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Dick Dumarcsq; Executive Director; ATEC
2090 Wexford Court, Harrisburg, PA 17112
Phone: (717) 540-7121 FAX: (717) 540-7121
Email: ccdq@aol.com

STAFF

Editor Thomas W. Wild
Art Director Krista Buuck
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1401 Aviation Drive, West Lafayette, IN 47907-2015
Phone: (765) 494-9968 FAX: (765) 494-2305
TWWild@tech.purdue.edu

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Thomas W. Wild, Editor
ATEC Journal
Aviation Technology Dept.
Purdue University
West Lafayette, IN 47906
TWWild@tech.purdue.edu

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An Overview of Aircraft Maintenance Activity as it Relates to Security in the Air Transportation System

By Kathleen Sweet, J.D.
Purdue University

Aircraft technicians within the aviation industry have become an increasingly important component within the overall concept of aviation security. Aircraft technicians occupy a strategic position within the aviation system in that these individuals have access to mechanical elements of the aircraft with the purpose of repairing, maintaining, or otherwise trying to preserve successful operation of the aircraft. However, because it is during this time that the aircraft is also most vulnerable to a purposeful form of sabotage, that aircraft technicians should also be tasked with recognizing any unusual or inappropriate intrusion into those same components. Aircraft technicians play a key role in subverting any nefarious attempts to hinder the safe operation of the aircraft by anyone attempting to place a dangerous instrumentality within the aircraft. Proper security training should therefore be critical to effective maintenance in today's threat environment.

The ease and speed with which much of current aircraft technician work has been moved overseas provides a curious contrast to the strict controls on foreign ownership of domestic airlines that the United States has long maintained. In light of the current security threat environment, the subsequent need for improved security awareness training for aircraft technicians will be encouraged as well as the need for increased utilization of the aircraft technician's work force in security functions and the need for more regulatory control of domestic airline's off shore sites.

CURRENT TRAINING REQUIREMENTS

As the aviation industry grew, aircraft maintenance became a technical field that was regulated by federal legislation. Certification was made necessary with oversight provided by the FAA beginning in 1958 (FAA Oversight, p. 1). As is well known, training for FAA certification includes completing 18 months of practical experience with power plants or airframes, 30 months of practical experience on both, or graduation from a Federal Aviation Administration (FAA)-approved Aviation Maintenance Technician school (Experience 2005, p. 1). The candidate must also pass three tests consisting of a written exam, an oral test, and a practical test that cover 43 technical subjects (Basic 2005, p. 1). However, current standards necessitate no specific security training.

Ending in 2003, a study was published in order to ascertain the number of aircraft technicians that would be needed in the future and whether not those needs would be met at the current rate of growth (Summary 2003, p. 2). Although it was shown that the number of trained and FAA-licensed aircraft technicians would be sufficient through 2010, the study also illustrated that the curriculum used to educate and train aircraft technicians had not been sufficiently modified within the last 50 years; that it was obsolete concerning smaller and less complex aircraft such as those used in general aviation; and that not enough instruction was presented regarding the materials and technology used on current commercial aircraft (Summary 2003, p. 2). The need for security training was not addressed at all, regardless of the fact that aircraft technician's play a critical role in preserving the physical security of the aircraft.

LOOPHOLES

Now that U.S. aircraft are also maintained overseas, regulations and training need to address the new reality. Aircraft technicians and their support staffs are responsible for the direct care and safe operation of the most essential portion of the air transportation system: the aircraft themselves. Aircraft technicians are unique in that their profession allows them prolonged, unmitigated access to the most vital systems of an aircraft. Historically, commercial airlines have routinely provided for aircraft maintenance at airports that were a part of the airline's normal routes, such as repairs taking place at a hub location for a particular airline (Airline Maintenance, p. 1). In a dramatic shift, it is currently estimated that approximately 50% of all aircraft maintenance is now taking place at outsourced facilities (Security, p. 1). Northwest Airlines, for example, eliminated hundreds of U.S. aircraft technicians and shifted maintenance operations to Singapore and to the

People's Republic of China; arguably seeking reduced labor costs (Kehaulani-Goo, 2005, para. 4).

Current regulations require that only airline-affiliated technicians be subject to a pre-employment, FBI background check, but foreign and domestic independent contractors are not covered by these requirements. Specifically, post-September 11 Federal Aviation Administration (FAA) regulations require all airport-based airline employees in the United States to submit to a "Fingerprint-based Criminal History Background Check" that probes into the previous ten years of the employee's past. As must be immediately noted, the fact that these rules do not apply to operations outside the continental United States, nor to employees working for off-site contractors represents a potential danger to the flying public and a disparity in security oversight.

Given the less thorough background checks at outsourced facilities, these services can attract technicians mainstream domestic airlines may have refused to hire. More importantly, while almost all aircraft technicians working at airlines are certified in aircraft maintenance, vendors often use only a handful of certified aircraft technicians who oversee large groups of uncertified workers. Therefore, the majority of the work force is likely to be free to engage in unsupervised activities for a given amount of time each day. Adequate supervision is a recurring issue open to debate and the standard of training in both basic maintenance and security protocols is questionable at best.

Physical security of these facilities represents an additional vulnerability, given that safeguards enacted for in-house maintenance in the US do also not apply to them. Worse, some foreign repair stations are located in areas where terrorists are known to operate. Additionally, many large commercial aircraft, which are part of the CRAF, are overhauled at maintenance facilities in China, potentially threatening military readiness should they become made unavailable by the Chinese.

NEW LEGISLATION

Recent proposed legislation strengthens the oversight of foreign repair stations by requiring drug testing of employees, but what needs to be addressed further is the overall disparity in hiring and employment standards among these maintenance shops.

The FAA Reauthorization Omnibus bill, a version of which is currently pending in the US Senate, requires foreign repair stations to have drug and alcohol-testing programs that are as stringent as U.S. programs. (AFA Government Affairs Department, 2006) The FAA bill, usually updated every three years, subjects the foreign stations to security audits and inspections without notice, similar to US requirements. Upon passage, the bill mandates that, within 90 days, the FAA must send Congress a plan to increase oversight of foreign repair stations that perform maintenance on U.S. aircraft. Within 240 days of final passage of the bill, the FAA will be required to finalize regulations applying to foreign repair stations. The FAA then has an additional 18 months in which to conduct reviews of all these foreign repair stations. If a foreign repair station fails to correct security issues within 90 days of notification, its certificate to repair U.S. aircraft will be suspended (Miller, 2005, para 8). These provisions should be passed and enforced with all deliberate speed but are realistically years away from full implementation.

Meanwhile, low wage domestic and foreign maintenance providers are generating an increasing amount of business with domestic airlines. U.S. air carriers are continuing to outsource their maintenance to both overseas and domestic providers at an ever-increasing rate. At the same time U.S. air carriers are eliminating the in-house maintenance function and the aircraft technicians involved.

GOVERNMENT EFFORTS POST 9/11

Shortly after the tragic events of September 11th, 2001 the government began a sweep of non-citizen airport workers, in an effort to track down potential "security threats". The ongoing three-year-old immigration action, referred to as Operation Tarmac, resulted in more than a thousand arrests and indictments at more than 200 airports around the country. Some of those arrested were aircraft technicians. Although this sweep was successful in detaining a large number of undocumented workers, none of the persons apprehended were ever convicted of charges even remotely related to terrorism. The government has continued to carry out sweeps and to pick up undocumented workers, but the supporting regulatory effort contains no sanctions for the employers hiring these workers. In light of the fact that enforcement is weak, employers are likely to continue to employ these workers.

Specifically, in March of 2005, the Immigration and Customs Enforcement (ICE) agency arrested 27 illegal aliens who were working at one of the largest aircraft maintenance contractor facilities in the United States, TIMCO, located in Greensboro, North Carolina at Piedmont Triad International Airport. The raid was part of the already-mentioned 3-year-old, multi-agency effort that has resulted in 1,120 arrests and 775 indictments

(Breed, para. 9). Six aircraft technicians arrested held the Federal Aviation Administration's top aircraft technicianal certification, allowing them to clear airplanes to return to service (Breed, 2005, para 1). Newspaper reports revealed that some of the undocumented employees had entered the US from Mexico and South America, the Sudan and an assortment of Pacific Rim countries. These arrests were symbolic in the sense that they took place in the United States where the airlines and the FAA have the chance to oversee third-party contractors. Most of the illegal employees were eventually put through deportation court proceedings. As a result, more investigative efforts have been put in place to prevent the hiring of undocumented persons and others with criminal backgrounds but the problem persists.

FAA inspectors continue to focus mainly on maintenance at airlines in hangars where in-house maintenance takes place rather than at third-party contractors in the U.S. or abroad. In addition, some foreign repair stations subcontract work out to other contractors, which are not licensed or cleared by the FAA. Congressman James Oberstar (D-MN), a member of the House Transportation and Infrastructure Committee, when referring to outsourcing and off-shoring of aircraft maintenance has said, "The current accident rate does not mean there is no risk. The next tragedy is just around the corner." (Airline maintenance, 2006, pg. 1)

RECOMMENDATIONS

The enhancement of aircraft security at all facilities can only be accomplished with more specific training; improved procedural controls; improved regulatory support and better physical security protocols. The training needs to be supported with legislation and supplemented by regulatory control of the entire maintenance function, both domestically and internationally. Currently, much of the emphasis within the field is placed on maintaining the safety of the aircraft and its systems to ensure that the aircraft is air-worthy (Basic 2005, p. 1). The same, if not more stringent, standards should apply to security of the aircraft. Curriculum and training should be periodically evaluated and improved upon in order to assure that certified aircraft technicians are knowledgeable and able to work effectively within the current security environment (For aircraft 2002, p. 1). Even though the primary focus of aircraft technicians should be in regard to the aircraft and its operations, technicians are particularly well-suited to serve the additional function of supplementing all aspects of security including facility, aircraft and personnel management.

In conjunction, direct supervision of all personnel working on aircraft needs to be improved. It is common knowledge that sporadic supervision is the norm in many facilities both within the US and at many overseas facilities. More focused regulatory control of minimum supervision requirements can assist in the development of better procedural security. Documents should be reviewed and audited on a regular basis by certified personnel keeping records meticulously updated and kept available for review. (Aircraft and Avionics 2005, p. 2). In the past, non-certificated facilities only performed minor maintenance tasks however these facilities now perform not only on-call maintenance but also scheduled maintenance. Scheduled maintenance includes the inspection of crew and passenger oxygen, aircraft fuselage, wings and engines, as well as critical repairs like replacement of aircraft engines. Non-certificated repair stations are performing such work even though they are not required to have the same systems of quality control and oversight that are present in air carrier operations, or FAA-certificated facilities. This provides a window of opportunity for criminal misconduct and needs to be immediately addressed.

Outside contractors offering maintenance service must be held accountable to at least the standards applicable to airline-affiliated personnel. It is vital that the U.S. and federal agencies work with other countries and governments to help correlate and develop the standards and regulations affecting foreign repair stations (H.R. 4582, p. 1). Moreover, in one government inspection, the IG found specific discrepancies in records checks of six airlines and 10 repair stations (FAA, 2005, pg. 10). These discrepancies included cases of improper maintenance procedures, overlooked maintenance discrepancies and incorrect logbook entries. Federal legislation, particularly after September 11th, has become increasingly invested in the concept of security; subjecting it criticism. Although there have been legitimate questions raised regarding whether or not the public should have more influence over current procedures and operations, the removal or modification of federal oversight, at this time, could detrimentally affect the current standing of the aviation community and national security (Lotterman 2005, pp. 1-2).

Security procedures correlated to physical security are also important in maintaining the safety of aircraft and the maintenance facility itself. In addition to physical controls, the use of aviation identification badges to identify all employees and personnel in the facility should be employed supplemented with closed circuit TV. Furthermore as regards the hiring process, federal standards should apply to all facilities that offer aircraft maintenance (Hess 1996, pp. 683-694).

CONCLUSIONS

With the passage of legislation that allowed for airlines to use outside entities for the maintenance and repair of their aircraft, there is now increased concern over the amount of security and control that this allows. Although aircraft maintenance and inspections are important in order to ensure that systems are running as efficiently as possible, it is also an opportunity to further improve and expand upon the aircraft itself. Alternatively, along with the ability to improve performance and capability, the opportunity to use aircraft as a form of weapon to both manipulate and terrorize, either accidentally or through purposeful sabotage, is also inherent. After September 11th, one of the few benefits that came subsequent to the attacks was the recognition and acceptance that security is something that must achieved, and not taken for granted. Standards, regulations, training, and curriculum instruction, as well as expectations of all of those involved, must allow for the development of the industry while taking into consideration that it must be balanced with the security and well-being of those it serves. While aircraft technicians and their support staffs are responsible for the direct care and safe operation of their aircraft, the contributions made by aircraft maintainers to airport and aviation security should be considered just as important as the quality of the aircraft they maintain.

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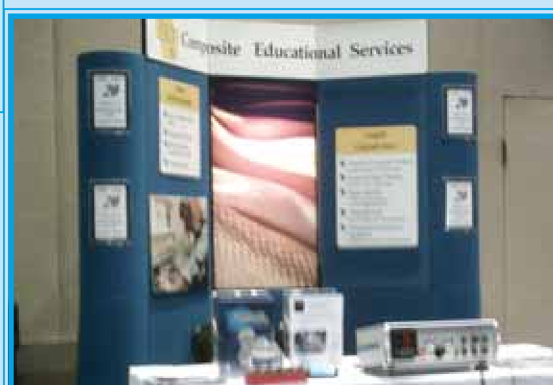

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Simulating Airline Level Maintenance in the A&P Program

By Raymond E. Thompson, Michael W. Suckow, Timothy D. Ropp

ABSTRACT

Capstone experiences are often very technical with limited exposure to broader planning, personnel or financial issues. With the industry-wide growth of integrated engineering product teams, it is crucial for graduates to understand operations as a functional system and their role in managing the process in addition to narrower technical concepts. This paper describes the development and implementation of active capstone learning approach for students in an aircraft manufacturing and maintenance B.S. program. The targeted learning outcome is for students to develop an airline maintenance package while managing its delivery and execution, utilizing supervisory as well as technical skills. Students experience tremendous growth when rigorously challenged to take on this significant responsibility. Coping with adversity and challenges in the workplace teaches quick thinking and decision-making to adapt to changing situations with equipment and personnel. This broad-based active learning better replicates the environment confronting graduates in the engineering and technical workplace.

INTRODUCTION

Capstone experiences are often very technical with limited exposure to broader planning, personnel or financial issues. With the industry-wide growth of integrated engineering product teams, it is crucial for graduates to understand operations as a functional system and their role in managing the process rather than focusing on narrow technical concepts. Airline maintenance is a highly process driven activity. Significant planning and research is necessary to develop a efficient and effective maintenance program for assets that are widespread geographically. Additionally, most aviation maintenance operations, even while utilizing technologically advanced testing and repair methodologies and competent technicians, are structured such that the technician is driven to divert attention away from a critical maintenance step (often embedded within a series of steps on a maintenance procedure) when uncertainty regarding a maintenance step or component structure/location arises. The result is eroded situational awareness and a much greater risk of steps performed inappropriately or completely omitted.

The problem is compounded by the reality of operational pressures associated with a combination of cycle-time and regulatory requirements in the maintenance environment. A break in situational awareness of the task at hand (task interruption), by forcing the technician to exit and then re-enter the proximal work environment, along with additional operational pressures to “get the job done”, is the leading cause of the maintenance error of “omission” – failure to complete a step [1].

These are some of the challenges facing students interested in airline maintenance and engineering. Designing a capstone experience for these students requires more than technical competence. Rapid decision-making, ability to adapt to change, and the inclusion of legal, labor, financial and personnel issues must be added to the mix.

CAPSTONE ELEMENTS

In 2003 the faculty in the Aeronautical Technology (aircraft maintenance and manufacturing) major of the Aviation Technology department at Purdue University implemented a significant revision to the curriculum placing a greater emphasis on transport category aircraft. A capstone course, AT 402 Aircraft Airworthiness Assurance was formulated to provide a broader overview of airline maintenance program development and management. The Aviation Industry Advisory Board worked with the faculty suggesting certain elements such as work process development, finance, and labor issues should be included. Various role playing models were discussed with the goal of simulating the transport category airline maintenance environment.

GOALS AND OBJECTIVES

The broad course goals are for students to research and develop a specified maintenance program, study differing managerial models, and include aspects of finance and labor into their maintenance program. More specifically, the students create a maintenance program for the Aviation Technology departments’ Boeing 727 or 737 aircraft. The students create a set of work cards that condense required maintenance items into a number of discrete work packages. The AT 402 students then act as a “ramp manager” or “lead technician” with ‘employee’s’ from a lower level class.

COURSE DEVELOPMENT

Underpinned by key industry principles essential for coordinating teams in technical operations such as time management, job and process tracking, safety and team communication, this course evolves each semester and has special points of emphasis. During the first two semesters, the emphasis was on maintenance processes and work card creation. This resulted in creation of a robust work card format, development of safety mission rules, and the use of process mapping. During the third semester the emphasis was on improved team building and communication skills. As a result the current shift data turnover tool was created and extensively tested. This past semester the emphasis has been on data tracking and training for the lower level students. For fall 2006 the emphasis will move to an increased knowledge of labor practices and negotiation of a work agreement with the student workforce. As each area of emphasis matures, additional components are added. All previous components are employed in the course having become standard practice. Thus the intensity and breadth of the experience grows each semester

PLANNING THE PROCESS

Transport category aircraft maintenance protocols are dictated by the Federal Aviation Administration (FAA). Each air carrier may tailor their specific maintenance program to their unique needs as long as the aircraft manufacturer's specifications and the FAA regulations are met. In general, there are multiple levels of aircraft inspection. Preflight, or transit, checks generally are done overnight at the terminal gate. These are cursory inspections looking for leaks or other damage. The letter checks include "A" (operational checks and lubrication), "B" (more in-depth operational checks and light maintenance), "C" (in-depth inspection of aircraft systems and components), and "D" (in-depth inspection and maintenance of aircraft structure) [2]. Each semester the AT 402 students are assigned one or more of these checks.

For the spring 2006 semester, the students were assigned the "C" check for the Boeing 727. The Boeing Company provides standard maintenance data and checklists for operators to use directly or as the basis for their own inspection programs. The "C" checklist contains approximately 100 items. The items are categorized into zones such as powerplants, wings, fuselage, control cabin, etc. The students were grouped into teams and assigned a number of inspection items. Each team then researched each step in the aircraft maintenance manual. Specific procedures, equipment, time, and personnel were identified. Since we were creating our own maintenance package, multiple steps could be combined into the same work procedure. Next, each team created a set of process maps of the procedure (see Figure 1). The map included data, decision points, and process steps. This was a very useful activity for each team to thoroughly understand their process. Each team

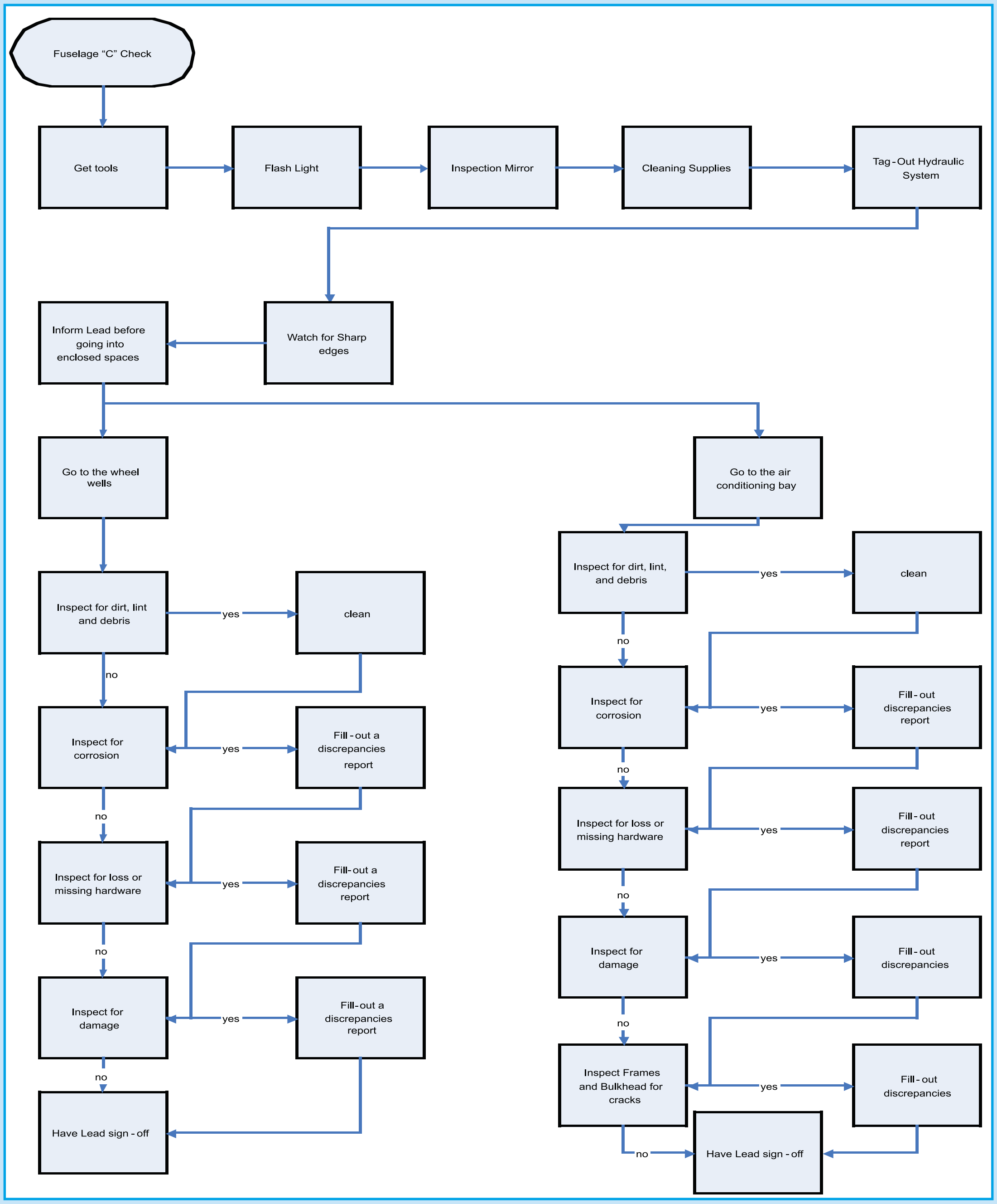

Figure 1
Fuselage C Check Process Map

presented their map to the class and an evaluation discussion followed. Maps were revised as necessary.

Each team used the process map as a guide for creating a set of work cards. The work card is a step-by-step procedure that contains the work steps, manual references, inspection criteria, and quality inspection techniques created by an airlines engineering department. The aircraft technician uses a work card when inspections are done since they include data specific to the individual aircraft being worked upon. The cards were then Alpha tested and any discrepancies, errors, unclear or missing information, etc., was noted. The annotated cards were revised by the creating team and a Beta test performed.

Creating robust work cards, while important, are alone insufficient for an airline maintenance process. The AT 402 students needed to also understand and implement management of the maintenance process. In general, one student is assigned as the 'ramp manager" for each laboratory (work shift) period. The ramp manager completely plans and executes the lab. Planning includes studying what work the previous shift accomplished, left incomplete, or did not begin. Next, the ramp manager determines the work to be accomplished during his or her shift and assigns tasks to his or her lead technicians. The leads are also AT 402 students. There are two pre-shift briefings that occur. First, the ramp manager briefs the leads on what they need to accomplish, resources needed, and special issues such as safety or other ramp activity, and assigns the AT 372 work force to each lead. Next, the lead technicians assemble their workforce and brief them on what tasks they will be working. Special emphasis is given to safety since the teams are performing real work on a fully functional aircraft. Other classes use the aircraft and often there are tours or other visitors in the area. The ramp manager must be aware of all these factors and distractions during planning and supervision. The instructional faculty act as "base managers" and mentor the ramp manager and leads. The base manager will halt the process if necessary and provide direct instruction. For example, if the base manager observes a potential safety hazard he or she will stop work and work with the ramp manager to correct the situation and discuss how the ramp manager needs to modify their technique. It is not intended as a punitive action but a learning experience. As tasks are completed the ramp manager assigns addition work cards until the end of the shift.

A critical component in airline maintenance is the compilation of data and transmitting that data into the next shift. Airlines that do a poor job of communicating are inefficient and have high costs. Work is repeated unnecessarily or missed, inventory is mishandled, and deadlines for bringing the aircraft back into service missed. Data is collected electronically, in written form, and orally. Tracking and verification is critical. In the air carrier environment the ramp manager begins his or her shift 30 – 60 minutes before the current shift ends. This allows the current ramp manager to brief the incoming manager thoroughly and allows the incoming manager to plan the shift appropriately. This verbal communication is supplemented with the electronic input of complete work into the maintenance tracking system. Unfortunately, academic scheduling does not follow the same patterns as the industrial workplace. There are four shifts per week for AT 402. The shifts have a minimum of three hours (sometimes days) between them. This causes problems for the ramp managers since they have to rely on the written documentation from the previous shift. After several iterations, we currently track the work done in a modified Excel spreadsheet (see Figure 2). At several points during the shift, the lead technicians enter the work performed. The ramp manager summarizes and leaves additional information of interest for the next shift. The base managers will insert data as necessary to assist the ramp manager with planning. Shift-briefings and data transmission are covered in lecture and with exercises to demonstration proper techniques.

The ramp managers also have to work with real issues such as no-shows, missing or broken equipment and other problems discovered during the maintenance process, called non-routine items. The ramp managers constantly have to reassess the work flow and adjust to changing conditions – just like the real workplace.

STUDENT DEVELOPMENT

The AT 402 students are first or second semester seniors. While they have had a variety of education experiences, this course is designed to 'put it all together' in a demanding environment where change is constant. Simply dropping students into this type of situation would cause frustration and failure. The instructors prepare the students by engaging them in active problem-solving, system research and presentation, communication exercises, leadership mentoring, team building,

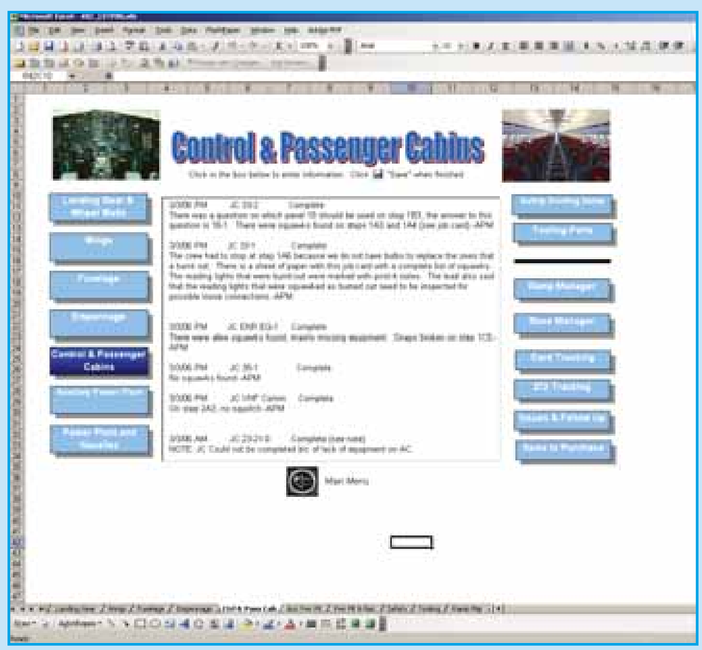

Figure 2
Excel-based Shift Communication Briefing tool

general coaching. Lecture ranges from content delivery on airline maintenance practices, finance, and law, to debates over current labor issues in the industry.

Several activities in particular provide significant preparation for the students. The class does a safety assessment by identifying risks that may be encountered performing work on the aircraft. Each lab group is split into four teams and given the checklist to be used. They brainstorm and note risks in any form to people or equipment on Post-It notes. Using an affinity diagram process, they condense these risks and identify methods or procedures to mitigate the potential hazard. This information is brought together in the form of "Mission Rules" modeled from NASA [3]. The safety mission rules act as a guide for insertion of cautions, warnings, and preventive measures when creating the work cards. This structured quality method is an excellent tool for analyzing processes.

Each student team is assigned an area of the aircraft for research and presentation. The Federal Aviation Administration requires all maintenance personnel to be properly trained [4]. This includes general familiarization training and recurrent training. The student teams created a set of general familiarization training modules for the lower level class. This included all major system areas of the aircraft and human factors, safety, new employee orientation, and log book data handling. The teams presented them to each other for critique and then actually trained the lower level students prior to their beginning work on the aircraft. This resulted in each student becoming a technical expert for some system or procedure and a resource to be consulted by the ramp manager when questions arise.

FOUNDATIONS OF MISSION CONTROL

To instill within ourselves these qualities essential for professional excellence:

Discipline: Being able to follow as well as lead, knowing that we must master ourselves before we can master our task.

Competence: There being no substitute for total preparation and complete dedication, for space will not tolerate the careless or indifferent.

Confidence: Believing in ourselves as well as others, knowing that we must master fear and hesitation before we can succeed.

Responsibility: Realizing that is cannot be shifted to others, for it belongs to each of us; we must answer for what we do, or fail to do.

Toughness: Taking a stand when we must; to try again, and again, even if it means following a more difficult path.

Teamwork: Respecting and utilizing the ability of others, realizing that we work toward a common goal, for success depends on the efforts of all.

To always be aware that suddenly and unexpectedly we may find ourselves in a role where our performance has ultimate consequences.

To recognize that the greatest error is not to have tried and failed, but that in trying, we did not give it our best effort

Figure 3
Foundations of NASA Mission Control

Each student is challenged to lead by example with professional behavior modeled by the instructor. The lower level students can bring complaints to the base manager for consideration (and have). This results in mentoring of specific students and class discussion of work place issues and rules.

At the end of each shift a NASA Mission Control style management debriefing occurs [3]. The base manager, ramp manager, and lead technicians openly discuss what worked, what did not work, and improvements to be made and lessons learned. The ramp manager ensures this data is noted in the shift briefing tool so the next shift can build on their experience. Finally the students must conduct themselves according to the principles contained in The Foundations of NASA Mission Control (see Figure 3) [5].

A major component of the course is the empowerment of the student. They are rigorously challenged on everything from style, work produced, to preconceived beliefs. At a glance, this course develops a maintenance program. However it is actually about developing people and the process of developing a maintenance program. During the eight weeks of actual work on the aircraft, it is gratifying to watch the increase in confidence and leadership that takes place.

OUTCOMES

The success of this course is not the creation of a maintenance process, but rather the broad-based experiences that take place while creating it. Capstones often focus on a specific technical task to accomplish to specified performance goals. There may be a budget to follow and costs to track. While those are importance skills, they fall short of the full breadth of work an engineer or technical manager experiences. When we examine the shortcomings of most organizations, we find them related to communication, organizational, and personnel problems. This capstone is highly focused on those issues. Without them, students cannot fully grasp what their career path holds in store.

We see tremendous growth in each student's ability to organize, work with deadlines, employ leadership and communication skills, planning, and real-time decision-making. While we cannot fully simulate the dynamics and pressures of an active airline maintenance operation, we attempt to bring all the elements of such an operation into play so our students fully experience all aspects of that environment.

To date, the outcomes have been very positive. The Aviation Technology Industry Advisory Board spent time during their March 2006 meeting observing this class and talking with participating students about their experiences. They overwhelmingly approved of what the course is doing. This validation is important since we are able to show we are meeting the needs of the airline industry.

Student feedback has been mostly positive. Initially the students are somewhat dismayed by the work demands and challenges imposed. As they move deeper into the maintenance program process they begin so see why certain tasks are required. An additional factor is the entire maintenance program and employee training must be completed in six weeks. This creates a high pressure environment where tasks have 24 – 48 hour turn times.

One area noted for by the faculty for improvement is providing students with an observational experience early in the semester where they see an airline maintenance operation. Seeing how a work shift is planned and executed would bring the content of the course into focus much quicker. In Indiana, we have limited options close to campus where students can see such an operation. Since the events of September 11th, additional restrictions also make it difficult to take groups into the secure areas of a major airport. That is a challenge for the instructors to address for the fall 2006 semester. Once work on the aircraft begins, the pieces fall into place for the students.

It is especially gratifying seeing the growth in student curiosity and knowledge seeking. After a recent session on labor relations in the airline industry, a significant number of students stayed after class to continue the discussion. Many of them had a preconceived notion of who was right and who was wrong on current labor issues. As we discussed this in class, you could see the class considering alternate viewpoints. The questions asked after class reinforced this as they dug deeper into the issues.

SUMMARY

When provided with a capstone experience containing all career path and workplace attributes the students experience tremendous growth. When rigorously challenged to take on significant responsibility beyond their technical comfort zone they consistently produce outstanding results. Coping with adversity and challenges in the workplace teaches quick thinking and decision-making to adapt to changing situations with equipment and personnel. This broad-based active learning better replicates the environment confronting graduates in the engineering and technical workplace.

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Dr. Raymond E. Thompson, Michael W. Suckow, and **Timothy D. Ropp,** Aviation Technology, Purdue University, West Lafayette, Indiana

APPENDIX A: SAMPLE JOB CARD

Aircraft Number: N9051U | **Purdue University** | **Originating Shift (circle): AM PM**

Date: ______________________

Page 1 of 4

Card Number: 53-1

General Task Description Inspect and clean the main landing gear wheel wells.	
Hazards & Warnings 1. Tag-out the hydraulic system before starting. 2. Tag-out APU 3. Make sure your lead knows where you are at all time. That way no one tries to taxi the aircraft with you in the wheel wells. 4. Watch out for sharp edges.	
Required Tools & Equipment 1. Flash light 2. Inspection Mirror	N/A
Supplies 1. Cleaning supplies: solvent, rags, hand broom and dustpan	N/A
Other Information If an area is to dirty to inspect, clean with solvent and a rag.	

Aircraft Number: N9051U | Purdue University | Originating Shift (circle): AM PM

Date: ____________________

Card Number: 53-1

INSTRUCTIONS | SQUAWKS

1 Main Landing Gear Wheel Well Inspection

1A Main Landing Gear Wheel Well Inspection

1A1	Tag-out the hydraulic system and the APU.	
Completed (Tech):		Inspected (Lead):
1A2	Go to the left main landing gear wheel well.	
Completed (Tech):		
1A3	Inspect the left main landing gear wheel well for dirt, lint and debris.	
Completed (Tech):		
1A4	Sweep large items (if found), such as leaves, out of the wheel well. Wipe the are down using solvent and a rag, as listed above. Then dry the area using a clean, dry rag.	
Completed (Tech):		Inspected (Lead):
1A5	Inspect the wheel well for corrosion. If corrosion is found fill out a discrepancy report.	
Completed (Tech):		
1A6	Inspect the wheel well for loss or missing hardware. If any lost or missing hardware is found, fill out a discrepancy report.	
Completed (Tech):		

Aircraft Number: N9051U | Purdue University | Originating Shift (circle): AM PM

Date: ____________________

Page 3 of 4

Card Number: 53-1

INSTRUCTIONS | SQUAWKS

2 **Main Landing Gear Wheel Well Inspection**

2A Main Landing Gear Wheel Well Inspection

	INSTRUCTIONS	SQUAWKS
2A7	Inspect the wheel well for damage. If any damage is found fill out a discrepancy report.	
Completed (Tech):		
2A8	Go to the right main landing gear wheel well.	
Completed (Tech):		
2A9	Inspect the wheel well for dirt, lint, and debris.	
Completed (Tech):		
2A10	Sweep large items (if found), such as leaves, out of the wheel well. Wipe the are down using solvent and a rag, as listed above. Then dry the area using a clean, dry rag.	
Completed (Tech):		Inspected (Lead):
2A11	Inspect the wheel well for corrosion. If corrosion is found fill out a discrepancy report.	
Completed (Tech):		
2A12	Inspect the wheel well for loss or missing hardware. If any lost or missing hardware is found, fill out a discrepancy report.	
Completed (Tech):		

Aircraft Number: N9051U | Purdue University | Originating Shift (circle): AM PM

Date: ____________________

Page 4 of 4

Card Number: 53-1

INSTRUCTIONS | SQUAWKS

3 **Main Landing Gear Wheel Well Inspection**

3A Main Landing Gear Wheel Well Inspection

	INSTRUCTIONS	SQUAWKS
3A13	Inspect the wheel well for damage. If any damage is found fill out a discrepancy report.	
Completed (Tech):		
3A14	Have your Lead inspect your work.	
Completed (Tech):		Inspected (Lead):
3A15	Untag the hydraulic system and APU.	
Completed (Tech):		Inspected (Lead):

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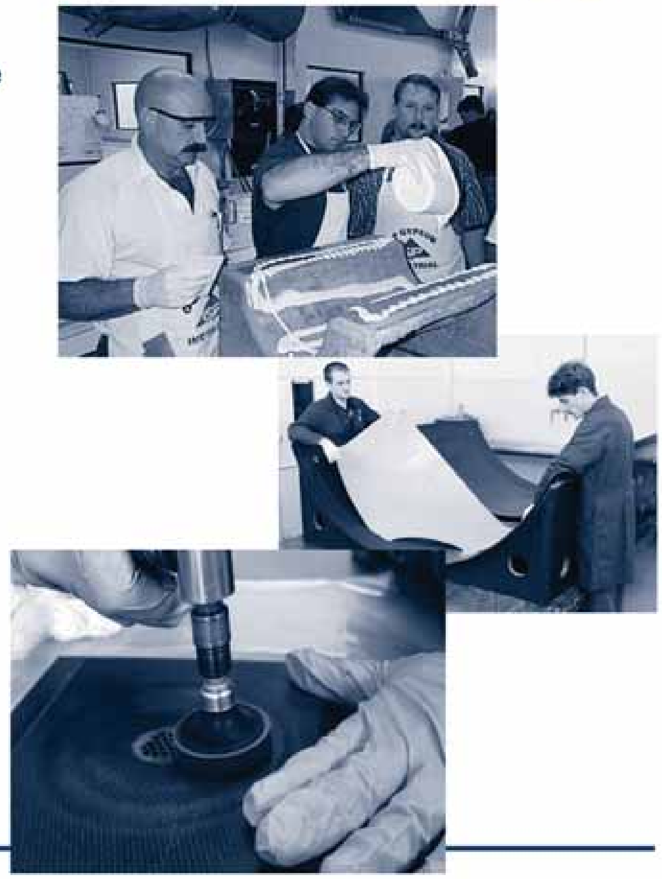

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ABARIS TRAINING

Continuous Improvement of Part 147 Programs through Outcomes-Based Assessment

By David L. Stanley

ABSTRACT

Virtually all educational programs have come to rely upon some type of accreditation as an indication of quality and industry acceptance of the curriculum. In some instances, industry hiring and employment practices actually include a requirement for graduation from specifically accredited programs. Educational programs may also use the accreditation process as a mechanism by which to gain new mission focus and provide the necessary impetus for continuous improvement. In addition to these considerations, the importance of credit transfer and requirements of financial aid programs have helped to make accreditation a standard requirement for Part 147 programs, as well. In the past, FAR 147 programs have primarily focused on certification and accreditation whereby traditional criteria have driven the process and the curriculum. The question is now being asked: can we in aviation maintenance training focus on outcomes rather than a prescriptive listing of established criteria? If so, our programs may benefit from the positive aspects of outcomes-based assessment.

This shift is already underway for other engineering and technical areas of study. Rather than relying on a predetermined listing of curriculum hours, faculty licensure, equipment, and facility requirements as a pre-requisite for certification, these considerations are being driven by the educational outcomes of such programs. A philosophical approach to certification relying on outcomes based assessment eliminates the need to meet what may be outdated, unwarranted or even counterproductive criteria. Recently, revisions of this type have been adopted by the Technology Accreditation Commission (TAC) of the Accreditation Board for Engineering and Technology (ABET). While the outcomes approach is new for TAC, these same guidelines have been implemented successfully by the other commissions of ABET for some time.

Can Part 147 programs use the ABET model for accreditation? Will outcomes-based assessment allow such programs to maintain the vital aspects of aviation maintenance training while also embracing the important tenets of accreditation? In this discussion, these questions will be addressed, with the hope of opening a dialogue on the topic of outcome-based assessment and its place for aviation maintenance technician training.

CONTINUOUS IMPROVEMENT OF PART 147 PROGRAMS THROUGH OUTCOMES-BASED ASSESSMENT

Certification of Part 147 schools has long been focused on the processes of training that the schools provide. Critics sometimes describe it as the bean-counters approach to certification; it has been referred to, in accreditation terms, as the "process approach". Numbers of instructors per students, numbers of hours of mandated instruction and experience, square footage of instructional and laboratory space, and other specific requirements have been accepted criteria for certification. Entwined with the process is the premise that individual students begin with the same level of knowledge, ability, and skill, and require a specified number of hours of instruction and experience in order to perform at the requisite level. At the conclusion of the prescribed training, A&P certification involves a complex series of tests, which are generally outcomes-based in design.

In retrospect, Part 147 has actually led the charge for outcomes assessment as applied to the testing phase, but it has failed to fully adopt this philosophy, particularly with respect to program certification. As a result, Part 147 programs have a foot in the boat of process and another in outcomes-based assessment, and they are beginning to drift further apart. Accreditation, most specifically in engineering and technology curriculum similar to Part 147, has long been on the move towards outcomes assessment. At some point, choices should be made concerning the direction aviation maintenance training takes for certification and licensure. Can Part 147 programs move further towards outcomes-based assessment as a basis for accreditation or certification? To address this issue, it is important to examine a number of related matters, beginning with accreditation, and the purposes it serves.

WHY PURSUE SPECIALIZED ACCREDITATION OF ANY TYPE?

To answer this question, an historical perspective on accreditation is important. Accreditation became a national initiative in the beginnings of the 20th century, and continued to mature largely as an American philosophy since that time. Early on, accreditation had goals that included greater cooperation and reciprocity among educational institutions of higher learning, the development of common definitions and standards, and the establishment of college entrance requirements (1). While institutional accreditation standards were drawn up and applied to colleges beginning around 1910, specialized accreditation was also taking form as the American Medical Association (AMA) developed a rating system and began making inspection visits to schools. The evaluative basis for these early efforts was a set of standards, including, for instance, a maximum number of students, a minimum endowment, and other specific values that had the effect of invoking order for higher education at a time when little existed.

As higher education expanded and matured, many viewed these standards as prescriptive and rigid, and as obstacles to the progress of education. This led to an introspective time in accreditation during which the old standards were eventually replaced with "criteria". Accreditation embraced a process of normative evaluation whereby the data from the institution undergoing the process was compared with data from a large group of institutions. Under this philosophical approach, conformity to these norms was the rule until after World War II, at which point critical thinkers recognized the need for improvement and rejuvenation in postsecondary education. Even then, some elements of outcomes-based assessment became evident in the new questions raised, including, "What is the educational task of the university?", and other inquiries of a fundamental nature (1). Nonetheless, accreditation continued to rely more on prescriptive and process terms, and less on educational outcomes.

Reliance on criteria related to the process of education continued in particular for specialized accreditation due to the more specific nature of the programs under review. Nevertheless, as funding for education became more challenged, and credit hour requirements for graduation increased, the sometimes-onerous mandates of processed-based accreditation came under fire. Outcomes-based assessment offered an opportunity to clarify and re-focus the mission of programs in the face of tightening budgets and declining enrollments, while at the same time increasing credibility and stature within the discipline. Could this same rationale serve as impetus for further application of outcomes assessment to Part 147 bachelor degree programs?

Accreditation today serves the twin purposes of quality assurance and institutional and program quality improvement (2). It may take the form of institutional accreditation or specialized accreditation. Institutional accreditation is performed by regional agencies for each of the Middle States, New England, North Central, Northwest, Southern, and Western regions in the United States. Specialized accreditation is often sought by specific programs within institutions, and is typically associated with national professional associations, including engineering, medicine, law, or with specific disciplines (2). Accreditation is generally thought to be of a voluntary nature, however, the objectives of accreditation according to ABET, include the identification of specific programs that meet minimum criteria for accreditation to, among other groups, state licensing or certification board (3). In the aerospace industry, it should be noted, specific accreditation is becoming a standard expectation for all employees in technical and engineering positions, including those for which A&P credentials, knowledge, and skills are considered to be of significant importance. Simply stated, in many arenas, specific specialized accreditation is now a requirement for licensing, certification, and employment.

WHAT IS OUTCOMES-BASED ASSESSMENT, AND WHAT DOES IT HAVE TO OFFER?

In the past, accreditation placed great emphasis on the inputs of the educational process, including budgets, square footage of facilities, equipment, and faculty credentials. These quantities were compared with accepted, normative values, and student work was evaluated as examples of quality (4). While this process helped insure that programs possessed the necessary resources to carry out their mission, it did not have as its primary focus the products of education, nor did it allow for adequate variation among programs.

Outcomes assessment as a tool for specialized accreditation is a continuous process of curriculum development with the goal of program improvement and learning based on solid data. It accomplishes these goals by the following:

- Application of a continuous assessment program to address teaching and learning processes and outcomes.
- Use of quantified data measuring student learning – what they are truly studying and what they are learning.
- Documented feedback from alumni, employers, student evaluations, and instruments of coursework evaluation.

Outcomes assessment identifies the desired outcomes of learning, provides global information about student performance, and helps to identify areas of learning in which students are struggling. Analysis of grades, overall project work, and specific items in projects and exams are part of outcomes assessment. Outcomes assessment, it can be seen, generally emphasizes more specific competencies, while institutional accreditation focuses more on general education. Under the ABET definition the following steps accurately capture the procedural concepts for outcomes assessment (4):

- Plan it
- Do it
- Check it
- Revise it
- Repeat it

Under outcomes assessment, emphasis has shifted to the outputs of education, whereby learning, feedback from alumni, and employer satisfaction are the first considerations and the inputs are weighed to complete the picture. This focus on outcomes might be considered as a sign of and a tool of program maturation, whereby the old standards for education and instruction are continuously challenged, and the products must answer to evolving expectations. Outcomes assessment performed properly and continuously provides practitioners with a significant competitive edge. Does a downside exist? Successful application of outcomes assessment forces programs to critically evaluate historical practices and jettison unwanted, sometimes dogmatic thinking. It is not a process to be taken lightly, and committed engagement may call for extensive change.

HOW DOES PART 147 CERTIFICATION DIFFER FROM OUTCOMES-BASED ACCREDITATION?

Generally speaking, Part 147 programs continue to be certified under the process means of accreditation, described by some as the "bean-counter" approach. However, it should be noted that the A&P certification process now includes many elements of outcomes-based assessment. The oral and practical tests, for instance, specify performance and knowledge required of the applicant, which is very much representative of outcomes assessment. On the other hand, the written exams, due to the requirement that all questions must be published, do not provide a reliable test of knowledge, and are only a check on short term memory and retention. On the front end – program certification – the FAA stipulates that in order to prepare students adequately, the facilities, equipment, hours of instruction, and faculty credentials must all meet established standards (5). This cookie-cutter approach to program certification that is prescriptive and restrictive, and lead to wasted resources.

The problem is we don't fully trust the outcomes process - we apply it to the student in testing, but not to program certification. As a result, programs have one foot in the boat of process, and another in outcomes-based assessment, and the two are drifting apart. As a result, programs languish in curriculum development, while new and important subject matter continues to be excluded due to time restrictions. Furthermore, the current approach essentially stifles the utilization of new technology, which in other areas of study has enabled great progress in education and efficient training very much as a result of outcomes-based assessment. The common availability of computers, for example, has enabled the study of complex subject matter in many different settings, but under Part 147 requirements, such study counts only when it is directly supervised by a properly certified instructor. What could be truly designed as self-paced instruction is governed by the bean-counter approach that prescribes a certain number of minimum hours for completion under the supervision of instructors. Our limited and valuable resources are spent in protecting the process when they could be dedicated to improving outcomes.

Under outcomes assessment, program certification could be expected to change significantly. While the inputs to the process - square footage, number of hours of instruction, and other considerations - would still be important, they would be judged in response to the expected outputs of education. Program and educational outputs would require careful consideration, using a ground-up approach divorced from historical expectations. In the outcomes process under ABET, for instance, assessment must utilize multiple measures as prove that objectives are being met. These include student portfolios, student performance in project work, results of surveys to assess graduate and employer satisfaction, and other tools, as well. Existing requirements and expectations for requisite skills, knowledge, and abilities would be challenged for applicability. Such an effort would require communication with employers and graduates of Part 147 programs to collect information regarding stakeholders' level of satisfaction with the products of education and suggestions for improvement. It is possible that the resulting feedback might indicate that the topic of dope and fabric, for instance, is less significant now than in years gone by, and that more emphasis should be applied to other parts of the curriculum, or to new subject matter. All of the curriculum would come under critical evaluation, and careful thought would be given to the knowledge, skills, and abilities required and important for the airframe and powerplant mechanic.

Current certification requirements mandate the use of written examinations, followed by oral and practical examinations to evaluate learning and test for certification. While the oral and practical tests are generally considered very good examples of outcomes-based assessment in practice, an argument can be made that they are not reflective of the desired outcomes of learning. One glaring problem exists in the testing phase. Regulations mandate that all questions on the written exams be published, which has the unintended consequence of making the "writtens" less a test of knowledge, and more a challenge to short term memory and retention. A shift to outcomes assessment would probably require a challenge to these requirements, with the hope that written tests could be developed that better discriminate with respect to knowledge and critical thinking.

IS IT POSSIBLE TO ACCREDIT OR CERTIFY PART 147 PROGRAMS THROUGH AN OUTCOMES-BASED ASSESSMENT PROCESS?

This is a difficult question to answer, and one which requires an understanding of the demands imposed by outcomes assessment. It forces the users to take a fresh look at the institution of learning. ***All of those involved*** with the process, including the entire faculty and administration, must be focused on the effort to identify and quantify the knowledge, skills, and abilities important for program graduates. This, in turn, requires that the curriculum be responsive to stakeholder needs, and to embrace change in order to foster continuous improvement. Outcomes assessment leads to inquiries at the most fundamental level, and challenges the program to make essential changes.

Can Part 147 programs be certified under such a process? Most would probably agree that Part 147 curriculum and certification processes should respond to the needs expressed by the aerospace industry and by program graduates in the years to come. Outcomes assessment is a process that can enable change and encourage continuous improvement. Frankly, some elements of Part 147 qualify now under the definition of outcomes assessment, including the oral and practical exams. Written tests that provide for better discrimination of applicant knowledge and critical thinking would help to round out the certification phase, and shore up the entire process. A willingness to consider the educational advantages and implications of new technology, to accept demonstrated skills, and to rely less on prescriptive requirements for program certification and for instruction would help remove many barriers to improvement. Starting in this direction requires agreement that change is necessary to remain abreast of the current environment, to be more nimble, and to prepare for the challenges ahead in the aerospace industry.

Consensus agreement on necessary change is problematic if not impossible, and many will argue that industry should not drive curriculum and program development. The authors understand these arguments, and further agree that very careful thought must be given to the fallout of any such decisions. Certainly, training providers must work with the FAA to make the final decisions on any change, either in terms of subject matter or with respect to certification procedures. Agreement on any change of this nature will require the participation of the many, not just a few of the interested parties.

SUMMARY AND CONCLUSIONS

Accreditation evolved over the last century to become in itself nearly an institution. Battles were fought over this very issue, as academic institutions struggled to remain autonomous in the face of accrediting demands. Outcomes-based assessment, it could be argued, became a weapon that academia used to re-claim territory carved out by accrediting bodies. Through this process, institutions of higher learning re-defined their missions, gained a new focus and a competitive edge. Outcomes-based accreditation has become accepted as a means to foster continuous improvement and to provide a check on quality for all the stakeholders.

Outcomes assessment as a basis for accreditation or certification can enable the process of continuous improvement, and provide opportunity for stakeholders to have considerable input in the process. When this occurs, the curriculum and instructional philosophy is able to respond better to the needs of program graduates and employers. In the field of technology these stakeholders hold the key to a competitive edge for any area of study. Part 147 programs have, without a doubt, improved considerably over the years. Nonetheless, the mandates for process and content as well as the limitations and restrictions on operation have served to limit the growth and development of our programs.

Part 147 is now somewhere between the historical bean-counter approach and the outcomes-based approach to certification and accreditation. Can certification continue under present requirements while accreditation of such programs commits to another path? The answer is probably no. **Complete** devotion to the outcomes assessment process would most likely lead to changes that conflict with current certification procedures. If, however, we could place our trust in the process, further movement towards the outcomes approach to accreditation and certification could be very positive for both our students and the industry. It would lead to a call for some changes, and some might even by significant. An introspective examination of the program, and the important knowledge, skills, and abilities would be required. These identified outcomes then would provide a basis for the input requirements, enabling increased flexibility and more responsive programs. FAA oversight and approval of the process and commitment to necessary change is obviously essential. If all involved, including trainer providers and FAA, agree that change and continuous improvement are necessary for Part 147 to respond to the needs of aviation and the aerospace industry, then outcomes-based assessment may be the vehicle that could provide transportation to that destination.

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AUTHOR BIOGRAPHIES

David Stanley is an associate professor at Purdue University, who teaches primarily power plant technology curricula within the Aviation Technology Department. He serves as the curriculum chair for Aeronautical Technology and is charged with development responsibilities for the curriculum and for the overall globalization efforts of the department, as well. Professor Stanley has long been involved with bio-fuels research and test cell development initiatives required to support those activities. He has a strong interest in diversity of the student population, and along with other interested faculty colleagues, has published several papers on the topic.

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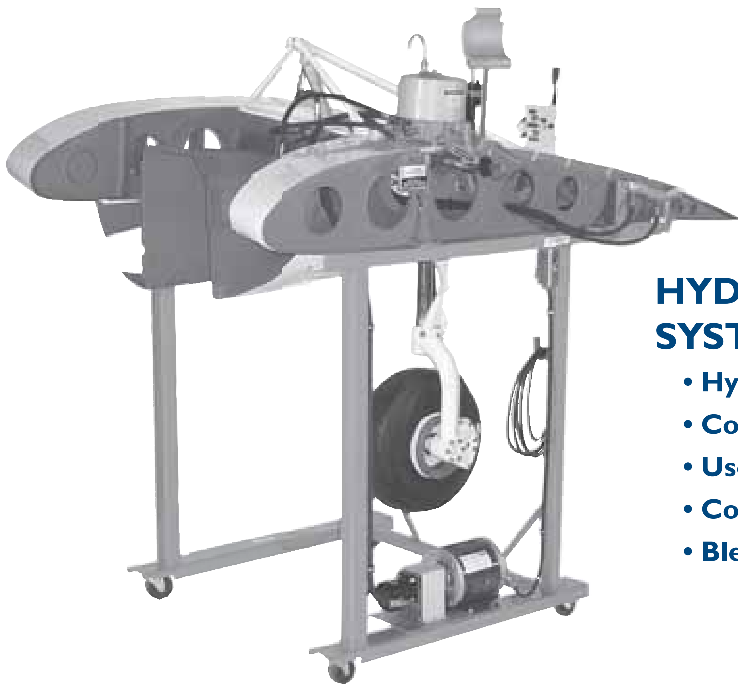

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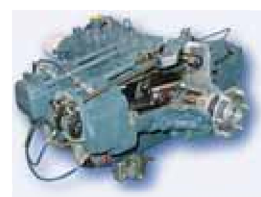

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A Call for Contemporary FAR 147 Training

By Joseph C. Hawkins
Middle Tennessee State University

ABSTRACT
While current FAR Part 147 training curriculums are adequate entry level mechanical skills, employers criticize the syllabus because they must provide supplementary training for new technicians lacking a base of knowledge with current technology aircraft. The lack of emphasis on the federal level to update FAR 147 curriculums coupled with almost no industry support widens the already huge training disparity between FAR 147 programs and modern aircraft systems. An inequality that expands exponentially as a multiplicity of advanced aircraft come into the market.

A CALL FOR CONTEMPORARY FAR 147 TRAINING

"FAA should review the required curriculum at aviation maintenance technician schools, identify courses that do not reflect widely used aircraft technology and materials and either de-emphasize or replace them (General Accounting Office, 2003)."

Long before George Cayley theorized lift and drag factors, aerospace was perceived with incredulity. As technology advanced, newspapers and movie reels followed the exploits of significant personalities and announced major aerospace advances with bold headlines and great fanfare. Now, as conceptual drawings evolve into manufacturing lines, public relations departments herald every development from first roll out to final certification with internet websites and DVDs. In contrast to the exciting coverage given to previous aeronautical achievements, an historical benchmark was reached this past September that received almost no mention from the media. In a ceremony that may well mark an event of significant progress in the aerospace industry, the Federal Aviation Administration (FAA) awarded the first ever airworthiness certificate for an unmanned aerial vehicle (UAV). A derivative of the military Predator B UAV, the General Atomics Altair is the first commercial unmanned aircraft approved by the FAA to fly the U.S. skies (Federal Aviation Administration, 2005).

Because of its special one year approval in the "Experimental" category, the Atomics Altair UAV does have significant operational limitations. Nevertheless, it certainly represents a variety of new challenges, not the least of which will be airworthiness requirements that become more defined as its type and design envelopes expand and systems mature. Admittedly, the potential impact and breadth of the commercial UAV industry remains unclear. Even so, with the emergence of the Very Light Jet niche, high performance composite aircraft, and the sport/recreation market, these industry trends could initiate the next major cycle of growth and employment opportunities for new technicians in the industry. As these innovative aircraft and new designs enter service, they accentuate the growing technological gap between industry advances and aviation maintenance training programs. The burden for FAR 147 training programs has always been how to obtain and integrate the latest technologies into a teaching curriculum that should by design remain relevant. But several factors hinder and even prevent the most earnest efforts of educators to present the latest technological standards and more adequately prepare future aircraft maintenance professionals.

Within the broad scope of its congressional mandate to regulate the aerospace industry, the FAA manages many high profile initiatives. Some of its most newsworthy priorities include passenger and cargo security, airway congestion and international agreements. For far too many years the FAA has had to manage these difficult agendas in an environment of declining budgets, reduced allocations and a dwindling workforce. In addition to its many safety and operational responsibilities, the FAA is also responsible for the approval and oversight of the training syllabi's used in FAR 147 technician programs. Given its many responsibilities on both the national and regional levels, it's not hard to understand why modernizing FAR 147 teaching parameters is not a high priority at the agency. Dealing with a variety of high profile issues on a continuous basis leads to a lack of urgency and allocation of resources when it comes to other programs. In the case of the FAR 147 training program, which has served the industry pretty well up to now, it can create a "if it's not broken, don't fix it" mentality within the FAA bureaucracy.

As a result, the ability of FAR 147 training programs to adapt industry trends and evolving technologies quickly into a meaningful course syllabus are stymied at almost every turn. Obtaining federal approval to change course material or to update course offerings in the maintenance curriculum is not easy. FAR 147 programs are hindered by a cumbersome and bureaucratic process that relies on mountains of paperwork and over tasked personnel from the local Fight Standards District Office. This unwieldy process does nothing to anticipate industry trends nor does it encourage forward thinking concepts. Current FAR 147 training programs also suffer from extremely limited industry support and sharing of engineering and maintenance resources.

Many aviation professionals, educators, and maintenance managers agree that the current FAR 147 training syllabus is antiquated at almost every level. But fault can not be laid at the

Figure 1
Expanding on the manufacturing practices and materials developed in the 1980s, composite aircraft such as the Diamond DA40 herald the need for updated FAR Part 147 curriculum addressing inspection and repair procedures.

door of any one entity. Responsibility must be shared not only by regulators and educators, but a broad industry spectrum of airframe and powerplant manufacturers, accessory suppliers, and training providers as well. For example, deciding to end its expensive marketing, spare parts, training and engineering programs supporting the Starship turboprop, Raytheon Aircraft recently completed an ambitious program to reacquire most of the Starships still in operation. Raytheon accomplished its goal by offering attractive incentives to Starships owners that included substantial discounts and special financing on current production aircraft. Just a few short years ago when they were introduced with great excitement, these graceful platforms represented a huge leap forward in composite manufacturing processes, certification, and systems integration. Despite a limited production run, the aircraft demonstrated an admirable safety record and service history in operations around the globe and in all types of environments (Huber, 2004).

Now, only a few of these high technology aircraft are still flying, while most are nothing but stripped out honeycomb resin shells waiting to be melted in a blast furnace in Arizona. The tragedy is that instead donating these intact airframes and powerplants to the multitude of FAR 147 programs across the county, only one ended up in a technical school, a few went to museums, while the rest are on schedule to go up in ciders. Contributing these airframes to FAR 147 programs achieves the same goal the destruction program was designed to achieve: shaving expenses by no longer having to provide parts, technical support and training. Instead of sending these aircraft to the furnace, their donation would certainly have been a quantum leap for FAR 147 curriculum enhancement. It also represents an opportunity for favorable news coverage for an industry with little to celebrate the past few years in terms of investor confidence and consumer satisfaction. Unfortunately, a misplaced corporate attitude won over the broader view. With the decision to eradicate any evidence of the Starships existence, Raytheon Aircraft negated a much greater benefit to the industry of exposing future technicians to the ground breaking technology that set the standard for current composite based airframes and systems design.

Figure 2
With an emphasis from aviation technician training providers, the FAA should allow repair and maintenance of radial engines to be deemphasized and new technologies such as light weight turbo-fans powering Very Light Lets include.

Figure 3
Digital avionics are crucial for the success of man new entry aircraft programs and further development of the Small Aircraft Transportation System. The industry should be encouraged to more actively support FAR 147 training programs exposing aspiring technicians to these developing technologies.

In its report, "FAA Needs to Update Curriculum and Certification Requirements of Aviation Mechanics," the General Accounting Office (2003) observes that FAR 147 programs are centered upon lesson plans developed in the pre-World War II years and focused on small uncomplicated aircraft and systems. The report notes that there are only about 4,000 dope and fabric aircraft operating in the United States, in stark contrast to the tens of thousands of modern commercial and corporate aircraft constructed of advance composites and operating with computer enhanced systems. As required by locally approved FAR 147 Program Manuals, more class time and resources are spent with dope and fabric than exposure to the practical applications of repairing engine cowlings and airframe components derived from modern composites. There should be a concentrated effort to change the portion of the curriculum dealing with expander tube type braking systems to one with an emphasis on exposure and developing individual troubleshooting skills on the computer based anti-skid systems onboard today's modern aircraft.

This is just one example of the plight FAR 147 programs experience in their efforts to upgrade maintenance training curriculums. Current FAA approved FAR 147 teaching techniques are mandated to include dope and fabric in favor of newer composites, utilize obsolete training aircraft instead of current new technology platforms, and systems training on aircraft that have been out of production for decades. Not by choice, they remain entrenched in lessons centered on early 20th century processes. When buying a new computer, have you ever wondered how outdated it would be once you get it out of the box? The miniaturization of electronics and the introduction of digital avionics that change the definition of "glass cockpit" on an almost daily basis mirror those same reservations. As aerospace technology evolves and adapts, FAR 147 training programs remain stranded in a time warp of wooden spars and propellers, desperately trying to keep up with technological evolution. The same analogy is easily demonstrated with new technology aircraft such as Very Light Jets and the development of remarkable low weight high thrust turbo-fans designed to power them and radial engines that powered the first large commercial transports.

The quest becomes how best to change a process entrenched in bureaucracy and outmoded traditions and that has little or no support from industry. Shortly after World War II, the military established a storage area for surplus aircraft in the western desert. Today, the Aerospace Maintenance and Regeneration Center (AMRC) at Davis-Monthan Air Force Base is the home of one of the largest aircraft "recycling" centers in the world, with thousands of aircraft spread over thousands of acres. While most aircraft stored at the AMRC will eventually be destroyed, a significant number are restored and returned to active service. The AMRC also supplies parts and tooling support for older out-of-production aircraft still maintained and flown by various operators around the world.

The civilian aircraft industry has several operations similar to the AMRC. In the case of the recent decision to destroy all the Starships, storing them intact at commercial operations or other not-for-profit centers, and developing an equitable program to donate airframes, propellers and powerplants to FAR 147 programs could provide a tremendous public outreach program between the industry and FAR 147 programs. Transportation and storage charges would almost certainly be less that the costs incurred from stripping and other dismantling operations and environmental concerns necessary prior to the airframes being destroyed or incinerated. Operating expenses for this technical resources center could be paid from membership fees into a consortium, which would than offer its member's priority selection of available equipment. Another option could be a broader access program subsidized through dedicated federal aviation revenues derived from the Aviation Trust Fund or congressional grants. As an enticement for manufacturers to contribute resources and recoup at least some expenses, the federal government could apply liberal application of tax credits or otherwise reduce corporate tax obligations. Aerospace equipment and tooling donations are a legitimate form of educational support, and their contribution should be encouraged and recognized in an accelerated and bipartisan form of corporate tax breaks and other business credits.

In addition to more vigorous manufacturing support, there are other approaches that should also be considered. The most significant of which is tied to current regulations and training trends. In the 1990s, the FAA conducted a comprehensive review of certification requirements for mechanics and repairman. The study was driven by several factors, the most significant was the recommendation in the accident report from the National Transportation Safety Board (1989) insisting on additional training for technicians in non-destruction testing procedures and corrosion detection after the in-flight structural failure of an Aloha Airlines Boeing 737 on April 28, 1988. The other major objective was to open dialogue between European and Canadian aviation authorities to more closely align conflicting airworthiness and ratings standards.

As the review gained momentum, numerous aviation groups' added inputs and a proposal was created identifying the need for a separate regulation, FAR Part 66 exclusively for aviation maintenance personnel. The intention of the new FAR 66 was the introduction of additional technical certificates and ratings, the expansion of current certification requirements, and increased training and recurrency requirements. The proposed FAR 66 contained many innovative ideas; unfortunately, the aviation maintenance industry's overall response to it was very antagonistic. Although supported by the majority of alphabet groups representing a variety of aerospace interests, the new FAR was considered too controversial by the FAA and consequently never adopted. Nevertheless, the study spurred the call for additional educational and training opportunities for maintenance technicians, particularity in new technologies. It also laid the groundwork for a grassroots realization of elevated professionalism and educational opportunities for technicians leading to promotional opportunities within the corporate structure.

Realizing the ensuring demand and attractive business opportunities developing, the aviation training market quickly expanded with a multitude of systems training and options for technicians. Today, these programs are as diverse in cost, format and availability as the variety of complex aircraft operated today. Almost every major airframe and systems manufacturer supports technical training for its equipment, either in-house or through a dedicated provider. It is of no small significance that these programs are marketed to maintenance professionals emphasizing systems knowledge and adherence to procedures with the adjective of enhancing airworthiness.

Contrary to the industry's negative reaction to recommended FAR 66 training requirements, encouraging aviation professionals to attend approved training programs is a natural offshoot of the FAA's mandate to ensure safety-of-flight. In an effort to expand their market base and attract repeat business, most maintenance courses now meet the requirement for renewal of a technician's Inspection Authorization. These initial and recurrent training programs have now become the industry standard for technical expertise and professional advancement, especially when transitioning to or introducing a new aircraft. To reduce accidents and exposure to claims, most aviation insurance carriers not only require pilots but maintenance technicians as well, to update and refresh their skills with recurrent classroom sessions to ensure coverage and renewal.

Just as manufacturers support their fleets and training providers, manufacturers should be encouraged to more actively support the FAR 147 training industry by making their maintenance, inspection and technological advances readily available to schools and instructors. Understandably, there will be serious proprietary concerns about disclosure of engineering and manufacturing processes. Nevertheless, manufacturers should be encouraged to share their systems requirements and technical items with FAR 147 programs within guidelines designed to protect unique engineering processes and systems. Allocating resources such as maintenance and structural repair manuals, in-depth system descriptions, equipment and other operational information would certainly advance classroom curricula and practical labs. What ever the market niche, these are the very groups that stand to garner the most reward for their assistance to technician training programs. There is no better avenue to advance the aerospace safety culture and prevent unnecessary accidents related to an inadequate training than to educate aspiring technicians in current technology. It not only changes a mindset that challenges new technology and ideals with apprehension, but could develop into a valuable recruitment tool for future aviation maintenance technicians.

Since the industrial revolution, transportation technologies whether air, sea or land have almost always outpaced federal regulatory concerns and safety standards. The important point this paper hopes to emphasize is that as technology advances, so too should the initial exposure for future technicians. It is time for FAR 147 programs to seize the initiative and go where they have never ventured before; manufacturing plants, accessory suppliers and training providers to garner the training resources and technical support essential in their quest to properly prepare maintenance professionals for current technologies and evolving designs.

George Cayley is remembered as the first accurate aircraft designer, and with the exception of two world wars and other conflicts, at no other time in history has such an abundance of exciting technologies come together. While designed primarily for the wartime environment, the UAV is envisioned as a significant commercial airframe. If industry forecasts are even partially correct, almost 13,500 VLJs could be in service by 2015. Should NASA's ambitious Small Aircraft Transport System program become a viable option in the national airway plan, the innovative materials and advanced avionics installed in these new technology aircraft must be inspected, maintained and repaired. Just as aerospace technology evolves, so too should FAR 147 training programs charged with the responsibility of supplying motivated and multi-disciplined technicians inspired to go higher, faster and further.

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Low-Cost Avionics Simulator

By Renee M. Hendricks, MS

From teaching an Avionics course at Purdue University for the past two years, it has been observed that there are not many avionics simulator software programs that contain the information required to assist aeronautical technology or Airframe and Power plant (A&P) students in a laboratory environment without the added knowledge of flight. So, a low-cost, computer-based avionics simulator was created which has greatly assisted in graphically showing how certain navigation systems operate in a laboratory environment.

AVIONICS STUDENT ENROLLMENT

The Avionics course is required for the aeronautical technology students, but, can also be taken by the professional flight students as an elective in their degree program. The students enrolled in the Avionics course have diverse backgrounds and areas of studies and it changes every semester. Typically, there is a combination of aeronautical technology and professional flight students enrolled in the course. The students' area of studies and backgrounds typically fall into four categories:

- Aeronautical technology students without flight experience
- Aeronautical technology students with flight experience
- Aeronautical technology students with an A&P certificate
- Professional flight students

The aeronautical technology students with flight experience can be divided into 2 sub-groups. These students have either obtained a private pilot certificate or they are enrolled or have been enrolled in a professional flight course. The aeronautical technology students with an A&P certificate can also be divided into 2 sub-groups. These students transferred from another university with a 2-year A&P certification program and they do not have any flight experience. They can also be military personnel who have their A&P certificate and have had flight experience as part of their military duties. So, one can see the diversity of the students' backgrounds and areas of studies. This makes the course difficult to teach at times because there are varying levels of experience and backgrounds among the students.

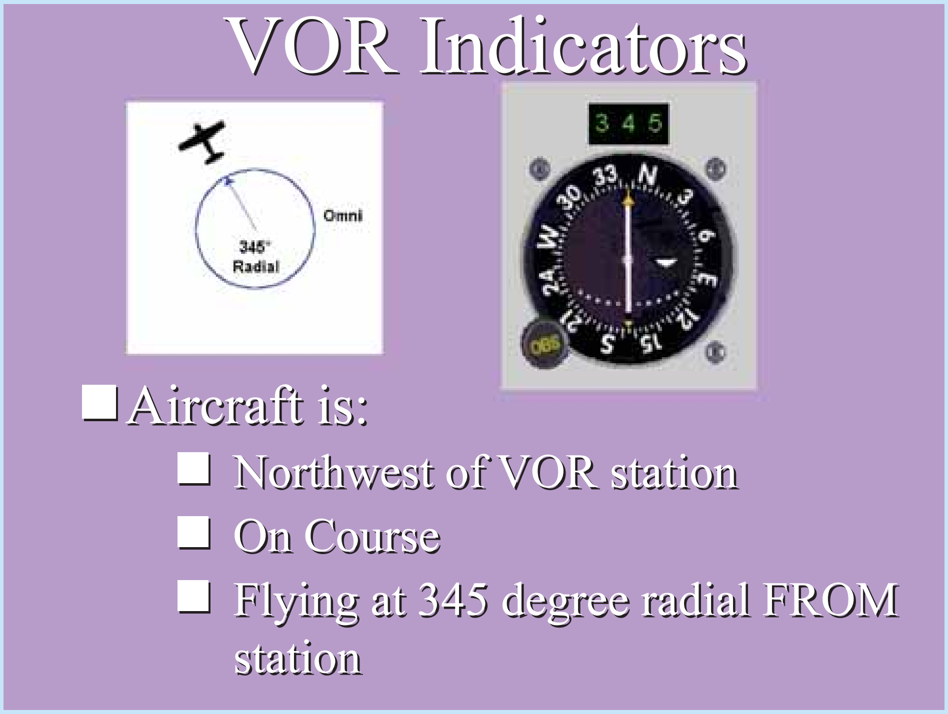
The aeronautical technology students without flight experience typically require more time in understanding the relationship between the aircraft position and the navigation indication display. These students, as graduates, will be maintaining and trouble-shooting the navigation systems and it is important that they understand not only how these devices operate, but, how they are utilized, in order to properly maintain and trouble-shoot them quickly and efficiently.

CURRENT DEMONSTRATION METHODS

Currently, various pictures and online, free simulators are utilized in class to demonstrate the aircraft position in relation to the navigation indicator display. Picture 1-1 shows a Power Point slide presented in lecture to demonstrate the VOR indicator in relationship to the aircraft position. The pictures in the slide are taken from the website http://www.navfltsm.addr.cm'vor-nav.htmm?. First, the pictures on the slide are explained to the students and then the students work on their own to determine the aircraft position and correction direction based on the pictures. Then, the bulleted items are discussed with the students as each bullet is displayed to them.

In additional to pictures, a free, online simulator is also utilized for lecture. It is called, 'Tim's Air Navigation Simulator'. Picture 1-2 shows the simulator homepage. The webpage address is: http://www.visi.com/~mim/nav/. First, the online simulator is demonstrated in lecture. Then, in lab, each student is given the chance to test the simulator at his or her computer. Once the student feels comfortable with the simulator, the aircraft is removed from the screen, and the

Picture 1-1: Example VOR Lecture Slide

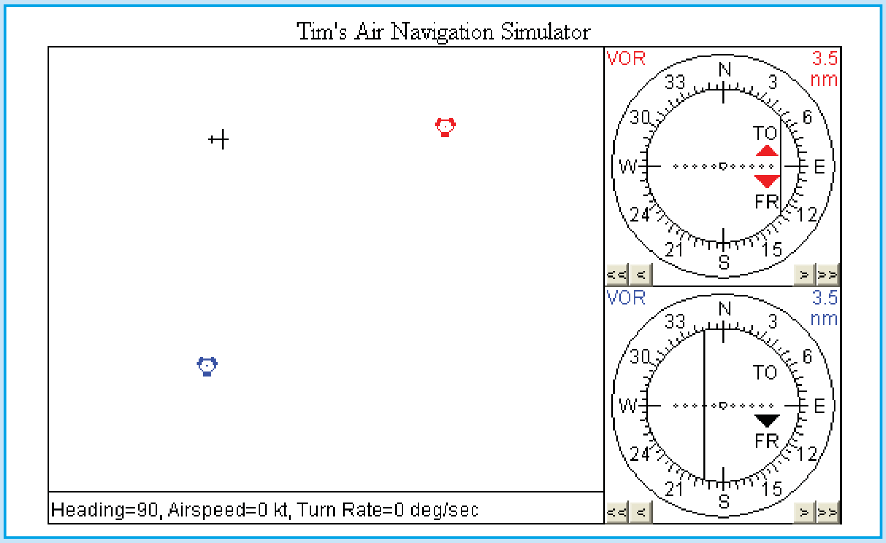


student is responsible in determining the aircraft's location by only adjusting the indicator controls. This simulator also allows the student to change the type of indicator, such as VOR, ADF, or HSI.

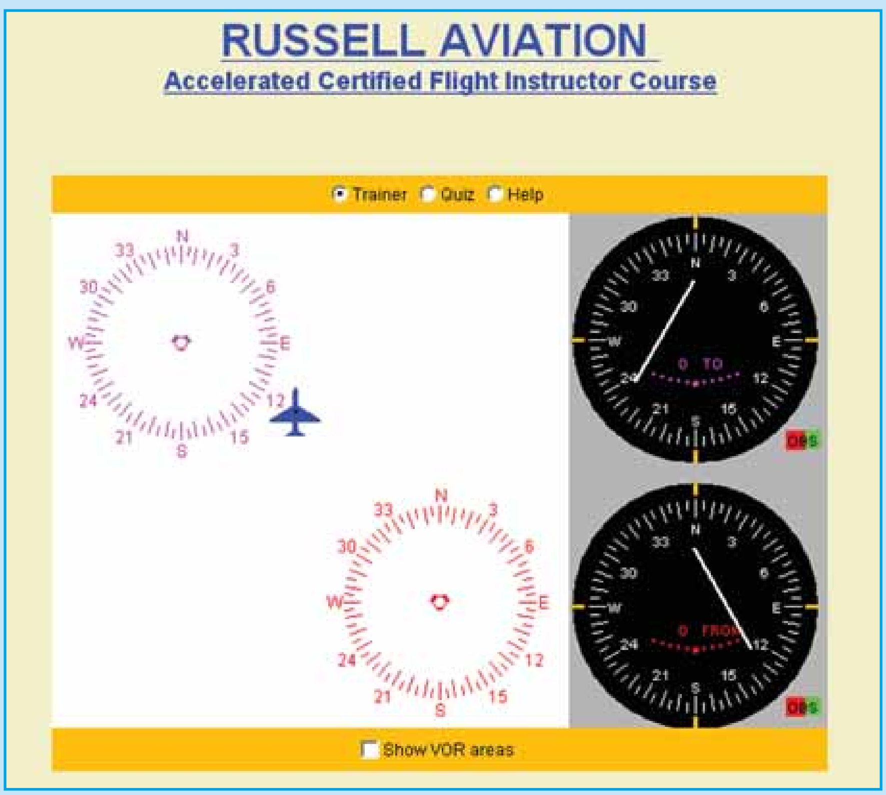
Another free, online simulator is also utilized for lecture. It is called 'Dual VOR Trainer'. Picture 1-3 shows the simulator homepage. The webpage address is: http://www.russellaviation.com/sims/DualVOR.htm. Again, the online simulator is demonstrated in lecture and then in lab each student is given the chance to test the simulator at his or her computer. Once the student feels comfortable with the simulator, he or she takes the provided quiz.

Each of these online simulators has been chosen for their ease in availability as well as their excellent graphical displays. Also, these items are all free of cost to both the instructor and students. Plus, the above examples do not require flight experience or knowledge, like many of the off-the-shelf flight simulator software programs that can be bought. These also save time in class and laboratory, when the students do not have to learn the entire program operation. Plus, these simulators allow the student to practice at their own pace and time outside of assigned laboratory times.

Picture 1-2:
Free, Online Navigation Simulator,
Tim's Air Navigation Simulator



Picture 1-3:
Free, Online Navigation Simulator,
Dual VOR Trainer



CURRENT SIMULATOR ISSUES

Many universities have various flight simulators, from the single-engine simulators to the Boeing 727 or 737 aircraft simulators. Unfortunately, most simulators are paid for and utilized by professional flight students. Based on the number of flight students and simulator flight hours available, there is typically not many hours left over, if any, for aeronautical technology students to utilize these simulators. If there are open times in the simulator schedule, the available times may conflict with the aeronautical students' class or work schedules. This causes these students to attempt to re-schedule a laboratory meeting at a different time and day. This can be difficult to accomplish with the various schedules that students and faculty follow.

Also, operating simulators can require additional people; one with a pilot's certificate and another who is familiar with the simulator software operation. It can also be difficult to schedule these individuals, too, for simulator usage. But, even when the simulator is available, all the indicators may be difficult for the students to grasp when only one or two particular navigation systems are being learned in lecture at that time. Simulator time is typically preferred for the end of the semester when the various communication and navigation systems have already been learned by the students.

LOW-COST SIMULATOR

There were many reasons for creating the low-cost simulator. As mentioned before, the flight simulators are not always available for the non-flight students. Also, granted there are free, online simulators, but, there are not free online simulators that demonstrate all the different possible navigation systems available. Plus, many of the off-the-shelf flight simulators require a large learning curve in understanding and utilizing the software program.

The simulator that was created for the Avionics students was based on a multimillion dollar simulator seen in a magazine. The simulator was created based on the following requirements:

- Affordable for both the faculty and students (approx. $2,000 per workstation)
- Display realistic cockpit and flight views
- Easily upgradeable, to keep the cockpit displays modern

The avionics simulator consists of one computer station and 2 flat-panel monitors. Table 1-1 shows the system components and costs. The Dell™ computer contains an Intel® Pentium® 4 processor and a dual monitor graphics video card. The monitors are Dell™ 19" UltraSharp™ flat panels. The monitors have adjustable heights and rotation angles. This comes in handy for different flight views and angles. The computer price is reduced because of the discount the university is given by Dell®. This is the reason why Dell™ was chosen for the computer purchase. Plus, it is a standard model purchased by our computer department, which will allow for easy maintenance and software upgrade installations by their staff.

Table 1-1 Avionics Simulator Components and Costs

Dell™ computer and two 19" flat panels	$1,622
X-Plane® Software, Version 8	$50
CH™ Yoke & rudder Pedals	$238
TOTAL	**$1,910**

Originally, the X-plane® Version 7 software program was purchased at $50.00, but, at a later date, the Version 8 program was purchased at a reduced price. Picture 1-4 shows the full simulator setup with both screens utilized. In the picture, the X-plane® program is on one monitor and the second monitor is utilized for Internet access. The version 8 software program also allows the cockpit to be displayed on one monitor and the plane location at another. This software program was chosen for its affordability and for its realistic cockpit and flight views compared to comparator flight simulator programs. Picture 1-5 shows the cockpit monitor zoomed in to see the realism in the software program. This program also has other options, such as designing and building your own aircraft that other competing programs do not contain. This program also depicts space travel to Mars, which many people may not have had the chance to view in a simulated environment before.

Picture 1-4: Low-Cost Simulator Set-up

Picture 1-5: Cockpit Monitor (Zoomed view)

Also, the yoke and rudder pedals are from CH™ products, under their gaming division. These two items were recommended by X-plane's website (http://www.x-plane.com/) and were purchased for that reason. The yoke and pedals are connected to the computer via the USB port. The yoke and pedals were purchased from a distributor. If these two items are purchased from CH products online, the total cost (including shipping) increases to $322.58. The picture of the yoke can be seen in Picture 1-6 and the picture of the pedals can be seen in Picture 1-7. This program does not require a yoke and pedals. It will also work with a typical mouse and keyboard. This may assist individuals who may need to cut costs when trying to build their own computer-based simulator.

Picture 1-6: CH™ Products Yoke

Picture 1-7: CH™ Products Rudder Pedals

SIMULATOR USAGE

First, the low-cost simulator operation is demonstrated in lab to all the Avionics students. Then, the laboratory times are divided to allow each student to operate the simulator individually. This also allows the faculty member or instructor to observe each student utilizing the simulator. Once the student feels comfortable with the simulator, a verbal quiz is given to the student over the navigation indications and the aircraft locations.

With the simulator software, various aircraft locations can be chosen. For example, if VOR is the current lecture topic, the students do not have to perform an entire flight or learn how to take off prior to observing the VOR indications. Instead, a particular aircraft and VOR station are chosen from the various lists available. Then, the aircraft position is chosen, such as on the runway or over the VOR station. The later option is typically chosen, which saves simulator time because the aircraft is immediately shown above the VOR station with the corresponding indicator in the cockpit. Plus, the aeronautical students without flight experience or knowledge do not have to learn how to take off and land in order to see a VOR indication.

As can be seen, this simulator does not provide the realistic feel of flight as a full flight simulator provides. Typically, the full flight simulators are utilized at the end of the semester when the various navigation systems have been learned by the students. These full flight simulators provide more of a final overview to the Avionics students, allowing them to see the full picture of navigation equipment operation. But, as explained before, these full flight simulators are difficult for the aeronautical students to access during the semester.

Also, the full flight simulators require far more maintenance and time to upgrade than the low-cost simulator requires. Plus, this low-cost simulator can be built at an even lower cost. As stated before, this simulator does not require a yoke and pedals, because it can be operated with the computer keyboard. This can decrease the cost of an overall system by a few hundred dollars. Also, the software will work well with only one monitor, which will lower the overall cost to build greatly. And, if many instructors do not have the money to purchase a computer, then, the software alone can be purchased and installed on an existing lecture room computer and the program can then be displayed on an existing projector. This would also allow the instructor to pause the program as needed and also allow as many students as possible to view.

Overall, the low-cost simulator has many valuable attributes, but there are also some minor issues. Unfortunately, the entire software program will not be executed unless the disks are in the computer at the time of the simulator use. So, an instructor utilizing this in lecture would need to remember to bring the disks to each lecture. Also, the software program has many options available to the end user, which makes it well liked, but, these additional options requires a computer to have a large RAM size for speed. The version 7 software requires 384 RAM, while the version 8 software requires 1 Gigabyte of RAM. Fortunately, the computer purchased early on was able to handle both software versions. If this was not the case, the version 8 software would not have been purchased or even installed. Fortunately, higher computer requirements were proposed in the development process in case a newer version was developed at a later date. But, there is a chance that if another version is created, the newer version may not be compatible with the existing computer. Also, the software program, like any gaming program, requires an extensive graphics card, which can also be expensive to purchase at times.

CONCLUSION

As can be seen from the descriptions and table, a low-cost avionics simulator with a $2,000 limit was created and built. As can also be seen by the two purchases of software, the system is not only upgradeable, but, has already been upgraded since the start of this process. Plus, the software program is capable of displaying realistic views.

Also, if additional computers are setup in the avionics laboratory, students in other aeronautical technology courses will also be able to utilize the simulators, if they, too, are experiencing difficulty in scheduling time for existing simulators for the flight students. Typically, an avionics laboratory is only utilized in 2-hour increments for each division lab meeting, so, this would allow ample time for other aeronautical technology students to schedule flight simulator time. So, this low-cost simulator is able to also solve additional scheduling problems for other aeronautical technology students.

RENEE M. HENDRICKS is an Assistant Professor at Purdue University in the Aviation Technology department. She started teaching at Purdue in fall 2004, teaching aircraft electrical and avionics courses. Her undergraduate degree is in Electrical Engineering Technology (EET) from Purdue University. She also completed her Masters coursework in Industrial Technology (IT) at Purdue University. Contact: rmhendri@purdue.edu

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ELECTRONICS & AVIONICS

Developing Learning Outcomes to Fit Industry Metrics

By Timothy Ropp & David L. Stanley

ABSTRACT

Many graduates from technology programs these days find themselves in entry level technical or first line leadership positions for which they are inadequately trained or prepared. The industry landscape has dramatically changed in terms of performance expectations for new hire graduates from a concentration on technical skills to a wider focus on job readiness. Industry advisory boards have given a clear indication that more than just strong grade point averages and technical capabilities are needed from program graduates. The graduate entering industry as a front line team member, whether in a leadership or technical role, must be able to hit the ground with the ability to problem solve "at speed" with expectations of an ever shortening learning curve.

For educators preparing graduates in engineering and technology fields, the message is clear: in addition to strong technical knowledge and skills, students also need a conceptual understanding of and experience with managing the technical aspects of the job. Even though the curriculum is tightly packed with technical study, there is much that can be done to address these issues and meet the skill and readiness needs of the aviation and aerospace industries. This paper addresses educational strategies that can be used to bring practical management and problem solving skills to students as they perform technical laboratory projects.

DEVELOPING LEARNING OUTCOMES TO FIT INDUSTRY METRICS

While measurements such as production cycle time and operational costs continue to rank as premiere metrics throughout the aviation industry, responsibility for successfully achieving these goals on a daily basis has been increasingly delegated to front line managers and technicians – roles typically taken by most technology and engineering graduates. In fact, as it has been long realized and now widely accepted that teams generally outperform individuals acting alone (Katzenbach & Smith, 1993), companies rely upon team members at all levels more than ever before to explicitly participate in achieving performance metrics once relegated to upper level managers.

New hire graduates from university engineering or technology programs are expected to be familiar with concepts not only in the vernacular of their field of expertise, but also with such globalized terms as "process excursions", "missed milestones", "recovery plans", "resource allocation" and "manpower planning". Empowered teams have evolved into "work cells" tasked with expectations to identify problems and rapidly develop countermeasures in addition to executing technical job roles, all while ensuring critical communication chains remain linked. Concepts of safety and quality are now an integral part of the process, not simply the role of the quality assurance department or safety coordinator. Unfortunately, many graduates enter technology fields with skill deficits precisely in these critical areas.

Technical expertise alone, therefore, is no longer a sole determinant of success for either the individual employee or the company. Put another way, even at the entry level position, engineering and technology graduates must be able to "think and do" – achieving technical work goals within the context of a myriad of daily process problems that must be managed, and which inevitably arise when people and technology mix. This rings especially true for any aspect of aviation maintenance, where principles of operational safety and quality are no longer just good ideas but are now regulatory requirements (U.S. DOT-FAA AC 145, 2004; U.S. DOT AR-04/36, 2004) and are integral parts of the business plan and performance metric success criteria.

Unfortunately, while the expectation exists that graduates entering the aviation support industry will be ready to "think and do", the reality is that the plan of study is overflowing with technical coursework all of which is considered to be critically important. Little time remains for study of practical management tools and people skills, and this frankly holds true across many other engineering and technical disciplines, as well. A new approach is needed that brings the practical incorporation of these important subject matters into the curriculum.

INTEGRATING THINK AND DO SKILL SETS IN A TECHNICAL WORK ENVIRONMENT

It is a well-known principle that an individual's capacity to perform any task is a function of fundamental skills and abilities. As is often the case in technical operations, when a need for problem solving arises, a solid foundation in both management and technical matters is often required to arrive at practical solutions. Generally speaking, for the technical or engineering-trained employee, global skill sets of this type are built upon on-the-job experience, which becomes a time-based investment in the new-hire. If graduates could come to the workforce having applied classroom knowledge of these combined disparate subject matters, they would require less additional training and experience to be fully qualified for the job at hand. Unfortunately, in technical education today, most management course material is relegated to the "nice-to-know" category of the learner's memory, while the focus on the skill-specific degree justifiably remains central in their cognitive endeavors. As a result, graduates of these programs typically enter job roles ill-prepared to overcome commonly encountered people issues or barriers to process flow, or are unable to adapt with the speed and resiliency necessary for problem solving required of the modern technical workforce.

Think and do skills sets typically develop over time in an environment where wide-ranging problems must be solved – on the job. While experience may be considered the only sure mechanism by which to develop these skill sets, the aviation industry has committed significant training and education resources with the goal of improving employee capabilities in these areas. Over time, such an effort pays dividends, but the cost in lost time and productivity may be considerable. These shortcomings in new hire readiness have filtered down to the accrediting bodies, and accreditation for engineering and technology programs is increasingly emphasizing the need for graduates to be well-rounded, able to work in teams, and immediately productively.

INTEGRATING INDUSTRY METRICS AS EDUCATIONAL STANDARDS

The difficulty in adapting and assimilating quickly into a company's corporate work culture exists on an international scale (Galarneault, 2003). This is especially troublesome for an industry like aviation, perhaps the most "global" and among the most volatile of technology industries. As the airline industry struggles in the United States, many aspects of airline maintenance may well continue to be driven off-shore in order to minimize costs. This global shift in the business of aircraft maintenance creates an even more critical need for people possessing a blend of technical and managerial skills and abilities to meet the wide-ranging demands of technical management (Lopp & Stanley, 2004). As it is, a strong technical education generally focuses primarily on the technology, leaving insufficient time for students to study management and people skills in stand-alone coursework. A new approach to these issues, one that focuses on these subject matters at the applied level, is of critical importance.

An upper level capstone course meeting this description is already underway at Purdue University in the Aeronautical Technology (AOT) program, and shows promise for providing graduates with requisite skills and experiences highlighted by the authors here. This course integrates required technical education with a focus in the following areas considered critical to successful functioning of high performing teams in the aviation maintenance industry (See Appendices A and B for specific breakdown of leadership assessment criteria and behavioral measures utilized in evaluation):

- Time management, planning and preparation
- Team communication
- Job assignment and process management / Problem Solving
- Safety

In this course, students utilize a variety of management tools introduced in the lecture portion of the course to manage the aircraft inspection processes ongoing in the laboratory. Large aircraft maintenance and inspection, important aspects of this particular course, require an enormous amount of planning, coordination, and teamwork, for which this subject matter under study applies specifically. Certainly the technical knowledge, skills, and abilities of the aircraft technician continue to be of considerable importance for this course. However, these functionalities are applied utilizing specific leadership and practical management skills that are under study simultaneously.

These types of activities that emphasize communication, teamwork, and problem solving are strongly supported by ABET, the accrediting board for engineering and technology programs. This accrediting body has strong representation from both academia and industry, and is focused on continuous improvement of educational programs. ABET stipulates program criteria, commonly referred to as the "A – K" criteria, which are statements that describe the units of knowledge or skill students are expected to acquire and demonstrate as a result of their educational experience (ABET, 2006). Among these are:

e) an ability to function effectively in teams;

f) an ability to identify, analyze and solve technical problems;

g) an ability to communicate effectively.

These are foundational skills for students in ABET-accredited programs and, when practiced in a realistic environment, should help prepare students to "think AND do" in the workforce. The educational challenge for this is significant. These ABET skills specified above must be developed and combined with management principles, some of which are learned in stand-alone courses. Teamwork, communication, and problem solving are studied in other Aeronautical Technology courses and are applied in laboratory projects, just as they are in this capstone course. In the laboratory for this capstone course, however, these skills are integrated with management principles, allowing students the opportunity to work, solve problems, and grapple with the issues that commonly occur in the industry. In this environment, hands-on application of basic problem solving concepts and management principles over-lays the technical work occurring at the same time to create a multi-dimensional educational experience.

The technical laboratory project in this laboratory typically involves aircraft inspection, fault diagnosis, repair and related activities. From the management perspective, the activities include process management, problem solving, staffing, coordination of shift turnover, and management of multi-task and bottlenecks issues. Note in Appendix A the behavioral measurements that apply for each assessment criteria - they are specific, observable, and measurable, at least in a subjective manner. These laboratory activities are conducted utilizing teams of students, and evaluations for grading purposes weigh heavily on productivity and effectiveness of these teams in achieving the stated goals for the lab (Appendix A and B).

The beauty of the concept is that students are placed into a non-jeopardy learning environment to practice critically important industry metrics of key management principles, which are supported by research into measures of performance in high performing technical teams in industry (Eiff, Ropp & Mattson, 1997). This further assists in driving critical leadership, management, and technical learning outcomes. Students are able to see the importance of such integrated skill sets, gain practical experience with it, and are prepared to take those practiced skills to the workforce. Certainly, challenges exist to make this learning experience valid and useful. It requires a team of instructors who have solid experience and knowledge of both the industry and sound educational practices. Grading of these activities typically relies to a significant extent on team evaluation, which can create some difficulties by itself. Additionally, subjective judgments are generally required of individual effectiveness. Assessing the value and validity of these efforts and the outcomes is another challenge, and requires communication with an industrial advisory board and the industry itself. Under ABET accreditation, outcomes assessment demands that feedback must be obtained routines from the industry and program graduates as to the quality of these efforts (ABET, 2006). The feedback received so far from the program's Industrial Advisory Council indicates that this initiative is working, and is of value to students as they enter the workforce.

As the workplace continues to grow in complexity, so does the job of higher education. Specific knowledge and skill in engineering and technology are critically important for graduates, and programs will continue to emphasize those as the industry demands. In addition to possessing these discipline-specific skills, graduates will also need to be problem-solvers, practical managers, and teams players when they enter the workforce. Understanding vitally important industry metrics and developing learning outcomes that support them is an initiative underway in Aeronautical Technology at Purdue University.

CONCLUSION

Organizations must still have decision makers and, ultimately, someone with the final say. However, traditional top down command and control management techniques are not achieving required results these days and employees can no longer rest in the comfort zone of "just following orders". Success has truly become a team effort in a very tangible way, and technical savvy alone no longer fulfills what industry perceives as a more urgent requirement of graduates in entry level positions: the ability to be a systems thinker – to critically assess and address problems with the entire operation in mind, not just one's own line of work, terminal gate or corner of the building.

For those in education, the new job is not one of providing more of the same, or doing the same things better. It is one that requires educators to create an educational experience that better simulates the daily challenges of the workplace. It is one that requires educators to recognize industry metrics and to respond with appropriate learning outcomes. This process demands more of instructors and students, alike. The working world is becoming more complex every day, and students must be prepared to deal with that complexity. For technology education, the challenge rests in creating a multi-dimensional educational experience, in which students utilize management and related tools to control processes in a laboratory environment where they are also studying and applying technical subject matter. It is a serious challenge, but it can be done, and the feedback so far indicates it is worthwhile.

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Timothy Ropp and **David L. Stanley** are professors at Purdue University.

APPENDIX A – OPERATIONS LEADERSHIP ASSESSMENT CRITERIA

Time Management, Planning and Preparation
Behavioral Measurements:

- Arrives to lab with enough time to assess and plan shift workscope and manpower needs.
- Assesses previous shift's turnover information.
- Utilizes shift briefing tool (formatted template) and briefs crew on planned work for the shift.
- Plans and adjusts accordingly for jobs completed early or when resources are required (timely communication and follow up to retrieve resources for crew or move to another job).

Team Communication
Behavioral Measurements:

- Briefs crew on planned work for the shift.
- Persistently communicates resourcing or safety needs to Foreman or instructor until resolved.
- Utilizes shift briefing turnover tool; accurately records work accomplished that shift
- Ensures job cards are signed and appropriately re-filed.

Job Assignment and Process Management / Problem Solving
Behavioral Measurements:

- Delegates planned work effectively, maximizing available crewmembers.
- Identifies bottlenecks or multi-task situations when they arise (i.e., work teams needing simultaneous access to the same area on the aircraft) and resolves the situation appropriately.
- Identifies and resolves parts or other resourcing needs appropriately.

Safety
Behavioral Measurements:

- Incorporates safety issues and reminders in crew briefing at shift start.
- Utilizes required and appropriate safety equipment and procedures (i.e., goggles, gloves; using appropriate lift or elevated platform equipment; announcing "hydraulics" before hydraulic power is applied; fall protection etc.).
- Ensures crew utilizes required safety equipment and procedures.
- Immediately communicates unsafe conditions or resourcing needs to Foreman and/or instructor.
- Clear priority is given for high risk or major tasks (i.e., engine/apu runs, towing/taxi, control surface movement) before secondary tasks are addressed.
- Ensures flight deck communication with ground safety point prior to initiating high risk or major tasks as above.
- Ensures required emergency equipment (i.e., fire extinguisher during engine/apu operations) on stand-by.

APPENDIX B – OPERATIONS LEADERSHIP ASSESSMENT EVALUATION SHEET

			Shft 1	Shft 2	Shft 3	Shft 4	Shft 5	Shft 6	Shft 7	Shft 8	Shft 9	Shft 10	Shft 11	Shft 12	Shft 13		
402L	Lab 01	F-06	1, 2, 3	1, 2, 3	1, 2, 3	1, 2, 3	1, 2, 3	1, 2, 3	1, 2, 3	1, 2, 3	1, 2, 3	1, 2, 3	1, 2, 3	1, 2, 3	1, 2, 3	1, 2, 3	1, 2, 3
			RM	L	L	L	L	RM	L	L	L	L	RM	L	L		
Time Mgmt. / Preparation																	
Job Tracking & Process Mgmt																	
Safety																	
Team Communication																	
			L	RM	L	L	L	L	RM	L	L	L	L	L	L		
Time Mgmt. / Preparation																	
Job Tracking & Process Mgmt																	
Safety																	
Team Communication																	
			L	L	RM	L	L	L	L	RM	L	L	L	RM	L		
Time Mgmt. / Preparation																	
Job Tracking & Process Mgmt																	
Safety																	
Team Communication																	
			L	L	L	RM	L	L	L	L	RM	L	L	L	L		
Time Mgmt. / Preparation																	
Job Tracking & Process Mgmt																	
Safety																	
Team Communication																	
			L	L	L	L	RM	L	L	L	L	L	L	L	RM		
Time Mgmt. / Preparation																	
Job Tracking & Process Mgmt																	
Safety																	
Team Communication																	

Rating Key: 1 = Sub-standard 2 = Meets 3 = Excellent

S&K TOOL SCHOLARSHIP WINNERS

The winners of the S&K Tool Scholarships were announced at the ATEC Annual Conference Awards Luncheon on April 4, 2006. The three students selected for these awards were:

Simone Newby, Kansas State University, Salina, KS

Colin Snyder, Aviation Institute of Maintenance, Indianapolis, IN

Tracy Rosas, Reedley College, Reedley, CA

Each student will receive a set of S&K tools shipped directly from the S&K Company which are valued at $1400.00. These students of ATEC member schools applied to the Northrop Rice Foundation who administers the scholarship program and whose Board serves as the selection committee.

Scholarships will be available again next year and information and applications may be procured from the Northrop Rice Foundation and ATEC web sites. Information and applications are also available from Ivan D. Livi, ivan.livi@verizon.net and Cathy Landry, CathyL@alphabravo.com.

ATEC Update

ATEC CONFERENCE

Over eighty schools and one-hundred fifty attendees participated in the 2006 ATEC Conference at the Stardust Hotel in Las Vegas. Programs on trends and opportunities in AMT education were well received. The presentations with the highest evaluations were: (#'s 3-7 were tied)

1. NCATT: Promoting Professionalism in Aircraft Maintenance
2. Hiring AMTs: A Human Resource Perspective
3. Southwest Airlines: Creative Solutions to Unique Problems
4. Maintenance of Very Light Jets
5. Business Aviation: The Right Track
6. Care and Service of Aircraft Tires
7. Simulating Airline Level Maintenance in the A&P Program

ATEC 2007 is scheduled for the Orlando, Florida, Holiday Inn Resort on International Drive, April 1-3.

FAA APPROVALS

A major discussion throughout the Conference centered on how to convince the FAA to look at alternate ways of approving AMT programs, the 147 curriculum and the certification of new AMTs.

Industry speakers, ATEC Board members and attendees agreed that in the fast-paced, constantly changing aviation environment, there needs to be a new approach to approvals.

The NCATT model, new accreditations, outsourcing FAA approval processes were all discussed as potential ways to raise the professional image of the and provide program approvals that meet the needs of industry.

ATEC's Government Relations Committee will continue discussions with the FAA on this and other issues. The committee has had four meetings with the FAA since the 2005 Conference.

ATEC AWARDS

The Ivan D. Livi Educator of the Year Award was presented to Jerry Bradley from the Des Moines Public School System.

The Northrop-Rice Foundation Jim Rardon Student of the Year Award was given to Blaze Mitanoski from the Michigan Institute of Aviation and Technology.

Both received an all expense paid trip to Las Vegas with free conference attendance.

ATEC BYLAWS

At the Conference, members approved the following two changes to the ByLaws.

Change 1. Article III, Section 1

Individual membership is open to any individual interested in furthering and supporting the mission of ATEC.

Change 2. Allow absentee or proxy ballots for those members not attending the Conference so all members have an opportunity to vote. Change Article IV, Section 3, as follows:

> Members of the Board will be elected at the annual conference. Candidates will be identified by the Nominating Committee (Article VII, Section 2)…Schools not attending the annual conference may request an election ballot no later than 30 days prior to the annual conference. Proxy votes must be received no later than 7 business days prior to the conference. In the event that vacancies occur between annual conferences, replacements may be made by the President with the approval of the majority of the Board.

FAA FORUM

The FAA and the host school Embry-Riddle Aeronautical University will be holding the second forum on the future of AMTs as a career on May 24-26, 2006.

For additional information, e-mail Fred Mirgle mirglef@erau.edu or check the site www.erams.org.

The following were suggestions of critical issues to be addressed during the FAA's Forum:

1. How do we get reliable statistics on A&P technician supply and demand?
2. How do we market AMTs better?
3. How can we get approvals away from the FAA?
4. How do we get the news media to report all the job openings in aviation? They focus only on big airlines and layoffs.

SPECIAL VIDEO OFFER

Due to a double order that was returned, ATEC is able to offer the following individual tapes at half price.

The following video tapes are being sold in a single group for $200 which includes shipping. Normally, these tapes are sold for $460.

ATEC 8, 9, 29, 38, 47, 48, 50, 51, 54, 55, 56, 57, 62, 65, 72, 78, 93, 95, 97, 98, 103, 108, 117, 125, 128, 139, 140, 144, 150, 151, 156, 157, 158, 166, 167, 169, 170 and 171.

The first order with payment gets the tapes.

S&K TOOL SCHOLARSHIPS

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2006-2007 ATEC BOARD OF DIRECTORS

The contact information for the ATEC Board is attached.

Newly elected Officers and Board Members are:

Laurie Johns (Columbus State Community College) – President
Ray Thompson (Purdue University) – Vice President
Jerry Bradley (Des Moines Public Schools) – Board Member
Darrell Downing (Indian Hills Community College) – Board Member
Nick Herman (Toledo Public Schools) – Board Member
Tom Stose (Fairmont State College) – Board Member

The ATEC Board will meet via conference call in May and in Washington, DC on September 9-10, 2006.

WEBSITE

A number of new items have been added to the website since September 2005. They include Resources and Special Services, ByLaws, Faculty Scholarships and News Alerts.

The ATEC Journal is now being sent electronically to almost 600 people at institutions and companies worldwide. If you have not received your copy, send an e-mail with your request to domenic.proscia@vaughn.edu.z

Award Winners Conference ATEC 2006

Newly elected Laurie Johns ATEC President, Columbus State Community College; Dr. Ray Thompson Vice President, Purdue University Aviation Technology.

Outgoing ATEC President Charles Hawes, Michigan Institute of Aviation and Technology, receiving service award from Laurie Johns ATEC President.

Ivan Livi Instructor of the Year award presented to Jerry Bradley, Desmoines Public Schools. From left Ivan Livi, Jerry Bradley, Charles Hawes.

ATEC 2006 student of the year: Blaze Mitanoski from Michigan Institute of Aviation Technology pictured from left; Jim Lukins, Northrup Rice Foundation; Blaze Mitanoski; Charles Hawes ATEC President.

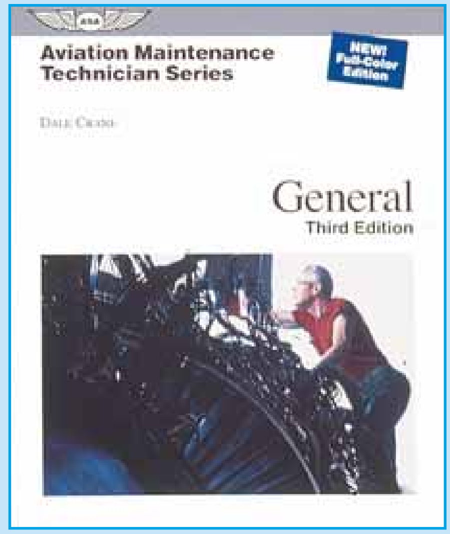
Industry News

Aviation Maintenance Technician: General

by Dale Crane

Now in Full-Color Third Edition

Newcastle, WA - The essential resource to pass the FAA Knowledge Exams, *Aviation Maintenance Technician: General* is the first book in Dale Crane's AMT textbook series. Created to set the standard for AMT training and attain a level of quality that surpasses all other maintenance textbooks on the market, *General* has been updated to today's practices and procedures. Now in its Third Edition, the textbook features **full-color illustrations** throughout.



This latest edition covers the first section of the FAA's required curriculum, incorporating an introduction to aviation along with basic lessons on mathematics, physics, and electricity. As the student progresses, specific aviation concerns are addressed, including regulations, mechanic privileges, forms, aircraft hardware and tools.

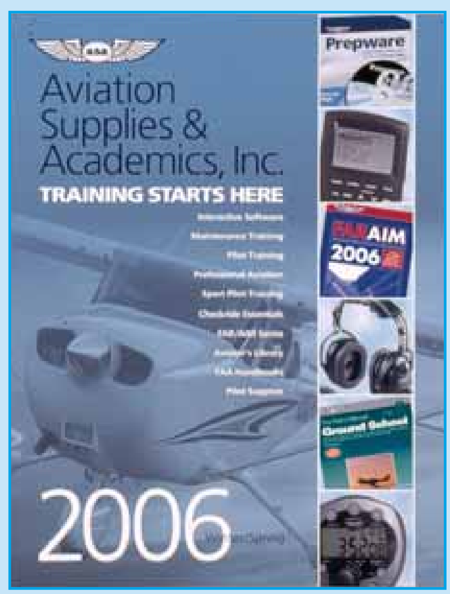
Crane's textbooks consist of the most complete and up-to-date material for A&P training. The curriculum meets 14 CFR Part 147 requirements and Subject Matter Knowledge Codes from the FAA mechanics knowledge tests. This versatile format is designed for at-home, classroom, or university-level training. This comprehensive textbook features full-color charts, tables and illustrations throughout, in addition to an extensive glossary, index, and career information.

Also includes a study guide in the form of Study Question sections, with answer keys printed at the end of each chapter - perfect for evaluation by an instructor or for self-testing. Crane's textbooks are all-inclusive; no separate, inconvenient workbook is needed by the student or instructor. Soft cover, 828 pages, illustrated, indexed.

International Aircraft Directory Now Available from ASA

A one-stop reference for the world's most popular aircraft!

Newcastle, WA - Whether you own, rent, or are in the market for buying an airplane, this directory has the information you're looking for all in one easy-to-use, convenient source. By the editors of *Plane & Pilot* Magazine and now in its Third Edition, it's filled with detailed descriptions and photographs of more than 500 airplanes from around the world. Types of aircraft covered include single-engine, multi-engine, jets, classic antiques, homebuilts, kitbuilts, sailplanes, motorgliders, warbirds and military aircraft flown by civilian pilots.



The directory lists airframe and powerplant information and historical facts, standard data and performance specifications such as horsepower, thrust, weight, speed, and range to answer the questions most commonly asked by pilots. Throughout the well-illustrated pages, you'll find interesting anecdotes on prominent manufacturers, airplanes, and personalities in the aircraft industry This is a tremendous source for information on aircraft no longer in production as well as new models of current production aircraft, representing the majority of civilian aircraft in service throughout the world.

Aviation enthusiasts and pilots will find this portable reference tool useful for spot-checking facts about a particular model, identifying unusual aircraft, and recognizing trends in airplane design. The *International Aircraft Directory* acquaints pilots with the past so they can appreciate the present and pay tribute to those planes that have, and continue to play an important role in our aviation heritage. Soft cover, 304 pages, illustrated and indexed.

ASA's 2006 Catalog Now Available

Newcastle, WA - Aviation Supplies & Academics, Inc. (ASA) announces the release of their 2006 catalog. ASA's annual catalog is the company's primary tool to inform the aviation community of product descriptions, part numbers and pricing for the complete product line. This product line consists of textbooks for pilots and aviation maintenance technicians, test preparation books and software, FAA handbooks, pilot supplies, and flight simulation and tutorial software – all published or manufactured by ASA.

The 32-page, full-color 2006 Product Showcase features more far-ranging coverage of aviation topics with the new titles added to the ASA library. All new items are clearly marked. ASA remains committed to supplying the industry with the most current FAA publications, including Practical Test Standards and Handbooks. The Test Prep, Prepware, Virtual Test Prep and FAR/AIM series are published annually to ensure pilots have the most current information available. The ASA pilot supply collection and innovative software – including the new Flight Instructor Refresher Clinic – keep students, pilots and instructors flying. Each product is explained in detail and accompanied by full-color images.

This new catalog continues ASA's mission – **"Training Starts Here"** – and offers a wide spectrum of products specifically designed to meet the needs of all aviators including student and sport pilots, flight instructors, airline transport pilots, and aviation maintenance technicians.

Sun and Fun Airshow in Lakeland 2006

By Tom Wild

While attending the Sun and Fun airshow this year a strange thing happened in the parking lot which by the way is a long way from the airshow. Several cars in my parking row caught fire and burned quite thoroughly as you can see in the picture. This was the highlight of the show for me as the burned cars were close to my vehicle. Many excellent aircraft were on display such as the one on the cover of this issue, along with an excellent airshow.

ATEC 2006 EXHIBITORS CONTACT INFORMATION

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Robin.Lamar@awam.org

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3902 Industrial
Rowlett, TX 75088
(972) 463-6080
(972) 463-0078 FAX
John Wing, President
johnwing@wingaero.com
Wing Aero is an aviation distributor that supplies AMT and flight training material to the US market, specializing in Tech Schools and Colleges and University aviation programs. Same day shipments of ASA, Jeppesen, Gleim, McGraw-Hill, Rod Machado, and many others are just a few of the lines we've serviced to ATEC schools for 20 years. Wing Aero offers a paid freight program to participating institutional customers.

FAA Office of Runway Safety
& Operational Services
15000 Aviation Blvd, Rm 3011
Lawndale, CA 90261

Dear AMT Instructor:

Preventing runway incursions is one of the Federal Aviation Administration's (FAA's) highest priorities. Though relatively small in number when compared to the high level of traffic that moves safely through the nation's airports every day, runway incursions present a special challenge. Not only do they have the potential to put lives at risk due to the number and proximity of aircraft operating on the airport surface, but they also take place in a complex and dynamic environment.

The Western-Pacific Office of Runway Safety & Operational Services is taking a special interest in whether or not mechanics are receiving the necessary training in Airport Signs and Markings. Specifically, we would like to know:

1. How much time do you devote to the following in your curriculum?

	< 1 hour	1-2 hours	over 2 hours
a. Airport Signs & Markings	❑	❑	❑
b. Runway Markings	❑	❑	❑
c. Taxiway Markings	❑	❑	❑
d. Airport Layout	❑	❑	❑

2. Do you have practical projects associated with the items above?
   - Yes ❑
   - No ❑
3. Are you interested in a PowerPoint presentation pertaining to Runway Safety for mechanics?
   - Yes ❑
   - No ❑
4. Would you incorporate the PowerPoint material into your curriculum?
   - Yes ❑
   - No ❑

In addition, my office would be glad to work with you to incorporate the airfield markings, signs, and lights and basic airport layout sections into your training curriculum. We are also available to conduct an on-site presentation of Runway Safety for Mechanics.

If you desire our help or have any question or comments, you may direct them to Dr. Paul Foster at email: paul.m.foster@faa.gov or call him at 310-725-6687.

Dave Kurner
Runway Safety Program Manager


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