower BTU content of this fuel translates into reduced range. On the other hand, advantages for this fuel are said to include reduced deposits and cleaner burning, both of which may lead to consideration of increasing the time between overhaul (TBO).

A new fuel is in development in West Lafayette, Indiana, by researchers at Swift Enterprises who claim it will be a seamless, drop-in replacement for 100LL, Gerald Benner, the CFO of Swift, said that not only with this fuel meet all of the performance levels established by 100LL, it is also expected to extend aircraft range by 15% as a result of its higher energy density (personal communication, April 16, 2009). Those considerations coupled with octane equivalent to or better than that of 100LL and the promise of reduced emissions generate considerable interest in this bio-mass based fuel. Questions remain, he noted, including the true cost of production and the realistic pump price. Right now the company is working through the regulatory requirements of the FAA, and those of the airframe and engine manufacturers, as well. These are challenging issues, given that the specification for 100LL, actually calls out a requirement for lead among other things l that this biomass based fuel cannot meet either by definition or by design. A pilot plant is in the works, however, that will scale up production and provide telling information about true market costs of this promising fuel.

THE FUTURE OF FUELS FOR SPARK-IGNITION ENGINE

Of the fuels mentioned above, it should be expected that 100LL will be around in the immediate future but with a limited horizon, and that aircraft with diesel engines will continue to operate using Jet-A. The other fuels under discussion are either in development or are not in production, and each of them face significant challenges of one kind or another. Avgas without lead will have reduced octane compared to 100LL, and will meet the needs of only those airplanes with low compression engines. Although this group represents a large segment of general aviation, the interests of those operating high performance aircraft will not be served by fuel with reduced octane. Diesel engines, from all appearances, will eventually take their place in new aircraft designed from the ground up with those powerplants in mind. It is likely, at least in the view of the authors, that the current controversy surrounding the use of Jet-A in aircraft diesel engines will be resolved favorably so that Jet-A will continue to be the fuel of choice for those powerplants. It is unlikely, however, in the view of the authors, that many existing airplanes equipped with spark ignition engines will be retro-fitted with diesel engines. Although STCs are available to install the Thielert (TAE) diesel engine on several airframes, for instance, it is a considerable and costly undertaking.

If either 82UL (a never-in-production spec fuel), and 94UL (not yet a spec fuel, but could likely become one, quickly) were to come into production, little, if any change in airplane operation, support, and maintenance should be expected for those aircraft that could tolerate the reduced octane. However, it is conceivable, at least, that engines requiring the lead for lubrication and protection in the combustion chamber might see some additional wear when using the unleaded fuels. Certain supplemental type certificates for engines operating on autogas, for example, stipulate that the operator should regularly buy a tank of 100LL for the lead content in the fuel. Aviation maintenance personnel will need to fully understand these issues, and be prepared to diagnose and respond appropriately to problems that may result following the shift to such a fuel.

For those airplanes requiring the octane of 100LL, shifting to reduced octane fuel could be problematical. If technology and strategies were developed to make such changes possible, aviation maintenance personnel might well be involved to effect the changes. These could include, possibly, reductions to compression ratios, installation of (approved) advanced engine controls, and new limits on boost for turbo and supercharged installations, any of which may constitute major alterations to the aircraft. While such change could create opportunities for those working in aviation maintenance, it is obviously the hope of all concerned that another answer will be found to replace 100LL, as mandating reduced octane fuels will further hobble general aviation in otherwise very difficult times.

Could the Swift fuel provide the answer general aviation is looking for? A fuel that emulates the octane performance of 100LL, has at least similar energy content, is cheap, and is renewable, has been the Holy Grail of aviation for many years, now. Although nothing is certain, Swift Enterprises is nearing the conclusion of the development effort, apparently, and is now hoping to work through the regulatory and approval processes. If this fuel lives up to its hype, it could be a transparent replacement for 100LL and other grades of aviation gasoline, which would, of course, be very good news for maintenance and other support personnel in aviation, as well. General aviation wishes Swift Enterprise the best of luck.

DIESEL ENGINES AND JET-A

The above fuels are targeted for the spark ignition engines that prevail in aviation. A different solution has been under development for some time to bring diesel engine technology to general aviation with a plan to use Jet-A as the fuel. Diesel engines are not new to aviation - in fact, a Packard diesel won the Collier Trophy nearly 70 years ago. Many diesels were designed during that time, but they all suffered from a very high weight-to-horsepower ratio, which made them impractical for airplane use. In World War II, liquid-cooled Jumo Diesels powered a number of German aircraft successfully; however the relative light weight of the turbine engine made it the powerplant of choice for larger aircraft, at least, following the war (Aero-Diesel, 2001).

Given the availability of Jet-A, and its generally lower cost in comparison with 100LL, it is no surprise that diesel engines have been resurrected for aviation purposes. The progress to date, however, has not been quite as good or as rapid as was originally hoped. As far back as 2001, some predicted that the TAE 125 diesel engine made by Thielert Aircraft Engines, for one, would soon power a certified airplane, and that spark ignition engines and the need for aviation gasoline would largely disappear in the near future (Aero-Diesel, pg. 58). Acknowledging the intense scrutiny that 100LL had come under for its lead content, aircraft companies began to give serious consideration to the diesel engines available at the time. Diamond Aircraft certified their twin-engine DA 42 TDI and single-engine DA 40 TDI airplanes with Thielert diesel engines, but soon thereafter the engine manufacturer became insolvent while their engines continued to suffer serious and expensive development problems, including an airworthiness directive requiring the replacement of the transmission.

According to John Layne, a Diamond sales representative, the German-designed Thielert engine requires the use of metric tools, and maintenance personnel must attend factory training specific for these engines (personal communication, April 16, 2009). Mechanics may replace fuel pumps, turbochargers, and the clutch, which is designed to dampen the high power pulses of the diesel engine, but they may not open the engine. Replacing the clutch, he noted, costs approximately $2600 and is required after 300 – 600 hours of operation. Attempting to overcome these costly problems and find economical solutions for their customers, Diamond elected to work closely with Austro Engine, a new aviation engine manufacturer in Germany, in the development of an engine that could replace the Thielert engine on their airframes. The Austro is also a geared engine, but rather than a clutch as is used on Thielert engines, it has a torsional device installed between the engine and the propeller to absorb the high power pulses associated with the diesel engine. Kenneth Harness, the COO of Diamond, stated that Diamond is encouraging owners of their Thielert-equipped airplanes to re-engine with either the new Austro AE 300 engine or the venerable Lycoming IO-360, which was certified as on option on this airframe just recently (personal communication, April 17, 2009). Owners may find motivation to follow this advice, in light of the fact that mandatory gear box inspections must be performed on the Thielert at 300 hour intervals, and a new gear box costs $16,000. Potentially, this may drive the amortized overhaul costs over $100 per hour, in comparison with Lycoming costs for a similar size engine of approximately $12 per hour (Wikipedia, Diamond, 2009). Opportunities may abound, one would think, for aviation maintenance personnel to perform either repetitive inspections or engine changes on Diamond airplanes, as more than 800 of them are Thielert-equipped.

Although Thielert has been the most prolific manufacturer of diesel engines for airplanes, other companies are also building diesel engines. SMA, a French company, makes a 4-stroke diesel engine that produces 230 horsepower at 2200 RPM and is STC'd for the C-182. DeltaHawk is building 2-stroke diesels in a V-4, direct-drive configuration. No airplanes have yet been type certificated with these engines. Zoche is another manufacturer of 2-stroke diesels, but it builds radial engines, with four cylinders to a row. No airplanes have yet been type certificated with these engines. Wilksche Airmotive Ltd. also builds two-stroke engines, none of which have yet found a home aboard a certified airframe. Some of these engines have promising futures, if the manufacturers can weather the economic storm and make their way through the certification process.

CONCLUSIONS FOR AVIATION MAINTENANCE AND OTHER SUPPORT PERSONNEL

Several scenarios may play out over the next few years in the aviation fuel arena. It does appear likely that the new EPA lead standards will eventually push 100LL out of the market, to a large extent. If this happens soon and no fuel is found in the meantime that measures up to the octane of 100LL, then 82UL, which is already a spec fuel, and 94UL, which is NOT yet a spec fuel, may come into production rapidly. For those aircraft not requiring either the octane of 100LL or the protective quality of lead for the valve and valve seat, the change may be completely transparent. Mechanics may no longer find any lead deposits in spark plugs and other engine locations, which could save a little time and money. Otherwise, they are likely to notice no difference in their work or the operation of the engines following the shift to these fuels.

For those aircraft that require the octane provided by 100LL, the shift to a lesser fuel will require some aftermarket work, of one kind or another. Changes to compression ratios or ignition timing and installation of advanced controls, for instance, will require the services of aviation maintenance professionals. It is the opinion of the authors that an answer to the octane problem will be developed before 100LL is removed from production. That replacement fuel may be a gasoline with other additives substituted for lead, or it may be a Swift-type fuel, which is based not on petroleum products, but on bio-mass. Maintenance and other support personnel must be aware of these changes when they occur, and some alterations to paperwork and placards may be required. Beyond that, there may be little to notice from such a change.

Diesel engines, on the other hand, represent a significant change in engine technology, In view of this, training in the differences between diesel engine and spark ignition principles and characteristics is very important, so that the mechanic is better able to troubleshoot wisely, and work in a proactive manner. Most likely, if they are to perform work beyond a very basic level, aviation maintenance personnel will be required to attend factory training specific to the diesel engine in question. Given that diesel engine technology has been developed to a high art by the Germans, it should be no surprise to find that metric tools will most likely be required of the mechanic. The mechanic will find no magnetos or electronic ignition systems, but will be dealing with high pressure pumps and injection systems, which are the heart of diesel engines.

As a result of the extremely high compression ratios involved, diesel engines create high power pulses in comparison with their gasoline powered cousins. This characteristic has created fatigue issues and design challenges for propeller manufacturers, but apparently they are finding solutions to these problems (Disbrow, 2009). The diesel engine manufacturers are also working to overcome these issues. Thielert engines utilize a clutch between the engine and the propeller to absorb the pulse, while a torsional device is used for the same purpose on the Austro engine. The clutch on the Thielert installation has proved to be a costly wear item, as may be the reduction gearbox on those diesel engines using them. Aircraft mechanics are most familiar with direct drive engines, at least in piston applications, and therefore may require training in order to be prepared for this type of work. These new diesel engines may be equipped with a full authority digital electronic (or "engine") control, most often referred to as FADEC, to control the throttle, propeller, and other considerations in one lever. The FADEC will most likely NOT be a field-repairable item.

Other support personnel, including lineman, should become familiar with the different types of aircraft such that they know without question the fuel required in each case. Diesel engine aircraft will most likely continue using Jet-A and the fuel tanks should be clearly placarded as necessary to avoid confusion. The real problem may occur when two models of the same airplane, one with a spark ignition engine, the other diesel-powered, end up on the ramp, together. This could specifically be the case for both the Diamond DA 42 and DA 40 models, in the future. One version requires Jet-A, the other avgas. Over the years, a number of piston engine aircraft have been mis-fueled with Jet-A, the result of which has included fatal accidents, in the worse case scenarios, and only badly damaged engines for those fortunate enough to discover the problem prior to take off. Opportunities for such errors may increase as the fuel situation changes, and only thorough training for support personnel can prevent these from occurring.

RECOMMENDATIONS FOR PART 147 SCHOOLS

There is a new Part 147 regulation in the works, and the Part 147 working group appointed by the FAA has submitted their final report related to this to the Aviation Rulemaking Advisory Committee (ARAC). A Notice of Proposed Rulemaking (NPRM) is expected soon, followed by a public comment period (Johns, 2009). It seems unlikely that the new regulation will mandate inclusion of diesel engine technology, inspection, and repair topics in the Part 147 curriculum, but it is hoped that changes to the regulation may allow for easier and quicker incorporation of new and pertinent topics into the curriculum. Schools are obviously waiting for the new regulations, prior to making significant changes in their curriculum. As of now, those schools with the luxury of extra program time above and beyond their approved curriculum could unilaterally decide to focus some level of attention on diesel engines. In those programs that operate very close to the margins of the required time, however, it may simply NOT be possible to discuss these topics. Generally speaking, mechanics working on these new engines will be required to attend factory training, and the expectation is that owners of diesel engine aircraft will probably have little choice but to have maintenance performed by shops equipped and prepared for the job.

As the diesel engine manufacturers struggle to bring their new engines to the marketplace and survive in a difficult economy, the chances of aviation maintenance schools acquiring industry support for training of students appear unlikely. If and when FAA mandates this type of training, it will become a matter of priority to pursue relationships with the manufacturers and their service centers such that students can learn the technology using equipment typical of that found in the commercial world, and are then prepared for the challenges these promising powerplants and fuels bring to aviation.

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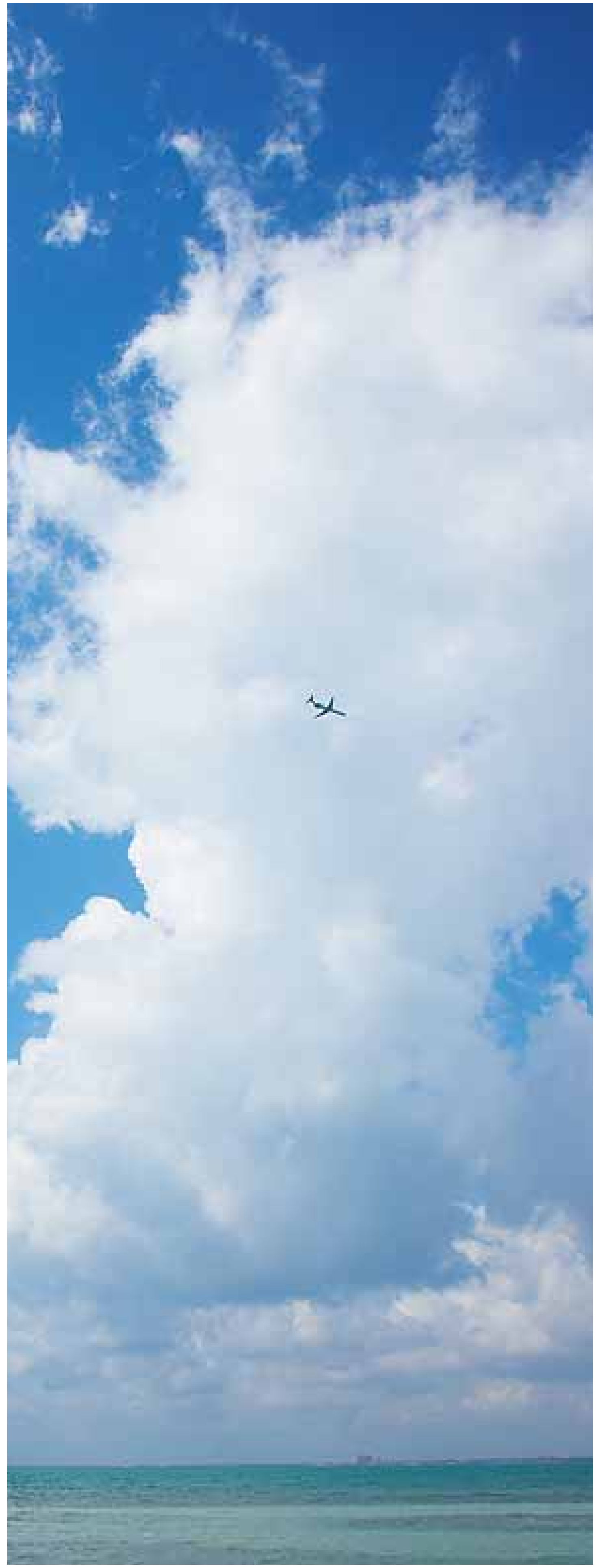
BIOGRAPHY

David L. Stanley, associate professor of Aviation Technology at Purdue University, divides his time among teaching, research activities, and administrative duties. He teaches primarily powerplant related courses for the Aeronautical Engineering Technology plan of study. Professor Stanley has been curriculum chair for Aeronautical Technology and currently chairs the ABET accreditation initiative. He has been a lead investigator in two bio-fuels research projects, and continues to explore alternative fuels for aviation applications. Professor Stanley has authored or co-authored more than 25 papers and presentations, and is continually engaged in scholarly activities as a journal reviewer. He was honored to be named by the Aviation Technician Education Council (ATEC) as Ivan Livi Instructor of the year for the year 2004.

He earned a Bachelor of Arts degree in Math and English Education followed by a Bachelor of Science degree in Aviation Technology and a Master of Science degree, all at Purdue University. He holds the Airframe and Powerplant (A&P) certificate and is a certified flight instructor.



Is ABET for You? History and Rationale of Pursuing ABET. Inc. Accreditation

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INTRODUCTION

Are these credentials worth the effort for your school? That is for each school to decide for themselves. The specific criteria for Aeronautical Engineering Technology programs are described in the Technology Accreditation Commission's criteria (ABET, 2008). The criteria are outcomes-based in that the focus is "on what is learned rather than what is taught" and allow programs to innovate and improve (ABET, 2009). This series of articles will highlight the reasons why, and give basic information on why we decided to pursue this course of action, and some of the basic blocks of building the system of review.

"In 2005, ABET formally changed its name from the "Accreditation Board for Engineering and Technology" to ABET, Inc. This allows the organization to continue its activities under the name that represents leadership and quality in accreditation for the public while reflecting its broadening into additional areas of technical education." http://www.abet.org/history.shtml

"Currently, ABET accredits some 2,700 programs at more than 550 colleges and universities nationwide. Each year, over 1,500 volunteers from its now 29 member societies actively contribute to ABET's goals of leadership and quality assurance in applied science, computing, engineering, and technology education, serving as program evaluators, committee and council members, commissioners, and Board representatives. ABET has been recognized by the Council for Higher Education Accreditation (CHEA) since 1997.

Over the last few years, our faculty members have attended the ABET meetings to garner a better understanding of ABET accreditation process. One of the recurring themes that surfaced was the necessity to "keep the process simple", and to have everyone involved to prevent the tasks from becoming overwhelming for any one person/persons. This need not be an overwhelming task. With a very busy faculty, getting them to buy in may be the hardest obstacle to overcome. Through conscientious thought of this specific issue, we developed a system that keeps the time element involved to a minimum, yet keeps the individual faculty members active and in the loop.

THE LEGACY - OUTCOMES BASED TRANSITION IN PART 147 SCHOOLS

Outcomes based assessment is a departure from the old count the number of "hours students sit in a seat" approach. In the past engineering courses have had a similar type of accounting for the seat time as had aviation programs. In the case of engineering and engineering technology the method has been to make sure the student took X amount of calculus and physics, and at the end of having been through all those classes, engineering faculties assumed the student would turn magically into a functioning engineer. Aviation has historically used a similar method. The aviation student is required to spend X amount of hours in an aviation class, and by virtue of warming a seat for all those hours an airman is produced. This method of accounting for seat time for aviation students is not likely to go away in the near future, however for those 4-year aviation programs that go beyond the A&P certificate, there may be a benefit to looking at new methods used by engineering for educating students in the 21st century. Because of a crisis in the knowledge base of graduating engineers, the accreditation board for engineering and technology known as ABET, Inc. (Formerly the Accreditation Board for Engineering and Technology) has adopted a radically different approach to education. This approach is known as Outcomes Based Education.

In the outcomes based system it is no longer sufficient for a student to sit in a seat for a certain number of hours and take tests. The outcome based system requires that the school examine the program as a whole and the content of the courses to make sure that the student is being given the required information in a manner that the student can maximize learning. Goals for the program and the courses are identified, and these goals are monitored throughout the program every semester. If the students did not meet the goals the methods are adjusted to improve the learning. This method goes beyond simply measuring scores on a standardized exam. It examines the methods of assessment, both examinations and other wise, are evaluated to make sure they can accurately assess what the student knows.

In the past assessment in aviation programs has had advantage over assessment in programs like engineering. By the very nature of an aviation program there has always been some kind of capstone event where the student has been asked to pull all the concepts together and display their knowledge. For pilots, there have been check rides. For ATC and Dispatchers there have been practical examinations. For mechanics there have been the lengthy Oral and Practical examinations. And for all there have been the standardized FAA written exams. For better or worse these capstone events have provided a common ending point for all instructional programs to have some minimal feedback for judging the programs. They have provided uniformity in purpose and in content not found in other academic pursuits. While some might argue that these kinds of highly focused capstone events tend to more appropriately represent training rather than education, it should be pointed out that other professional disciplines also have very focused application based capstone events. To name a few, doctors and nurses take practical and oral examinations, lawyers take the bar exam, and engineers are heavily encouraged to take the practical engineering examination. While each of these shares the Part 147 aviation requirement for a knowledge of specific applied detail, success at the application of this detail is accomplished best when the appropriate education has been applied as well.

However, examinations at the end of a period of study are still running in an open loop. Whether the exams are unit tests in a class, final examinations or even the aviation mechanic's Oral and Practical tests are still an open loop. The standards employed in aviation are artificially set in many places. Sometimes that standard is set by the FAA and sometimes it is set by the course instructors. If the standard used to measure success is the measurement of the number of hours a student attends a class, or is it whether that student passed a written test, there is no direct link back to the method of teaching or measurement of how well the students are learning.

It should not be inferred from what has been said that the authors take issue with the FAA standards as an appropriate base line. Rather the authors are saying that the FAA guidelines for attendance in class, and the successful completion of official tests and practical applications, should not be used as the only, measurement of learning. As the FAA is so fond of saying, the regulations provide the minimum standard. If outcomes based education is applied correctly it can therefore be possible to determine where the minimum standard is best and appropriate and where in other places better or different methods need to be applied.

In the old methods used in teaching data may or not be collected on why students met or did not meet the set standard. If data has been collected on student performance it might or might not accurately relate to what was taught in the class or how the material was taught. In many cases, making sure that the course content, course delivery, and student evaluation is left up to the individual instructors. In some programs the program chair provides a centralized guidance on how student should be evaluated. In either case, historically, it might be assumed that as long as the students have met the FAA standards it is assumed that the teaching mission has been accomplished.

In an outcomes based system the FAA requirements are one of the inputs for assessing success. Industry inputs may be another. Faculty inputs may be another. Data collection on post graduation job placement may be another. In cases where a school is tracking external data the school may showing the desire not simply for the student to meet the FAA standard, but for the student to secure better jobs in industry. The school may be attempting to satisfy the needs of a close industrial partner such as an airline, repair station, or aerospace manufacturer. Using inputs from many different sources an educational program can gather inputs on how well the program is accomplishing its goals for the type of student produced. The program can also gather information on how well individual courses are succeeding at teaching specific concept areas. Since different schools serve different customers, the manner in which FAA topics are taught may differ. Even with the FAA standards as the foundation for the program, every school will have a need to tailor its program for the specific industrial customers it wishes to serve. What this means is that for many aviation schools, using the FAA standards as the method for assessing program success is not the capstone event for the program. Successful accomplishment of FAA standards is one key element in the process. So how does a school measure the accomplishment of its goals beyond those given by the FAA?

In an outcomes based system, the school must develop a documented system for determining its goals, measuring its success, and improving where it has shortcomings. This improvement of shortcomings is an element that even in a regulated FAA environment where many schools do not have a documented system. In a Part 147 program for example the regulations are clear on program content, hours to be spent, and how the outcome is to be measured, but even in this highly structured system, the FAA does not provide a regulated system on how to measure why students did not learn, and how to improve the learning system. The system used today by many aviation schools follows the concept that the FAA provides the standards, the schools put the students in the seats for a certain number of hours, and if the student does not meet the standard, then that is the student's problem. While most aviation instructors do not really believe that in practice, that is in actuality the way the current system works in philosophy.

To close the loop on knowing that the academic program is meeting it objectives, there are concepts which should be documented:

1) The goals of the program both internally and externally.

2) How the goals are to be met.

3) How meeting the goals will be measured

4) What the acceptable level of accomplishment is of the program goals.

5) What changes will be made to improve to meet unattained goals.

6) How the goals are to be re-assessed for future validity.

Items 1 and 2 are probably familiar to aviation schools already with regard to the internal goals of the program. The regulations governing an aviation program already dictate the general goals in broad terms and tell how to meet these goals. Collaboration with the FAA can often fill in some of the acceptable details. These details then show up in whatever operating manual or operating specification the school submits to the FAA for approval. Items 1 and 2 may even be familiar to a school in terms of how it wants to interact with its external customers and industrial partners. Some schools may have goals of wanting to supply graduates to for general aviation careers, or for major airline careers, or to transition military personnel to civilian careers. These are goals that program can have as it sets its sights on the markets it wants to serve.

Specifics on items 3 through 6 however are usually not defined, documented, measured and evaluated, and systematically tracked for improvement. The old method of having faculty sit around at a meeting and randomly discuss improvement concepts is not acceptable in an outcomes based system. Even assuming good intentions, good interactions, and a motivated faculty, undocumented open loop method is a hit and miss system at best. It operates on incomplete data, and is subject to all the common failings of a subjective assessment.

In an outcomes based system, the faculty and administration should be able to have data from all aspects of items 1-6 with which to make decisions. A documentation system must be established to continually collect and track the data from items 1-6.

Outcomes based assessment also requires continual tracking and improvement of the individual courses. Once the program goals are established and a documented system for tracking, collecting, evaluating, and improving those goals are in place, a similar system must be put in place at the course level. Again in an aviation program the FAA often has specific course related goals that it wants accomplished. In reality however these goals are very broad. In a maintenance program the FAA may require that a student demonstrate the ability to remove and reinstall a major flight control surface. In a flight program the FAA may require that a student working toward an instrument rating be able to hold a specific altitude. While on the surface these may appear to be specific course goals, in reality they can be taught in a variety of ways both to meet the FAA requirement and to exceed it. If there were no variability in aviation programs, FAA Principle Inspectors from Flight Standards District Offices and from FAA Regional Offices would have nothing to oversee, since everything would be identical everywhere.

In reality schools already determine how they are going to meet the FAA regulation and supply the FAA with that information for approval.

In this system, except for the fact that the student must regurgitate specific technical information for the FAA on written tests and on practical examinations, there is basically no data collected on how well the student learned the information or how the student might have learned it faster and better. Using only the course exams, FAA written tests, FAA oral exams, and FAA practical exams, provides little or no feedback to the school on how well the material was taught or how to improve the teaching. Compounded to this problem is that much of the FAA test material is subject to the Freedom of Information Act and is actually in the public domain. While it is really not a problem if a student chooses to memorize the entire database of FAA written test questions, since they probably will learn something along the way, this makes using the FAA exams and maybe even the schools exams of limited help in assessing how well learning is happening actually in the courses.

Just like at the program assessment level courses must be assessed based on:

1) The goals of the course

2) How the key goals will be met

3) How the goals will be measured

4) What the acceptable pass/fail rates might be

5) What changes are made in the courses to facilitate better learning

6) How the goals will be re-assessed on an ongoing basis.

This circle of assessment basically involves; developing the goal, teach the goal, measure the goal, evaluate the teaching and the measurement means, improve the teaching and the measurement, re-assess the goal, and back to the teach the goal. This is well beyond what the FAA currently requires and provides a level of course and program assessments that can meet and exceed the FAA standards compared to the old concept of just counting the seat time and pass the written examinations.

In the engineering community, this method of program and course assessment has already become a fact of life. A the number of domestic students attending engineering schools has plummeted to record lows over the past 20 years, and as graduating engineers found themselves ill equipped to perform practical engineering. Schools have come to the realization that improvements have had to be made in the way they measured and assessed their success. This outcome based model developed by ABET has become the standard for educational assessment and it is gaining acceptance beyond engineering. Many aviation schools have some of the same issues as engineering in terms of being able to define what their goals need to be and how they need to accomplish them. Four year aviation programs housing A&P programs seem to be under especially hard pressure to define what their program goals should be, and to show university administrators data on how the program is succeeding at goals which are important to industry.

There are a variety of ways to go about setting up a system of establishing the goals and tracking the data for a program and for courses. There may be as many ways as there are schools. The faculty in one computer engineering program created an elaborate computer software program that monitors students' successes on key test and lab projects. Over 50 parameters per class are measured each semester. The software uses information from a variety of sources to determine internal validity of the test questions and lab projects, as well as tracking student performance against a variety of measures. OK that is one way to do it; however even by engineering standards many people thought that system was overkill: serious overkill. Other schools have used relatively simple tools to measure and track the accomplishment of the key goals. Assessment accrediting bodies have view either method as acceptable. Accrediting bodies however heavily emphasize the KISS method (Keep It Simple, Stupid) for measurement and tracking.

If an assessment program becomes complex and cumbersome the faculty will refuse to participate, and the flow of data will soon dry up. Also in a complicated system the faculty administering the assessment program will become over-whelmed.

The assessment bodies seem to be emphasizing several key points: maintain simplicity in the design of the tracking methods, measure a few key points, don't over sample, don't make too many changes at once, have the system updated two or three times per academic year, get all the faculty involved, and have a documentation system for collecting and analyzing the data.

It is in this last area that aviation programs seem to have a distinct edge over other academic programs. Aviation schools are accustomed to having a documentation system. Aviation programs must maintain and update program manuals for the FAA already. The practical examinations for giving check rides or mechanics exams have an extensive documentation process. In this one area, aviation programs have the potential to far exceed the capability of other academic programs, where faculty is often unable to work together to a common program document.

The Aviation Technology program here has chosen to pursue engineering technology accreditation for its aviation maintenance program. Purdue has chosen to keep the A&P program as a centerpiece of the engineering technology program. This decision was based in part on information gathered from industry partners and from engineering schools as a part of exploratory process for making the decision to move to an engineering technology program. These inputs have become program level feedback for the goals of Purdue's development of an outcomes based assessment program for aviation technology.

The follow-on article is the first in how Purdue University is incorporating these concepts into a simple system by explaining one method of developing such a documentation system. There will be others covering more of the building blocks of how this was accomplished at Purdue University.

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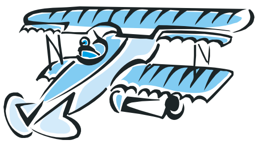
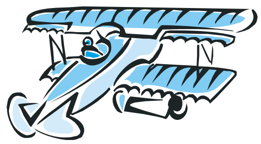
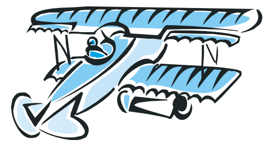
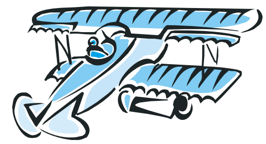

School Spot Light Vincennes University

Vincennes University has been doing airframe and powerplant training since the late 1960's. We have been located at the Indianapolis International Airport since 1992 and are part of an arrangement with Purdue University. Students can attend classes at the Aviation Technology Center and earn an A&P certificate and AS degree from Vincennes University and then earn a BS degree from Purdue University without ever leaving the building.

The ATC is a 90,000 square foot state of the art facility that houses VU's full functioning Boeing 737 and many other aircraft. Because of the 737 and other high tech lab equipment VU is able to better prepare our students to go right to work on big aircraft upon graduation. In addition to our standard 147 program we also provide General Familiarization training for local airlines and MRO's like AAR corp. Currently we offer Gen Fams on 727, 737, 757, and Airbus A320. Students attending Purdue can specialize in Air Traffic Control, Aircraft Dispatch, Aviation Management, composites, avionics, and NDT. For more information check out the website at www.aviationtechcenter.com.

U.S. Sport Aviation Expo 2009

The light sport aircraft expo was held at the Sebring FL airport winter 2009 with many displays, booths and flying demonstrations. Anything and everything that had to do with light sport aircraft was addressed at this weekend long aircraft feast. Many home built kits to complete aircraft and even an electric aircraft were on hand to view. Aircraft and engine venders had booths to explain and tell about their newest engines for light sport aircraft.

Electric aircraft which provided about one and half hour flight time.

Fly-bys were carried on all day.

Booths providing light sport information were very plentiful.

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Teaching Go-No Go Avionics Testing in a Part 147 Airframe and Powerplant Curriculum

Dennis R. Hannon
Assistant Professor
Southern Illinois University Department of Aviation Technologies

ABSTRACT

When technicians undertake an annual or 100 hour inspection on an aircraft, closer examination of the avionics systems beyond simply powering them up and listening to outputs or tuning in an automated weather station is not often performed. This omission may be due to the lack of proper test equipment available for use by the airframe and powerplant (A & P) technician, lack of knowledge as to how to perform basic avionics systems testing or both. Successful integration of go-no go avionics testing instruction into a Part 147 airframe and power plant curriculum is a step in solving the knowledge deficiency and a number of relatively inexpensive portable hand held test sets are available which can address a lack proper equipment. Students entering the A & P workforce who have completed go-no go avionics test training have the skills to perform procedures which can provide important operational information to owners and operators while enhancing aviation safety. In instances where deficiencies are found, the owner can either be referred to an appropriate repair station or, if the repairs are external and fall under the purview of a typical A & P shop, performed locally. Whatever the final outcome, well performed and documented basic avionics systems testing be of great benefit to both owner/operators and inspection facilities while promoting thoroughness and professionalism within the periodic aircraft inspection process.

INTRODUCTION

In my experience as both an avionics technician and instructor working with Airframe and Powerplant (A & P) and Inspection Authority (IA) personnel, I have noted that while most certificated inspection facilities and individuals perform thorough annual and 100 hour inspections, similar attention to performance validation of avionics systems performance is often lacking. The reasons for this may be several, including the lack of trained avionics technicians in residence at smaller inspection facilities, the lack of appropriate testing equipment, the fact that many avionics checks are not required by the FAA, or the idea that avionics test equipment of any value is too expensive and complex for the smaller inspection facility to acquire and maintain. While the first three reasons may still persist, low cost, calibrated test equipment is available that can provide valuable systems status validation which virtually any qualified A & P technician can operate with a minimum of training and practice (Hagge, 1992).

Back in the 1980s, common avionics test equipment often consisted of a suite of expensive instruments (figure 1) which may have included an IFR 401L Nav/Com test set and IFR 600A ATCRBS/DME Test Set or equivalents, a calibrated digital multimeter and various support equipment such as a high quality oscilloscope, pitot-static tester and the various interfacing devices to connect the test sets to the aircraft or units under test (UUTs). If the shop was equipped to test weather radar systems, equipment such as an IFR RD 300 WX Radar test set may have also been included. While excellent equipment in their day, the cost of acquisition of these instruments could easily have totaled well over $50,000.00 (Dallas Avionics). Today, thanks in part to the digital revolution, ubiquitous use of integrated circuit microprocessors, and judicious use of firmware and software, the cost of basic state-of-the-art test equipment for avionics flight line maintenance testing has come down considerably. The term *flight line maintenance testing* is used here rather than *bench testing and repair* as most manufacturers currently prohibit equipment handling beyond installation and in-service, or go-no go testing for proprietary, intellectual property preservation, and liability reasons. Even basic avionics system installation, once under the purview of even small mom and pop airframe shops, has become limited to those entities that have participated in a manufacturer operated or approved installation training and certification program. The days when many shops had the ability, not to mention the expertise, to open up a box and perform troubleshooting and repair at the component level are likewise long gone. Companies' warranties along with any inferred liabilities are usually instantly voided by attempts at the flight line maintenance level to perform in-box repairs. Whether this restriction is right or wrong may still be a matter for argument, but that is the way things are under the current avionics maintenance climate. These restrictions, however, do not preclude shops from performing extensive and meaningful go-no go inspections on avionics equipment nor do they preclude Part 147 schools from teaching the basics of go-no go testing using relatively inexpensive hand held test sets. It should be noted that the FAA does require periodic certification of VOR equipment used in IFR certified aircraft and perennial inspection of ATCRBS transponders all aircraft in accordance with appendices to FAR Part 43 beyond simple go-no go testing, however, a few types of these inexpensive hand held units can be used in this endeavor (FAA, 2008).

Figure 1. IFR RD-300, NV 401L and ATC 600A Bench Test Sets

While large avionics manufacturers such as Honeywell and Rockwell-Collins and many smaller ones have included built-in-testing (BIT) regimens in their Primus, Proline and similar equipment respectively, a technician normally needs to attend a week long, $5,000.00+ service school to take advantage of the full capability of these resources (Rockwell-Collins, 2005). Even so, these procedures are limited as to what is going on internally with the system or its interfaces and are not necessarily capable of determining whether a signal is getting out or external signals are getting in without distortion or degradation. Enter the hand held flightline testing units. These little, inexpensive devices can generate, transmit and receive communication and navigation signals as well as meet as FAA performance validation testing requirements when properly certified and calibrated. Proper and effective use of these units does require training, but they are relatively easy to operate and often the need to interpret data beyond direct indicator readout is manageable.

DISCUSSION

As to hand held test sets with which we have had extensive experience in our A & P training program, units manufactured by TKM, Inc. of Scottsdale, Arizona consisting of Michel Nav/Com NC 2210s and Michel ATC 3300s have become integral parts of the Aviation Technologies program at Southern Illinois University. The 2210 is designed to perform basic traditional communications and navigation systems testing and the 3300 is used to perform transponder function testing including performance validation as required in FAR Part 43 Appendix F when it is properly calibrated and certified (FAA, 2008). The NC 2210 retails for about $1600.00 and the ATC 3300 for about $2500.00 (Eastern Avionics, 2008). Annual calibration of the units run around $300.00 if no repairs are required. Conversely, annual calibration and typical recurrent repairs in traditional tests sets such as the IFR 401L and 600A run about $1,500.00 (Aeroflex, 2008). The testing that the TKM sets are capable of performing is non-invasive in that the units under test (UUTs) do not have to be removed from the aircraft nor do they need to be electrically connected to the test sets. The 3300, however, does have a provision for a direct, unattenuated coaxial connection between the test set and the ATCRBS transponder should that arrangement be necessary or desirable.

Testing procedures for the NC 2210 NAV-COMM test set are straightforward. The unit has two controls, one for function and the other for modulation select. Two liquid crystal displays related to each control are also employed. One indicator displays the carrier frequency and the other the modulation type. The function control, in addition to turning the unit on, permits the user to select the component and test desired. Included are: Localizer (LOC), Glide Slope (GS), VHF Omnidirectional Range (VOR) (4 settings), Marker Beacon (MB), Communication Receive (COMM) and Communications Transmit (TX). The modulation select control determines the type of modulation which is impressed on the appropriate carrier frequency for the unit under test (UUT) as related to the function control setting.

Carrier frequencies used for testing are limited to 118.000 MHz for communication receive and transmit, 108.0 for VOR and 108.1 MHz for localizer (automatically co-tuned to the paired GS frequency of 334.700 MHz). The common marker beacon carrier frequency of 75 MHz is employed in the MB Mode. The Marker Beacon setting permits tuning 400, 1300 and 3000 Hz tones on the 75 MHz carrier in dots and/or dashes relating to the outer, middle and inner markers respectively. Further, audio modulation can be varied from a continuous 1020 Hz test tone to dots or dashes on the COMM TX setting as well. Course deviation relating to four VOR function test settings of 0°, 90°, 180° and 270° can be varied by the modulation control in +/- 10, 20 and 30, or 40 degree increments. This option permits phase shifting of the 30 Hz variable and reference signals to verify appropriate course deviation indications on the aircraft VOR/LOC display. In the LOC and GS mode, the modulation control provides difference in depth of modulation (DDM) settings to verify proper needle deflection. A 1020 Hz identification test tone can also be included in the signal. LOC and GS modulation selections relate to differences in depths of modulation (DDM) represented by digits from 0 to 2 equating to the actual DDM differential values of zero, +/-.047, .094 and .188. In both the localizer and glideslope modes, either the 90 or 150 Hz modulating signal can be eliminated to demonstrate signal reliability indicator flag operation. Appendix 1 iterates conversions of DDM values and currents relating to LOC and GS needle deflection.

In addition to the operating controls and readouts, the unit has an adjustable whip antenna and RCA type phone jacks for audio out (headset), radio frequency out (RF) and modulation out (DMD) connections.

The NC 2210, figure 2 below, has an on-board rechargeable battery which the manufacturer rates at over 2 hours running time. Our experience, however, has demonstrated that portable power duration is substantially less for continuous testing and we have found that use of a light portable 12 VDC battery pack with a cigarette lighter/accessory power jack adapter and a power cord is convenient for prolonged on-the-ramp usage. A standard 12 volt 500 mA wall transformer-rectifier is used to charge the batteries or can also operate the units in test mode while charging the batteries where 120V, 60 Hz AC is conveniently available.

Figure 2. Michel NC 2210 Test set with accessories

Calibration of the NC 2210 may be performed by a certified avionics test equipment calibration facility and is recommended to be performed at least annually or following repairs. Manufacturer's tolerance of transmitted frequencies is generally rated at +/- .003% with accuracy varying from .005 to .01 DDM for LOC and GS and 1.5° for VOR. Transmitter signal frequency, distortion, phase shift and receiver operation measurements are among the calibration parameters analyzed and calibrated if necessary. The standard unit warranty is 2 years from date of purchase.

OPERATING CHARACTERISTICS AND LIMITATIONS

Most NC 2210 test operations and monitoring can be conveniently carried out with the test set in the cockpit and the antenna pointed out a window or vent. An exception to this is the marker beacon test in which the test set antenna and therefore the test set itself has to be in close proximity to the aircraft MB antenna. This operation would ideally require two technicians, one with the test set and one on the flight deck each equipped with FRS or similar band walkie-talkie if systems on large transport category aircraft are to be tested. If the aircraft is equipped with a 14 volt system and contains a cigarette lighter type accessory jack, a properly rigged and polarized power cord can be used to power up the NC 2210. The headphone jack on the test set permits the technician to listen to transmissions from the aircraft com radio so fidelity in addition to whether a carrier is present can be evaluated. This is especially important for a go-no go testing device as audio distortion; even with a good, strong carrier is not uncommon.

We have found that training time for our technicians is minimal assuming they have the basic understanding of traditional avionic systems which most airframe and powerplant technicians possess. The early Preliminary Users Manual for the TKM Michel 2210 was Spartan at best, requiring the user to do a substantial amount of interpretation (TKM, 2002). The revised manual provides some improvement, however, it is recommended that a step by step checklist procedure be developed for each test employed to prevent errors and assure proper test operations are performed, especially for technicians unfamiliar with avionic systems (Hawkins Associates, 2008). Following an introduction to operating concepts of aircraft communications, navigation and ILS systems, about an hour of additional training is necessary on the NC2210 for the user to become proficient in its operation.

Limitations of the NC2210, in addition to the requirement for the MB test to be performed with the unit close to the aircraft MB antenna, include the limited number of COM, NAV and ILS frequencies available on the test set. Conventional aircraft COM systems with 25 KHz channel separation can tune 760 channels (with well over 1,000 available on the new 8.33 KHz channel separation units). In addition, 200 VOR/ILS channels at 50 KHz separation are also available. The test set frequencies are limited to 118.0 MHz for COM, 118.1/334.7 MHz for LOC and GS ILS and 108.0 MHz for VOR. Each of these channels is at the lowest frequency in its respective band, limiting effective testing of center and high end signals in the respective bands. For relatively simple go-no go testing, however, these may be adequate.

The Michel 3300 ATCRBS Transponder Test Set, figure 3 below, is somewhat more complicated to use than the NC 2210, but offers a broad range of tests for both mode 3A and C transponders. Functions include interrogation signal adjustment including: pulse repetition frequency check; P1, P2, P3 and P4 level and P3, P3 and P4 position; pulse width and frequency measurements to check the tolerance of the transponder under test in receive mode. Reply test parameters include: frequency, power output, % reply, delay, squawk code identification, altitude code and pulse width. In addition to a digital reply code readout, a row of LED lights denoting the A, B, C, $D_{1, 2 \text{ and } 4}$ codes, F_1 and F_2 framing pulses and the SPI pulse is also present. As in the case of the NC 2210, the unit employs two readouts, the upper one for reply characteristics and the lower for interrogation characteristics. BNC type jacks are present on the front of the unit for interrogation and reply signal outputs. An external power port is also available for charging the on-board batteries or operation from an external 12 volt DC power supply.

Figure 3. Michel 3300 ATCRBS Transponder Test Set

Limitations of the 3300 are primarily related to difficulty in interpreting the readouts. While the operator's manual does a good job of explaining the meanings of the readouts and step-by-step directions on how to interpret them, the procedures are, in some cases, extensive and must be carefully studied and practiced to minimize user error. Battery time is given as 1 hour minimum, but as was the case in the NC2210, found to be substantially less. Again, either 120 volt 60 Hz AC or a 12 volt DC external battery pack is recommended for ramp use. Nevertheless, the relatively low cost and extreme portability permit cost effective operation when compared to more expensive traditional test sets.

SUMMARY

In our four plus years of experience with teaching and using the Michel NC 2210 COMM/NAV and 3300 ATCRBS Transponder test sets, the units have functioned without problems and have needed no repairs. Our A & P students have mastered the use of the sets with a day or two of training in conjunction with instruction in basic radio and traditional avionics theory. While the manufacturer indicates that battery operating time of both units is an hour or more using the on-board rechargeable battery system, our experience has shown the operating time to be substantially less. As such, we recommend that an external battery pack, the 120 wall transformer-rectifier unit or the aircraft under test 14 volt power (if available) be used to operate the units for any appreciable amount of time. The units are rugged; in they have been knocked over, dropped and subjected to high temperature and humidity environments while continuing to operate properly. Maintenance is minimal, calibration costs are reasonable and operation is fairly straightforward. As in any aircraft testing environment, proper training, calibration, certification of instruments, adequate documentation and strict adherence to procedures is a must and is emphasized in our program.

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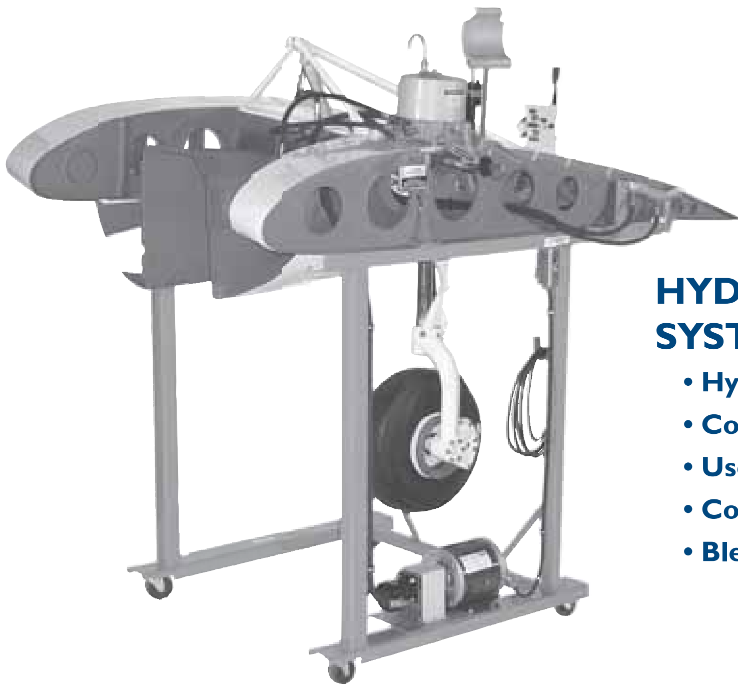

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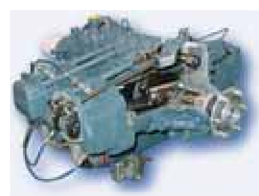

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ATEC Update

ATEC CONFERENCE

There were 101 AMT faculty from 67 schools who attended the April 19-21 Conference in Orlando. Overall, there were 147 participants which included registrants, exhibitors, speakers and guests.

- Forty-seven people attended the Cessna and FlightSafety tours on Tuesday. Twenty-two people went to the Sun and Fun aviation show on Wednesday.
- Evaluations of the conference were very positive with a number of people stating that this was the best group of speakers and exhibitors in the last few years.
- The top rated programs at the conference in rank order were:
  KlickerZ Technology in the Classroom
  Airbus Maintenance Technologies
  147 ARAC Overview of Proposed Recommendations
  Legal Issues for AMTs
  Latest Trends in Distance Education
- Each participant received an electronic key to the conference proceedings on-line.

Mark your calendar now for ATEC's 50th Anniversary Conference and Celebration, April 11-13, 2010 in Mesa, Arizona

Congratulations to five ATEC elected Board members:

Bret Johnson, Treasurer – Hallmark College of Aeronautics
Nick Herman – Aviation Center Toledo Public Schools
Paul Herrick – University of Alaska, Anchorage
Chuck Horning – Embry-Riddle Aeronautical University
David Jones – Aviation Institute of Maintenance

A list of all ATEC Executive Board members can be found at www.atec-amt.org.

ATEC DIRECTORY OF SCHOOLS

Although ATEC no longer prints a hard copy Directory, the recently updated on-line Directory can be found at www.atec-amt.org. Then on the left hand side, click on PART 147 Member Schools and click your state on the map.

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While ATEC Bookstore was originally conceived for ATEC members and instructors, you are welcome to share this site with your students. Doing so also supports ATEC, both financially and through student awareness, while providing a wide ranging library for your student's ongoing and extra-curricula interests.

For more information on ATEC Bookstore, please call Andy Gold at 970-887-2207.

MAINTENANCE DVDs FOR THE CLASSROOM

ATEC has almost 200 training tapes on DVD or video format to help enhance classroom instruction. Most are either $10 or $20.

To access the list and ordering information, go to www.atec-amt.org and click on Curriculum Resources.

SCHOLARSHIPS AND AWARDS

At the Conference, the Ivan Livi Outstanding Educator Award was presented to Mike Westenkirchner of Hallmark College of Aeronautics.

The Jim Rardon Student of the Year Award was presented to Brian Brunner of Pittsburgh Institute of Aeronautics.

ATEC awarded tuition scholarships for the first time along with books, tools, equipment and travel costs to attend continuing education programs.

A list of scholarships and awards is attached.

ATEC COMMITTEES

A draft list of ATEC Committees is attached. If you would like to be part of a particular committee, please contact ATEC at ccdq@aol.com. Be sure you send your name, institution, email and the specific committee you would like to volunteer for.

147 ARAC SUMMARY

The PART 147 ARAC Working Group has completed its deliberations and has submitted the final report to the FAA.

The following eleven recommendations were presented to the membership at the Orlando ATEC Conference on April 21. FAA representative, Ferrin Moore, stated that the process was so well done that he expects an NRPM (proposed rule) to be out in July/August for comment.

In addition to the two dozen or more ATEC members who helped with the process, ATEC would like to especially thank Ray Thompson who co-chaired the ARAC with Ferrin Moore over the last 18 months. A truly outstanding job.

The following is a summary of the recommendations to the FAA:

RECOMMENDATION 1 – CREATION OF A PART 147 TRAINING SPECIFICATION AND RESULTING RULE CHANGE TO 147.5(B)

Creation of a training specification for easier operations and updating of dynamic areas such as curriculum. The training specification also contains the curriculum subject area topics. This expands on the existing reference to operations specifications in CFT Part 147.5.

RECOMMENDATION 2 – MODIFY APPENDICES A-D

The curriculum subjects are updated and are maintained in the rule. A new method of dual teaching levels using knowledge and skill is recommended.

Curriculum Locations

- The curriculum subjects would be retained in Appendices B-D.
- In effect, the major topics will be listed.
- The curriculum items would be removed from the Appendices into a Training Specification document.
- Moving the curriculum items into a document that can be amended without rule change allows routine review and revision.
- 3 year phase-in recommended for curriculum

Proposed Level Changes (Appendix A)

	Knowledge Levels	Current Appendix A
A	**Be Familiar** – Familiar with basic facts, terms / principal elements of the subject. Instruction by classroom blended, or distance learning as applicable.	Level 1 requires: (i) Knowledge of general principles, but no practical application. (iii) Instruction by lecture, demonstration, and discussion.
B	**Knows** – Knows general principles, facts, and terms about the subject. Can explain the basic operation of component / system / concept. Instruction by classroom blended, or distance learning as applicable.	(2) Level 2 requires: (i) Knowledge of general principles, and limited practical application. (iii) Instruction by lecture, demonstration, discussion, and limited practical application.
C	**Understands** – Understands the principles, facts, and terms about the subject. Can apply this understanding to the subject and troubleshoot / analyze / resolve problems. Instruction by classroom blended, or distance learning as applicable.	(3) Level 3 requires: (i) Knowledge of general principles, and performance of a high degree practical application. (iii) Instruction by lecture, demonstration, discussion, and a high degree of practical application.

Curriculum Subject & Items

Existing

Level	Reciprocating Engines
1	1. Inspect and repair a radial engine.
2	2. Overhaul reciprocating engine.
3	3. Inspect, check, service, and repair reciprocating engines and engine installations.
3	4. Install, troubleshoot, and remove reciprocating engines.

Proposed

A	Reciprocating Engines			
	1	Types of engines	B	1
	2	Engine operating principles / theory of operation	B	1
	3	Horizontally opposed engine construction and internal components	B	1
	4	Radial engine construction and internal component differences	A	1
	5	Remove, inspect, and install cylinder assembly	C	3

RECOMMENDATION 3 – CREATION OF THE MAINTENANCE TRAINING REVIEW BOARD

A review board is created that performs a biennial review of the AMTS curriculum and recommends changes. The new board will be led by the Aviation Technician Education Council.

RECOMMENDATION 4 – CHANGES TO CFR PART 147.21(B) AND 147.21(C)

The minimum training hours specified in Part 147.21(b) are maintained at 1900 (combined airframe and powerplant) but are redistributed. A new distribution of:

- 450 hours general,
- 800 airframe, and
- 650 powerplant, are recommended.

RECOMMENDATION 5 – INCLUDE PART 148 IN DRAFT ADVISORY CIRCULAR "ALTERNATIVES TO CLASSROOM TRAINING" (DATED: 9/27/05) AND FINALIZE

Improvements in technology require AMT schools to be allowed to use alternative delivery methods where appropriate. The draft AC needs to include Part 147 and be finalized.

RECOMMENDATION 6 – CHANGES TO CFR PART 147.31

Clarification of terms, definitions, and processes are made to improved consistency in giving credit for previous training.

A school shall use an approved system for determining course grades and attendance. The absence system must show hours of absence allowed, which may be up to 5% in each class. Missed time in excess of 5% in each class must be made up with missed material made available to the student.

Proposed Level Changes (Appendix A)

	Skill Levels	Current Appendix A
1	**No Skill Demonstration Required**	Level 1 requires: (ii) No development of manipulative skill.
2	**Competent –** Be able to find and interpret maintenance data and information, and perform limited practical operations using appropriate data, tools, and equipment.	(2) Level 2 requires: (ii) Development of sufficient manipulative skill to perform basic operations. (iii) Instruction by lecture, demonstration, discussion, and limited practical application.
3	**Proficient –** Perform skill operations to a high degree of practical application using appropriate data, tools, and equipment. Inspections are performed in accordance with acceptable or approved data	(3) Level 3 requires: (ii) Development of sufficient manipulative skills to simulate return to service. (iii) Instruction by lecture, demonstration, discussion, and a high deg of practical application.

RECOMMENDATION 7 – FORMALIZING THE EXEMPTION PROCESS

The FAA routinely grants exemptions to allow students who have completed the General curriculum to take the written examination prior to completion of the airframe and/or powerplant curricula. New language in Part 147.35 eliminates the need for granting future exemptions.

RECOMMENDATION 8 – CREATION OF A SPECIFIC SCHOOL SURVEILLANCE TRAINING COURSE FOR PRINCIPLE INSPECTORS

Currently there is no course available for inspectors with AMTS surveillance responsibilities. A dedicated course will improve consistency of interpretation and enforcement.

RECOMMENDATION 9 – REVIEW AND UPDATE OF ADVISORY CIRCULAR AC 147.3A

RECOMMENDATION 10 – REVIEW AND UPDATE OF THE PRACTICAL TEST STANDARDS AND KNOWLEDGE TESTS

RECOMMENDATION 11 – REVIEW AND UPDATE OF 8900.1 GUIDANCE

While updating of documents related to rule such as advisory circulars and practical test standards is mandated, time limits for revision are provided.

ATEC FEEDBACK & INPUT

- The preliminary recommendations were presented to the ATEC Board in September 2008 for review and comment.
- ATEC's leadership role in the MTSB was discussed.
- ATEC Board comments were reviewed and addressed by the FAA in the final recommendations made by the ARAC working group.
- ATEC also participated in crafting of the final recommendations during the November 2008 working group meeting.

SUMMARY

- Since the creation of the CFR Part 147 Working Group in June 2007, we have had seven (7) in-person work sessions.
- The 11 recommendations address the current issues expressed with Part 147 to the extent we believe possible today.
- The creation of the training specification, transfer of curriculum subject topics to the training specification, and the biennial review process allow CFT Part 147 to adapt and evolve with industry for the foreseeable future.

CONCLUSION

- The recommendations being offered are a significant improvement to CFR Part 147.
- Allowing ATEC to play an active role in the PART 147 rule and providing leadership during implementation and periodic review, ensures that the needs of schools are addressed in balance with industry.

SURVEY RESULTS

Each year ATEC surveys all PART 147 programs to assess enrollments, graduates and those who accepted a position in aviation.
Note: Not all schools return the survey each year.

The following are the results for 1998-2008.

	1998 n=143 schools	1999 n=107 schools	2000 n=114 schools
Enrollments	11,699	14,209	13,827
Graduates	4,510	3,872	4,978
Grads Who Went to Work in Aviation	3,338	3,709	4,039

	2001 n=107 schools	2002 n=94 schools	2003 n=83 schools
Enrollments	12,328	11,199	10,862
Graduates	5,658	4,190	3,818
Grads Who Went to Work in Aviation	4,700	2,480	2,589

	2004 n=83 schools	2005 n=86 schools	2006 n=71 schools
Enrollments	11,791	7,680	9,753
Graduates	3,601	3,226	3,522
Grads Who Went to Work in Aviation	2,381	2,047	2,340

	2008 n=53
Enrollments	5,807
Graduates	1,834
Grads Who Went to work in Aviation	1,223

2009 ATEC SCHOLARSHIP AND AWARD WINNERS

S&K TOOL AWARDS

1. Luciana Sapien – San Joaquin Valley College
2. Michael Rogers – Hallmark College of Aeronautics
3. Carlos Rodriguez – George T Baker School of Aviation

WING AERO BOOK AWARDS

1. Aimee Enslinger – Gordon Cooper Tech Center
2. Lydia Daniels – Pittsburgh Institute of Aeronautics
3. Ed Georgie – Southwestern Illinois College
4. Keith Woockman – Southwestern Illinois College
5. Steve Hennigs – Lake Area Technical College
6. Daniel Murray – Lansing Community College
7. Ryan Turner – Coosa Valley Technical College
8. Neal Stewart – Indian Hills Community College
9. Michael Rogers – Hallmark College of Aeronautics
10. Whitney Oppe – Pittsburgh Institute of Aeronautics

VILLNAVE TUITION SCHOLARSHIPS

1. Russell Lane – Southern Arkansas University Tech
2. Aimee Enslinger – Gordon Cooper Tech Center
3. Lydia Daniels – Pittsburgh Institute of Aeronautics
4. Tyesha Cuttino – Aviation Institute of Maintenance
5. Keith Woockman – Southwestern Illinois College
6. Eric Trepanier – Department of the Air Force
7. Matthew Koudelka – Salt Lake Community College
8. Riley Petersen – Lake Area Technical College
9. Jeff Hoover – Middle Georgia Technical College
10. Whitney Oppe – Pittsburgh Institute of Aeronautics

NIDA CORPORATION TRAINING EQUIPMENT AWARD

1. Teterboro School of Aeronautics

ROTORCRAFT START PAC EQUIPMENT AWARD

1. Toledo Public Schools

NRF INSTRUCTOR ASSISTANCE PROGRAM SCHOLARSHIP

1. Aristeo Ramirez – Hallmark College of Aeronautics

DALE HURST MEMORIAL SCHOLARSHIP

1. William Dudash – Pittsburgh Institute of Aeronautics

FLIGHTSAFETY KING AIR MAINTENANCE SCHOLARSHIP

1. Raymond Thomas – Spokane Community College

SOUTHWEST AIRLINES BOEING SCHOLARSHIP

1. John Wolf – Vincennes University

LYCOMING PISTON ENGINE SERVICE SCHOOL SCHOLARSHIP

1. Bill Allen – Middle Tennessee State University

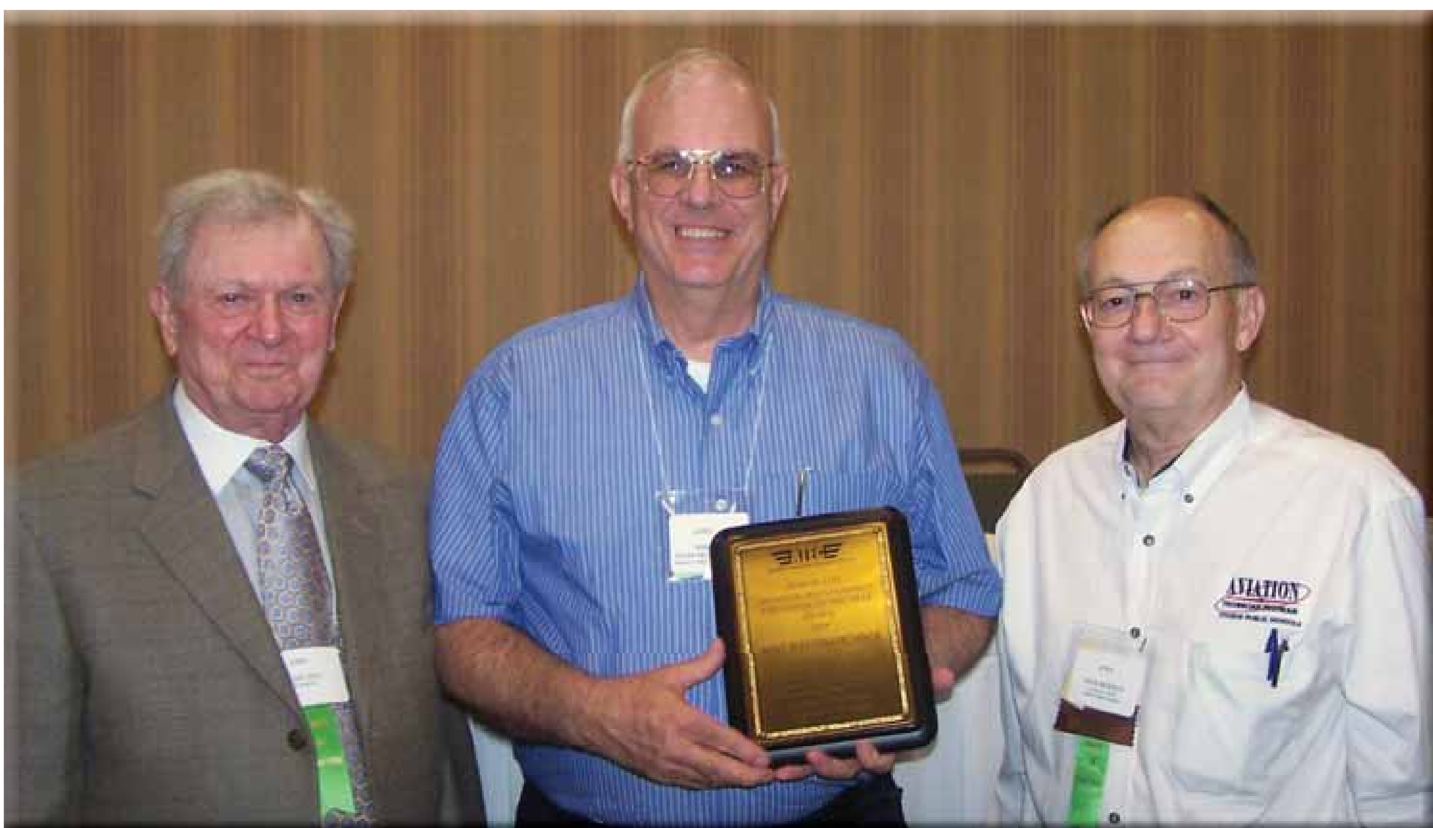
2009 AWARD RECIPIENTS

Outstanding Service Award

Laurie Johns, John Fisher-Club President

Jim Rardon Student of the Year Award

Jim Lukins, Brian Brunner-Pittsburg Institute of Aeronautics



Ivan Livi Instructor of the Year Award

Ivan Livi, Michael Westenkirchner-Halmark College, San Antonio, TX, Dick Herman-Award Chair

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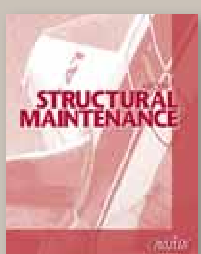

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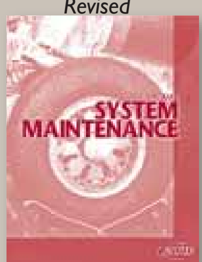

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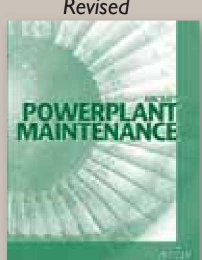
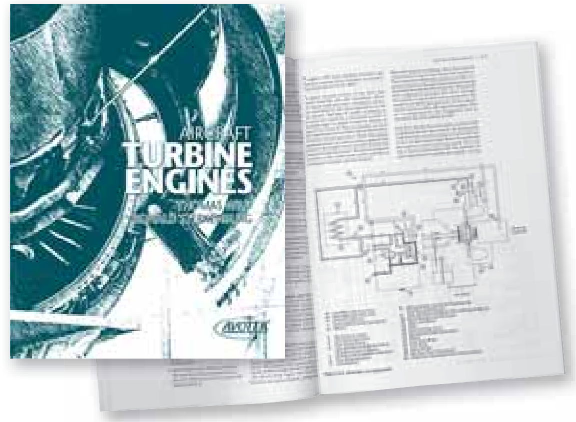


Aircraft Powerplant Maintenance
Revised



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