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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 Mindy Irby
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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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FAR Part 147 Curriculum; Keeping the AMT Learner in the Zone

Karen Sullivan, Assistant Professor

ABSTRACT

Outcome Based Education (OBE) is drawing interest from technical education institutes. The theory of evaluating what a student can do versus what a student knows is seemingly a more suitable theme for curriculum that's purpose is to prepare students for a "how to" work environment. OBE displays some similarity to an older theory of instruction called Constructivism. Constructivists believe that a learner will gain knowledge out of necessity as they work through problem solving tasks. The conditions for learning are structured around a collaborative commitment from both the learner and the instructor. It is the view of a constructivist, that an instructor has the responsibility of offering just enough help to keep the learner in the "zone of proximal development" (Vygotsky), that is the gap between what the learner can do on their own and what the learner can do with guidance. Constructivism theorists believe this type of instruction and evaluation will allow learners to achieve higher-level goals, such as the ability to successfully perform procedural tasks rather than the ability to simply recall declarative information about the tasks; A similar goal of OBE. An anticipated argument to this is, whereas evaluating learners' declarative knowledge of a subject through written exams may offer a range of scores, evaluating learners' procedural knowledge through objective based assessments may only provide pass/fail scores, thus upsetting the traditional criteria for academic advancement. This paper illustrates the relationship between the newer theory of OBE and the older theory of Constructivism and offers insights on using these methods when developing instruction and assessment in an attempt to keep the Aviation Maintenance Technology learner in the "zone".

INTRODUCTION

Educational institutions across the nation are buzzing with the notion of reform by the name of Outcome Based Education (OBE). This emerging method of education focuses more on what the learner is able to perform and the traits acquired rather than simply on the learner's ability to retain and regurgitate declarative knowledge. Putting the emphasis on what the learner can do seems to be a better fit in the technical education arena. More specifically, when an AMT students is tasked with troubleshooting a faulty hydraulic system, it's better to see the student actually fix the system rather than to just hear the student recite principles of hydraulic components that may be causing the fault.

Before beginning this discussion, it must be understood that implementing an OBE based program is much more than just rewriting classroom curriculum. This change requires a complete overhaul of the institution's entire educational program and cannot be entered into lightly. And unfortunately, restructuring a Part 147 school requires the permission of the FAA. But, restructuring not only requires a change in program goals, curriculum content and classroom instructional methods, it also requires the faculty following the program to learn OBEs unique terminology to ensure a successful transition. In addition, the traditional method of assessment used is not a suitable fit for an OBE based program that lends itself more towards a pass/fail type of grade.

OBE VERSUS CONSTRUCTIVISM

OBE claims three principles at the heart of its method of curriculum development; clarity of focus on outcomes, expanded opportunities and instructional support, and high expectations for learning success (McNeir). These characteristics show some resemblance to strategies often used in constructivist theories of instruction. 1) Constructivist theories are heavily based on retaining focus on the higher-order goals of the curriculum. Notice the similarity to the first principle of OBE stated previously; clarity of focus on outcomes. OBE uses the term "outcomes" as meaning a measureable ability the learner can demonstrate, constructivism uses the term "higher-order goals". 2) Constructivism sees the absence of pre-requisite knowledge not as a hindrance, but as a need to introduce additional support or "scaffolding" into the curriculum to ensure the achievement of those higher-order goals by all learners, which in turn can allow for a wider range of possibilities available not only to potential students but to other instructional methods as well. This is comparable to the second principle of OBE, expanded opportunities and instructional support. 3) By emphasizing the need for learners to be able to identify their own goals, constructivism creates a high motivation to succeed based on ownership of the learning process. The third principle of OBE is high expectations for learning success. Students know they are required to reach higher standards and are reassured by the availability of a supportive incentive system.

Having illustrated some comparisons between OBE and Constructivism, it becomes necessary to clarify that these three principles are not an iron-cad set of rules used by either of the two, the concept of OBE is “not restricted to a single authoritative model” (McNeir), but is merely the spirit of the two methods of curriculum development.

Constructivism includes a term coined by Lev Vygotsky known as the “zone of proximal development” with which he defines a stage in the learner’s development during which the learner is required to use their developing capabilities along with additional support provided by the instructor to solve the given task (Driscoll). The idea is for the instructor to provide guidance that will allow the learner to “bridge the gap between their current skill levels and a desired skill level” (Driscoll, p. 258). This “zone” or “gap” is where successful instruction should keep the learner at all times for maximum development. Drsicoll (pp. 393-402) explains five conditions for learning that can be used in the classroom to help maintain this zone: Embedding learning in complex and relevant environments, providing for social negotiation, encouraging ownership in learning, using multiple perspectives and modes of representation, nurturing self-awareness.

CONDITIONS FOR LEARNING

For the purpose of this paper, the first three conditions are explained here and then grouped together as attributes of an example of an applicable instructional method.

1. *Embedding Learning in Complex and Relevant Environments*

   If learners are only given simple tasks during their development, then when they are faced with a complex task in real life, the ability to successfully solve the problem may be prevented. Providing real and complex scenarios during instruction can maximize the learner’s skill development.

2. *Providing for Social Negotiation*

   Learners working in a group situation are required to share their ideas and hear other perspectives with the group members, which opens the opportunity for all of the learners to accept or decline other’s proposals or even to adapt their own to a more effective one.

3. *Encouraging Ownership in Learning*

   When a learner is allowed to manage their own learning style and needs, they will feel more invested in their education, it will have more value to them. However, this should always be accompanied by instructor provider guidance to keep the learner on task.

The use of micro-worlds and simulations are effective choices when developing instruction to meet these needs. These are “small but complete subsets of real environments” (Driscoll, p. 403) that are utilized to engulf the learner in a context that is full of rich, real life experiences. J.C.Dunlap and R. Scott Grabinger (1996) promote the use of REALs; rich environments for active learning. REALs promote generative learning by requiring the learner to use the information provided by the instructor to create usable knowledge of their own. This learning takes place in an anchored instruction scenario where the learner is placed into a realistic situation to apply that usable knowledge to solve real time problems. Typically, a REAL involves learners working with a group of their peers. This allows all of the learner’s perspectives to influence other’s knowledge. All of the characteristics of a REAL closely follow the first three learning conditions from Driscoll discussed earlier.

A group from Clemson University has developed a Virtual Reality aircraft inspection simulator (Duchowski). A heads up display, where the learner views the inside of an aircraft cargo bay, is programmed to show multiple defect inspection scenarios. The heads up apparatus is capable of tracking eye movement and the simulator records the learner’s selection of suspected defects in the airframe with the use of a mouse. The idea of the simulator is for the learner to develop their inspection skills by comparing their own performance with that of a previously recorded expert’s performance thereby enhancing their own ability to perform inspections. The comparison includes the path of eye movement from one defect to the next, the duration of each fixation on a defect, and the number of defects detected. This simulator takes the learner out of the classroom and immerses them in a realistic task performed daily in aviation maintenance facilities. Rather than an instructor simply listing criterial attributes of airframe structural defects and then testing the learner’s ability to memorize and regurgitate the list, this method allows the learner to see the airframe in its entirety and use the knowledge of the attributes to actually locate and identify suspected defects. By comparing the performance of the learner with that of an expert, the learner can receive feedback from someone other than just the instructor. The learner can also choose the duration of the task and also the number of different defect scenarios to view, allowing the learner to tailor fit the task to their needs.

4. *Using Multiple Perspectives and Modes of Representation*

   Environments include both ill and well-structured situations. Continually approaching a problem from the same angle does not allow for effective problem solving of ill-structured situations nor does it illustrate all possible solutions for well-structured situations. By using multiple interpretations of the problem, all paths to the correct answer can be made clear.

5. *Nurturing Self-Awareness*

   Being able to identify concepts and knowing how to use them together to create your own understanding enhances the learner’s ability to explore new or alternative views.

These two methods are closely tied together and both have close connections to Ownership in Learning. Being aware of your ability to understand and invent new structures is realized when presented with multiple views of the related structures and it is this awareness that can create pride and ownership in learning. Hypermedia can be a suitable method of instruction to fit these conditions. Hypermedia allows vast amounts of information, in a variety of locations to be accessed from multiple different users. The types of information gathered for hypermedia use can range from maintenance manuals to online technical support. This allows the learner to use all of the information to view a problem from many different angles. Over time, the learner will realize what is the most reasonable way to navigate through all of the sources.

Hypermedia is a promising method for training aviation maintenance technicians on the job and in the classroom. Technicians frequently rely on accessing operations manuals, fault isolation manuals, maintenance manuals, parts list and in worst case scenarios technical representatives. With a hypermedia system, it is possible to combine all of these sources into one (W.B. Johnson). Just as technicians in the field are required to access large amounts of information for one task, technicians in training must access large amounts of information in order to learn how to perform a task. The FAA Part 147 required course on aviation maintenance regulations involves large amounts of information that technicians in training must learn in order to correctly apply the Federal Aviation Regulations. Terrell Chandler discusses a hypermedia system that has been developed as a companion to this course, STAR-AMT, System for Teaching Aviation Regulations for AMTs (Chandler). STAR-AMT offers the learner "several different categories of learning environments: overviews, scenarios, challenges and resources" (Chandler). Overviews show the learner how the regulations relate to one another and also how they relate to the technician. Scenarios immerse the learner in real-life situations and illustrate how the regulations are correctly applied to solve the problem. Challenges give the learner the opportunity to apply the skills they have developed. Resources are any applicable information aids made available to the learner through out the process. These four environments allow the learner to access the same knowledge through four different paths, thus providing multiple modes of representation. Also, since STAR-AMT makes these multiple paths available, this allows different learners to understand how they best navigate the information to solve the problem in the scenario.

OUTCOMES BASED ASSESSMENT

Outcomes Based Assessment may be seen as a predecessor of OBE. A shift from a focus on how the learning is taking place to focusing on the result of the educational process (Woolston). Instructors who are following OBE may see the need to change the traditional way of grading the learners. What once was a low or failing grade is now an "Incomplete" with the chance to come back and raise the grade by receiving additional instruction to enhance performances. Or, perhaps, record grades in pencil making it possible to change the grade to reflect improvement (Spady). But in the world of the FAA, where hours in the seat and simply surpassing the average 70% reign, what possibilities exist for OBA? Spady and Marshall point out multiple levels of switching over to an OBE type of program. The lowest of which is Traditional OBE. This level consists of containing the change to the classroom, which means that this would not be a full transformation over to a true OBE program but to a Curriculum Based Objectives program. A CBO program is one where the emphasis is placed on mastering basic skills that are acquired in each individual classroom's curriculum. When dealing with the constraints imposed by the FAA, this may be a good place to start. Most institutions allow the instructor some academic freedom within their classrooms. A possible example of moving towards this type of assessment, may be to focus more on assessment techniques that mirror the practical exam tasks used during FAA testing rather than on standard written tests. Regardless of the particulars, it must be remembered that in order to achieve this type of environment, assessments should focus on requiring the learner to correctly perform a task rather than requiring the learner to simply declare the concepts needed to perform the task.

It is easy to see the connection of OBE and OBA to a technical based curriculum. The hard part is applying the methods to the delivery of the instruction and the assessment of the learner. By using the five methods explained, instructors can design classroom activities that will enhance the learner's development of skills. Continuous advances in educational technology make the use of Micro-worlds, simulations and hypermedia reasonable examples of these types of activities. It must be realized, though, that these methods may be expensive to develop and incorporate into existing curriculum. With the constraints that FAA Part 147 schools operate under, modifications may also be subject to additional requirements such as adhering to the Teaching Level designations for lecture and laboratory subjects set by FAR Part 147 Appendices A, B, and C. As for using OBA methods for issuing grades, academic freedom in the classroom may be the simplest route for instructors to make the switch. As long as the instructor can follow the 70% rule for pass/fail, the route to acquiring that 70% can follow an OBA method. It must be noted however, that exact methods for using OBA in the technical classroom, especially the FAR Part 147 classroom, is in need of more definite research.

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BIOGRAPHY

Karen Sullivan is an Assistant Professor at Southern Illinois University in Carbondale, Illinois. She is in her second year of tenure track and teaches airframe and general courses in the Aviation Maintenance Technology Program. Her area of study is in instructional development in technical education classrooms.

Karen earned her Bachelor's Degree in Aviation technologies at Central Missouri State University and her Master's Degree in Curriculum and Instruction at SIUC. She has been a licensed A&P mechanic since 1998.

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Teaching Human Factors to Protect Your Health using the Working Healthy - 8 and Computer Based Education

By James W. Allen MD + +

This paper will illustrate that health effects can be taught, presents subject matter using the Working Healthy -8, and discusses Computer Based Education as one method to present health information.

Prospective on the need to Teach Health Effects

Several non-aviation technical schools include work related health effects as part of their curriculum. Table 1 shows health topics taught in school for health care workers, firefighters, and construction workers. While these industries have access to health information, aviation maintainers do not. The reason given for this conspicuous neglect of health topics is that the curriculum approved by the FAA does not have a requirement for teaching health effects to aircraft maintainers.

Table 1: Selected health topics promoted by organizations within three industries

Industry	Promoted by	Health topic (example)
Health care	Joint Commission on Accreditation of Health Care Facilities	blood borne pathogens, handling sharp instruments
Fire fighters	National Fire Protection Association	medical standards, blood borne pathogens
Construction	Center for Construction Research and Training	health risks of dry wall, asbestos, use of tools

Students may ask us “Will my job make me sick?” For the aviation maintainer, the answer is “yes”. A study by the National Health Interview Service ordered 206 different occupations by their rate of non-fatal occupational illness. Aviation maintenance was in the top 25% when ranked by non-fatal occupational illness. Medical investigations of specific exposure incidents give dramatic examples of the effects when maintainers unknowingly engage in a deadly work process. Table 2 illustrates that these adverse health effects started in the early days of aviation maintenance and are not limited to any one work process.

Table 2: Maintenance processes with health effects identified by medical studies.

Maintenance process	Health effect	Year of study
Doping	18 dead	1918
Metal shaping	112 cases White Finger (female preponderance)	1943
Metal coating	65% experience contact dermatitis	1944
Painting	Occupational asthma (10% - 25%)	1980 to 2005
Electronic repair	5 cases, testicular cancer	1975
Parts cleaning	3 lose ability to walk	1988
Sealing/resealing	Depression and other psychological illnesses	2000

FAA regulations, recommendations, and advisory circulars present training topics such as maintenance human factors, general OSHA laws, and safety culture. These topics suggest that protecting the health of the maintainer is important. Medical studies shows that work on aircraft can make maintainers sick. Review of these studies and related medical material identifies health topics suitable for teaching.

SUBJECT MATTER: WORKING HEALTHY -8

To identify and teach subject matter relevant to the aviation maintainer I use a teaching tool called the **Working Healthy -8** (WH-8). Aviation maintenance instructors and maintainers in the hangar can use the WH-8 to recognize health risks and implement preventions (Figure 1).

Figure 1: Working Healthy -8. Follow the stairway to prevent exposures

CONSIDER others
Innocent bystanders

USE degreasing station
Cleaning leads to exposures

ANTICIPATE clean-up
A spill is inevitable.

FOCUS on the work environment
Hot, cold, CO, ergonomics do have an effect

DON’T forget your skin
Skin is second to lungs as a route into your body

THINK ventilation
Your lungs filter the air; Local Exhaust Ventilation is good

ASK for information
Implement steps to substitute or control exposures, lastly use PPE

PLAN your work
Health effects arise from a combination of duration and concentration

Let me give a general review of the WH-8 before going through specific steps.

1. The logo: stairway composed of eight steps. The fist step is planning your work
2. The terms: technical concepts but no medical terms.
3. The presentation: either as OJT or a stand alone presentation.
4. Instructor qualifications: an interest in creating a culture of safety and protecting health. Training the trainer might be an important issue.

The WH-8 does not address duration of training or level of detail. We're working on a curriculum that uses the WH-8 as subject matter to be taught side by site with existing instructional topics.

Review of the eight steps of the stairway highlights teach material that instructors can share with students.

Fist Step: Plan your work

Background: Health effects arise from the combination of the duration and the concentration of exposure.

Subject matter: The subject area to emphasize is that a health effect does not arise from one exposure, rather from multiple exposures over time. Figure 2 show how to reinforce this subject with a formula of health effects. Exposure to Noise illustrates the cumulative effect of noise exposure with the initial hearing loss at the frequency of 4,000 Hz. Since this frequency is above the frequencies used for speech, this first loss of hearing due to noise exposure will be unnoticed.

Figure 2: Health effects arise from repeated exposures.

Health Effect = Concentration *times* **Duration**

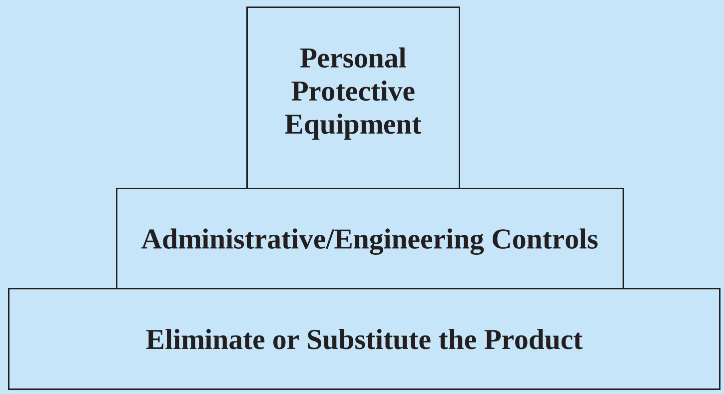
summation
for each exposure
over the work period

Second Step: Ask for information

Background: find out about the product you are using; then, implement steps to substitute or control exposures. Lastly use Personal Protective Equipment (PPE).

Subject matter: The safety hierarchy shows three levels for eliminating exposures (figure 3). To implement protections in the workplace, start at the bottom of the hierarchy. Maintainers typically use information from the second level, administrative/ engineering controls. Note that the Personal Protective Equipment (PPE) is the LAST item to use when trying to prevent overexposures. Even a simple foam ear plug must be inserted, or fitted, into the ear canal correctly to obtain maximum noise reduction ratio.

Figure 3: The Safety Hierarchy.
Three levels of protection used to eliminate overexposures in the workshop

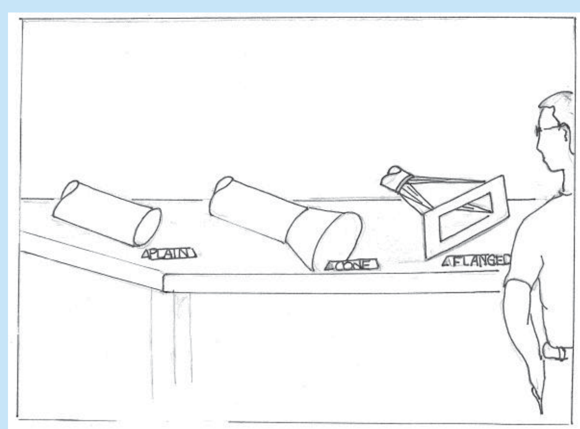


Third Step: Think ventilation.

Background: Lungs are filtering several liter of air per minute. The third step encourages maintainers to keep contaminants out of the room air.

Subject matter: Describe the use of Local Exhaust Ventilation (LEV). Existing shop equipment or tools such as sanders may already incorporate LEV. Different hood designs influence the capture of these stressors at their source (Figure 4).

Figure 4: Examples of different hood design for LEV



Fourth Step: Don't forget your skin

Background: Absorption of solvents through the skin is second to the lungs as the route of entry of solvents into the body.

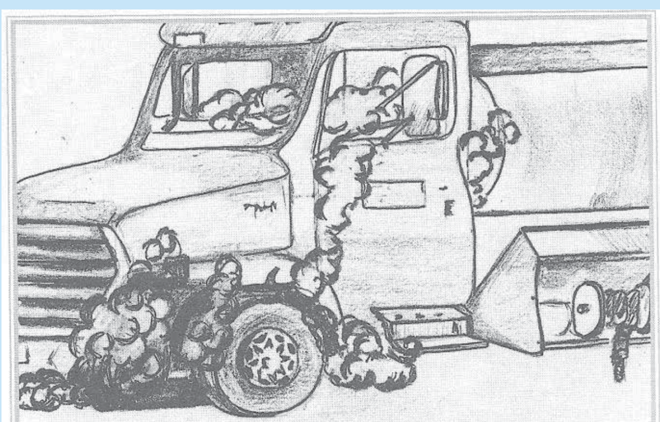
Subject matter: If your clothes are soiled with solvents, change to clean clothes immediately. Skin is porous. Wash off any exposures to minimize the potential for swollen, red and itchy skin. Hygiene is the subject matter of this step

Fifth Step: Environmental factors matter

Background: Heat, cold, carbon monoxide, poor body postures are examples of everyday exposures that have health effects.

Subject matter: OSHA investigated the death of a fueler at a major airport. The fueler died inside an idling fuel truck on a cold winter day (figure 5). Deteriorating seals in the cab allowed massive levels of carbon monoxide to enter the truck. Also contributing to this tragedy was the truck's position into the wind. Carbon monoxide kills.

Figure 5: Carbon monoxide fumes from an idling fuel truck



Sixth Step: Anticipate clean up

Background: Spills do occur so how do you clean up the inevitable spill?

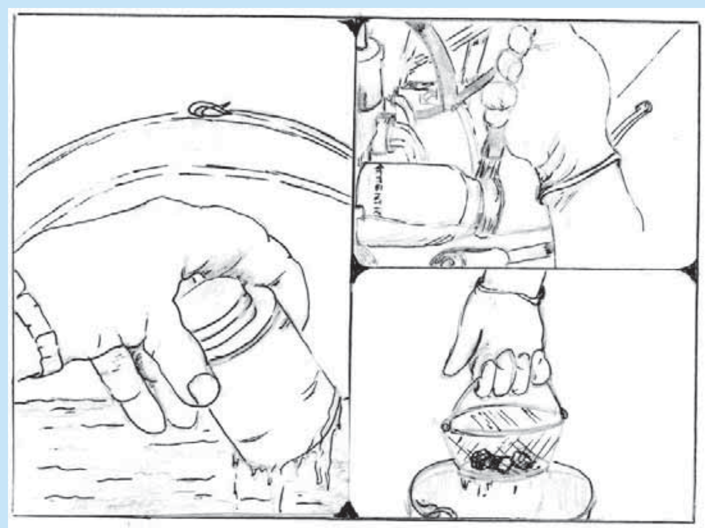
Subject matter: The Hazard Communication Standard with the MSDS requires chemical producers to provide users with information about the product including clean up. Currently an effort is underway to harmonize safety data cards from different nations. Students may soon see the International Safety Data Card.

Seventh Step: Degreasing stations are good

Background: Experience has shown significant exposures occur during the parts cleaning process.

Subject matter: Encourage the use of degreasing stations and products (figure 6). One aspect of these stations is to limit the contact of cleaning agents with the skin.

Figure 6: Avoid direct contact with cleaning agent (left frame) by using gloves (right top frame), and a cleaning basket (right bottom frame)

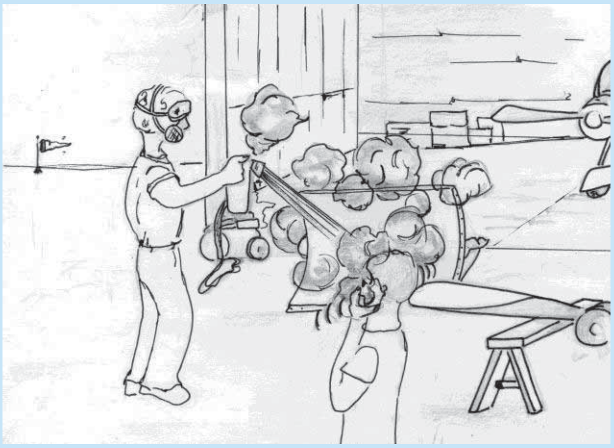


Eighth Step: Consider Others

Background: Sound travels and vapors spread so neglecting this step is devastating to the innocent bystander.

Subject matter: Even though the maintainer is protected, the innocent bystander receives a full exposure from the overspray (Figure 7). Some paints contain a chemical called diisocyantes which sensitize the body. On the second contact with the chemical, an asthma attack occurs. Occupational exposures account for up to 25% of the cases of adult onset asthma.

Figure 7: The innocent bystander receives an exposure even though not involved in the work process.



USING CBE: A MEANS OF PRESENTING THE WH-8

Table 3 outlines the three steps used to convert the WH-8 into Computer Based Education (CBE). The fist step is developing course content using Power Point. Power point slides are the visual presentations for the lessons. The notes section of Power Point contains script for each presentation. Adding the instructor's voice uses appropriate software such as Audacity to create vocal files. Significant advantages of CBE over paper based, classroom presentations are the capability to easily change course material and the power of animation. Editing and changing the course content is easy using alteration in the power point of vocal files.

Table 3: Steps used to create a lesson using CBE

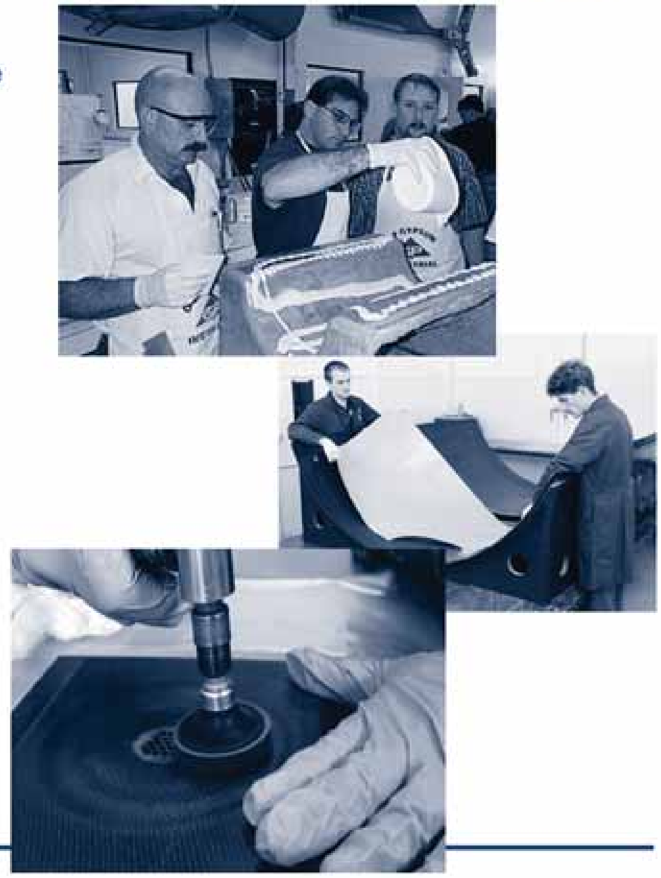
sequence	software	output
Develop course content	MS Power Point	Lesson organized into unit each with specific presentation.
Adding voice to the content	Audacity	Files of vocal presentations that match to each less
Editing and changing	As needed	Easily done so that the course matches

CONCLUSION: HEALTH EDUCATION FOR THE MAINTAINER

The high non-fatal occupational illness experienced by aviation maintainers suggests a need for health education. Non-aviation technical schools cover this material for their workers and so should aviation schools. The **Working Healthy -8** present a stairway composed of eight steps which if followed reduce maintainers' likelihood of developing a chronic disease from a workplace exposure. Each step of the WH-8 contains subject matter which can be inserted into an existing curriculum. WH-8 combined with CBE provides a powerful and attractive application to assure that students understand how to prevent chronic illnesses from workplace exposures.

An attachment to this presentation is the **Working Healthy-8** presented on the front side. On the reverse side are five basic health questions which serve as a gauge of the students' understanding of how work on aircraft can influence their health.

+ + Dr. Allen is a physician specializing in environmental exposures who retired from the Navy after a thirty year career. During that time he served as director of Occupational Medicine at the Navy's shipyards and air rework facilities. Currently he consults to the US Public Health Service, federal agencies, and private industry on medical effects attributed to workplace exposures. To contact Dr. Allen: Working Healthy Always LLC, P.O. Box 7642, Wilmington, DE 19803-7642, jallen@workinghealthyalways.com



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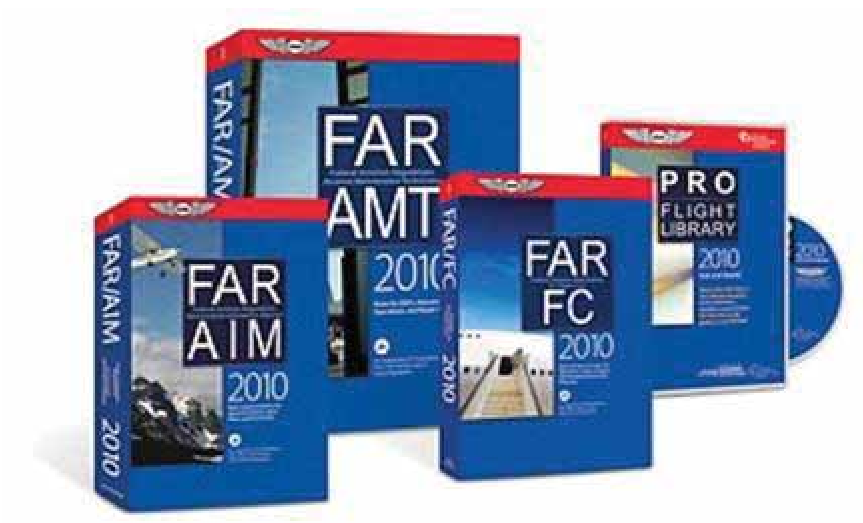

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Enrollment Trends in Airframe Powerplant-Aviation Maintenance Technician Schools and Enrollment-related Challenges

Raylene B. Alexander, Assistant Professor
***And* Kurt Barnhart PhD., Aviation Department Head**
Kansas State University -Salina

ABSTRACT
This study examined the enrollment trends of Aviation Maintenance Technician (AMT) schools over a ten year period and specifically taking into account the number of females enrolled in these schools. It would be a benefit to all AMT schools to know what these trends are, and explore how other schools have reacted to them. The research paper will also examine other enrollment-related challenges facing these schools. If recruitment is not their biggest challenge, this paper looks into what these challenges are. Enrollment issues will remain a very relevant issue as many AMT schools discontinue their programs and new schools take their place.

INTRODUCTION
The scope of the initial project survey was relatively large, and the results of the survey are divided into two subject areas; AMT enrollment and women in AMT schools. The survey was considered as two separate surveys; one used in this paper and the other used in a future research papers. This research paper analyzes the national state of AMT enrollments, and discusses the difficulties schools face in recruitment. The second subject; the enrollment and recruitment of women will be discussed in a future paper.

PROBLEM STATEMENT
Anecdotal evidence suggests that AMT schools in the U.S. seem to be having difficulty in the area of maintaining adequate student enrollment. The purpose of this study was to define these problems and understand the various ways in which institutions are approaching these problems.

LITERATURE REVIEW
Jeff Gruber at Columbus State Community College listed reasons why a career in aviation maintenance is not "a sought-after career by younger people." These reasons include the "general attitude of the younger crowd", the lack of competitive wages, and the fact that, as a job, aircraft maintenance is "looked at as a substandard position (Gruber)."

Brad Townsend, vice-chair of the NBAA maintenance committee, discussed "Operation Bootstrap" at several conferences; including the 2006 The Future AMT Conference hosted by Aviation Institute of Maintenance (AIM) and the 2009 University Aviation Association Conference. Operation Bootstrap is a proposal to create a technical certification, "Aircraft Maintenance Engineers" based on additional experience and education (Clark).

Aviation Maintenance, a prominent industry periodical, conducts annual salary surveys. These surveys show that salaries in the industry are indeed a subject of concern. The U.S. AMT Salary Survey of 2005 gives a window on the pay scale of aviation maintenance technicians over a three year period. Salaries for 2005 increased 7.2% over 2004 to an annual average of $62,600. In 2004, salaries decreased 4.1% over 2003 to $58,400, and 2003 salaries were at $60, 900. The average age of the 567 respondents in the 2005 survey was forty-seven years old, and 58% of the respondents indicated that they have more that twenty years experience in the field. Compensation remains a concern for 37% of the respondents in the survey (Salary Survey-2005). The 2007 salary survey showed an increase of 3.67% over the 2005 survey, for a salary of $64,900. (Salary Survey 2007)

The Aviation Technician Education Council (ATEC), Institutional Members are approved by the Federal Aviation Administration (FAA) under FAR part 147 with the exception of the Canadian Institutions which are approved by Transport Canada (TC). ATEC, conducts a survey of their member institutions each year, and participation is voluntary. The ATEC survey examines the enrollment of AMT students as a whole, instead of just the freshman students as this study does. It also goes further and examines numbers of graduates vs. graduates employed in the field of aviation.

Table 1. ATEC Survey Results

	ENROLLMENT NUMBER	GRADUATE NUMBERS	GRADS WHO WENT TO WORK IN AVIATION	NUMBER OF SCHOOLS THAT COMPLETED THE SURVEY
1998	11,699	4,510	3,338	143
1999	14,209	3,872	3,709	107
2000	13,827	4,978	4,039	114
2001	12,328	5,658	4,700	107
2002	11,199	4,190	2,480	94
2003	10,862	3,818	2,589	83
2004	11,791	3,601	2,381	83
2005	7,680	3,226	2,047	86
2006	9,753	3,522	2,340	71
2008	5,807	1,834	1,223	53

METHODOLOGY
For this study, surveys were distributed to every AMT school currently listed as an ATEC Institutional Member with the exception of schools located in Canada and any secondary institution. In January 2009, this listing included 108 institutions which included associated email addresses. This electronic survey was administered through SurveyGizmo.com. The survey was open for 15 weeks in order to maximize the response rate. Two reminders were emailed toward the end of that time period, again, to help ensure maximum survey participation.

LIMITATIONS/DELIMITATIONS
The Researcher concluded that some newer A&P schools may not have been listed, and some email addresses may have been missing or not current. A further limitation of this study is that the survey relied on self-reported data.

This research paper is limited in that it looks at freshman enrollment numbers and not total A&P student numbers. Retention was also not an area explored in this survey.

Raw survey data is included in its entirety and was not subject to alteration unless the anonymity of the respondent was in jeopardy. In this instance, brackets replaced the area of concern and a generic substitution was applied, since it was important that this was a blind study. The electronic survey was opened in January 2009 and it was closed in May 2009.

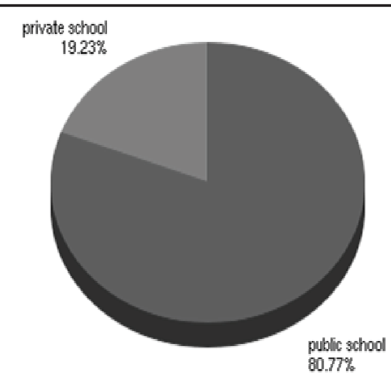
SURVEY
See Appendix A for the survey used in this study.

RESULTS
Of the 108 survey solicitations distributed via email, 24 were fully completed, including all ten year enrollment numbers, yielding a response rate of 22 %. Fifty-six were partially completed and that data is included where appropriate, however only data from the 24 fully completed surveys were used to analyze the ten year enrollment trends. Three respondents of those 24 completed the information on enrollments for evening classes, and those responses were included in this paper as raw data. All surveys were used to analyze the remainder of the data, but it should be noted that not all respondents answered every question.

ALL SURVEYS
Of all respondents to the general questions about their school; 23.08% of schools were vocational, 67.31% were two year institutions and 9.62% were universities. Public vs. private were divided into 80.77% of the schools were public and 19.23% are private.

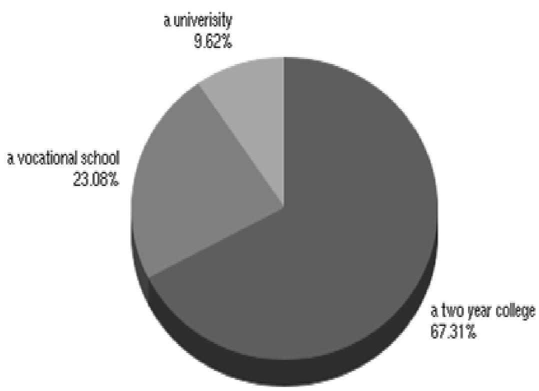
Your school is a public or private school?

Table 2. Public vs. Private schools



Your school is a university, vocational school or a two year college?

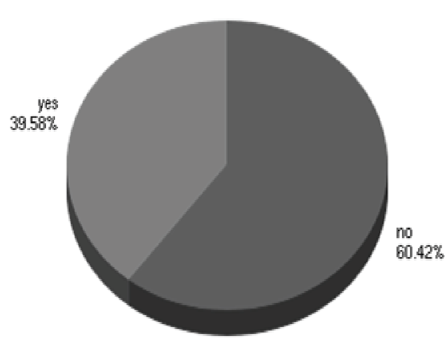
Table 3.



Fifty-two schools responded to these general questions. Forty-two schools are public and ten are private. Thirty-five schools responded that they are a two year college offering two or more degrees. Some vocational schools offer an Associate degree; this question was designed to separate schools that offer one degree vs. those offering more than one. Twelve schools were vocational and five were universities.

Do you have an evening A&P program? Evening A&P classes had 60.42% having no evening classes and 39.58% having evening classes. Forty-eight schools responded to this question. Nineteen were schools that have evening classes and twenty-nine did not.

Table 4. Schools with evening classes



In your A&P program, how many times do you have an incoming freshman (day) class in a calendar year? The question was also asked about the evening classes. It was quickly realized that the question could be confusing and interpreted in different ways. The results were not conclusive and did not add to the paper. Raw Data is included in Appendices B and C respectively.

Enrollment trends for the nighttime freshman class from 1999-2008. Only three schools completed the ten year enrollment numbers for evening classes, so the raw data was not analyzed. The raw data was included in Appendix D.

If enrollments are declining, what is your plan to address that? Of the thirty-six schools that answered this question, the following are exact quotes from the survey and a graph representing general responses. General responses are identified parenthetically in the raw data and then reinterpreted on the graph below.

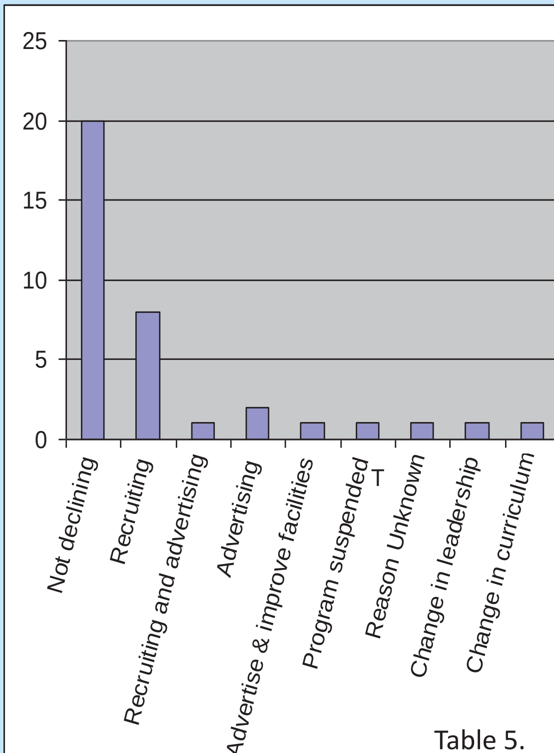


Table 5.

Table 6. Raw Data I

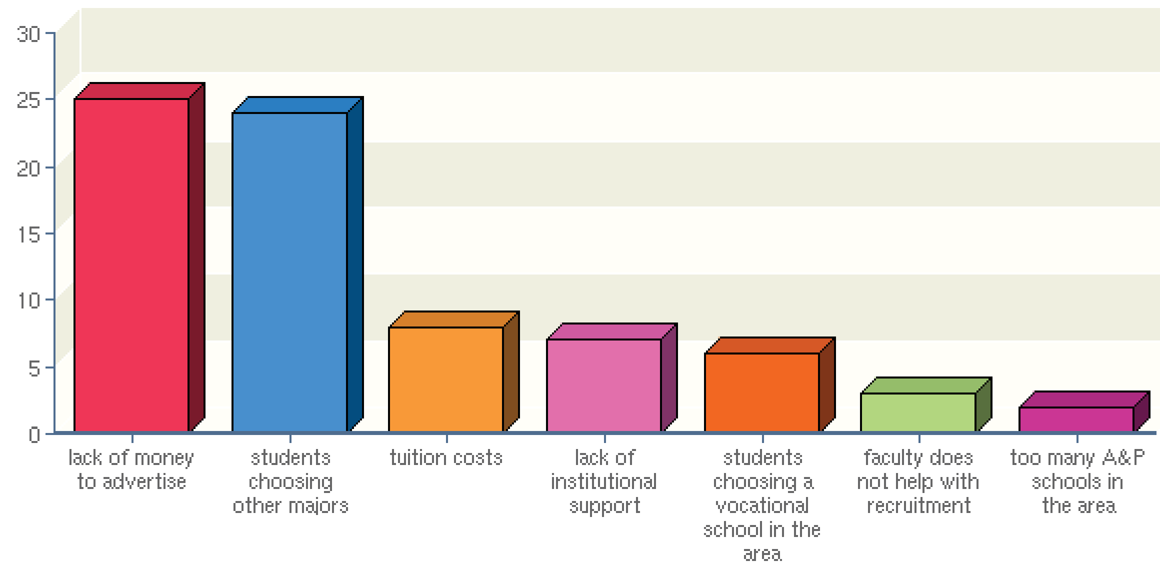
Building new facility and more direct advertising. **(Advertise and improve facilities)**
More active recruitment at the high school level. Possible merger with high school program. **(Recruit)**
Attend high school career fairs and air shows. **(recruit)**
Get more students, tell counselor to shut up at HS level. Most tell students they are wasting there time if the do not go to a university. **(recruit)**
Recruit more specifically to technical and vocational high school programs. Encourage faculty to visit more middle and high schools to recruit. Encourage faculty to attend more shows to recruit. **(recruit)**
More visits to high schools. **(recruit)**
We are not declining. We attend over 30 high schools career fairs a year. We set up booths at almost every major function in (the area). We have an active aerospace academy which fluctuates from 30-60 students a year and there are usually about 10% females. After these students complete their two years of dual credit they usually come back for evening classes to complete their A&P. These areas keep us gainfully employed. **(Not declining)**
N/A **(Not declining)**
N/A **(Not declining)**
N/A **(Not declining)**
N/A **(Not declining)**
N/A **(Not declining)**
We maintain classes below 10, if possible. **(Not declining)**
This program has been put in suspension as of Feb. 1st. I am no longer allowed to take on new students. **(program suspended)**
We have made radio commercials TV commercials open houses school visits career fairs and even offered insetives for science teachers to help promote our program to no available. I am stumped. I have resourses and $ for recruiting available **(unknown)**
Enrollment has increased over the past several years, we are offering dual cred classes to the high school students which allows them to complete the general courses upon graduation from high school. **(Not declining)**
Not declining **(Not declining)**
Not declining **(Not declining)**
Participating in HS Career Days Hosting HS Field trips using students to spread word. **(Recruiting)**
Since spring 2008 each incoming class has been full, including spring and fall 09. So numbers are increasing. **(Not declining)**

Table 6. Raw Data I - continued

Increasing marketing dollars, improving relationships with K-12 schools, getting middle school and high school students involved with aerospace career awareness, open house events, summer camps, ect. **(Recruiting and advertising)**
More advertising especially among non-traditional students **(advertise)**
We will continue to try to enroll students in our AMT programs, but if enrollments don't improve, soon, we will shift our efforts to our other associate degree programs. **(Recruiting)**
Enrollments are increasing. **(Not declining)**
For years we have not had an active Aviation Program Director. Our college just hired someone 5 weeks ago. **(Change in leadership)**
Enrollment is steadily increasing now. **(Not declining)**
Implement a new curriculum that focuses on newer aircraft and systems, with a greater focus on Avionics. **(Change in curriculum)**
Enrollment is steady **(Not declining)**
Increase marketing in various areas. **(Advertising)**
Our enrollment has been increasing over the past couple of years (except for the night program). We continually recruit via mail, email, tours, and events. **(Not declining)**
Recruit, Recruit, Recruit, job and career fairs, high school visits, what ever can be done with little or no budget. **(Recruit)**
Enrollment is steady, we are capacity limited at 275 students for both day and night. **(Not declining)**
We are a new FAA Part 147 AMTS, so unfortunately, we are at max capacity with waiting list. Plan to add additional faculty (X4) within the next year and a half. **(Not declining)**
Enrollments not declining. **(Not declining)**
Enrollment is increasing **(Not declining)**
Increasing **(Not declining)**

What do you think are your biggest challenges to increasing your enrollment? Thirty-nine schools answered this question. Their choices were; lack of money to advertise, students choosing other majors, tuition costs, lack of institutional support, students choosing a vocational school in the area, faculty does not help with recruitment and too many A&P schools in the area. The respondents were not limited to the number of choices they could mark.

Table 7.



If the above question did not include your biggest challenges to increasing your enrollment, what is it? Twenty-six schools answered this question. The lack of jobs or wages was mentioned six separate times. Another item mentioned frequently was that fewer students are interested in technical-vocational careers, or that people no longer seem as excited about careers in aviation as in the past, or the fact that there is a lack of knowledge about aviation maintenance as a professional career. Eight of the twenty-four schools mentioned these issues.

Table 8. Raw Data II

See above about counselors. They are stupid rejects who could not get another job.
Statistics show there are less marketable students and all other schools are more active in recruiting now than before. Also, prospective students seem more out of touch with mechanical, hands-on experiences from home or previous schooling.
We are suffering from the companies cutting back and laying off. We live in a military city and when the war ends we will see all those planes and their engines and we will grow.
Advertising, As a policy Community Colleges do not like to advertise technical programs. The school and local industry sells it self once we get people apprised of the offerings.
Having the right quality people in our Admissions Department.
Opportunity and availability of employment in the area is minimal.
High school guidance counselors not aware of aviation maintenance as a profession. Also, the trend is to push high school students to persue a degree rather than a certificate program in higher education. Primary reason remains lack of public knowledge of the aviation maintenance industry.

We offer A&P training to High school students. Our program is free but off campus and demanding. It is difficult to get students through their high school academic requirements and FAA requirements at the same time and have the student able to graduate with their class. Most students won't see the value in our program. We try to show them the value to our training which when compared to the post secondary institutions can save them up to $100,000.00.
Overcoming the general apathy of the current student population. Many just want to go straight into management, without knowing the aspects of aviation maintenance; FBO, manufacturing, commercial, ets.
Bad economy
[State regulations]....limiting daily time with students
Lack of understanding as to the importance of an AMT
Cannot increase number of students enrolling, our institution is at maximum capacity.
Lack of hiring aircraft mechanics in the area; negative press about a career in aviation.
We need a flying club to attract more students.
Lack of knowledge about the Aircraft Technician profession, and associated positions in the aviation industry.
Lack of funding
Job availability and wages
Industry support
Our college has a total enrollment of almost 25,000 students. It is difficult to get the support needed from the institution to advertise our program. That being said, we do not have the faculty or faculty space to take on many more students that we already have.
One of the biggest problems I see in attracting new A&P students is, there is a fence around all he airports and the summer small town airshows have all gone away. Lack of proper wages for the type of work we do. What gets the young kids motivated about a career in aviation anymore. A typical A&P student will put in more school and study time them most master degree programs. The pay and liability does not add up to the amount of stress involved in this field. KIids today want instant training with instant big bucks at the end.
Reference question 10 we really do not need to advertise now
N/A
Cost of replacement equipment that is old and worn out
We have been at or near capacity. Continuing to market program using present system of open house activities, tours, EAA Convention.
Overall interest in Aviation as a professional career choice. I do not see the Industry promoting the. Legacy and regional airlines should have a aviation marketing board to drive interest in the profession. The board is the better choice because any one carrir may "spook the horses" uses their brand.

ENROLLMENT TREND SURVEYS

The following discussion are based on the twenty-four fully completed surveys. Of these twenty-four; 29.2% are vocational schools, 62.5% were two year colleges offering more than one degree, and 8.3% were universities. Public versus private were divided into 79.2% of schools are public and 20.8% are private.

Regarding the number of females enrolled, twenty-two of twenty-four respondents completed this section. Of those twenty-two, some of the data was incomplete. In this case, the missing data were interpreted as no information available rather than as a zero. For this reason, percentages of women enrolled were calculated, rather than using the enrollment numbers, which should yield better information. See Appendix E for those percentages.

Number of admitted freshman/new students for the daytime freshman class from 1999-2008.

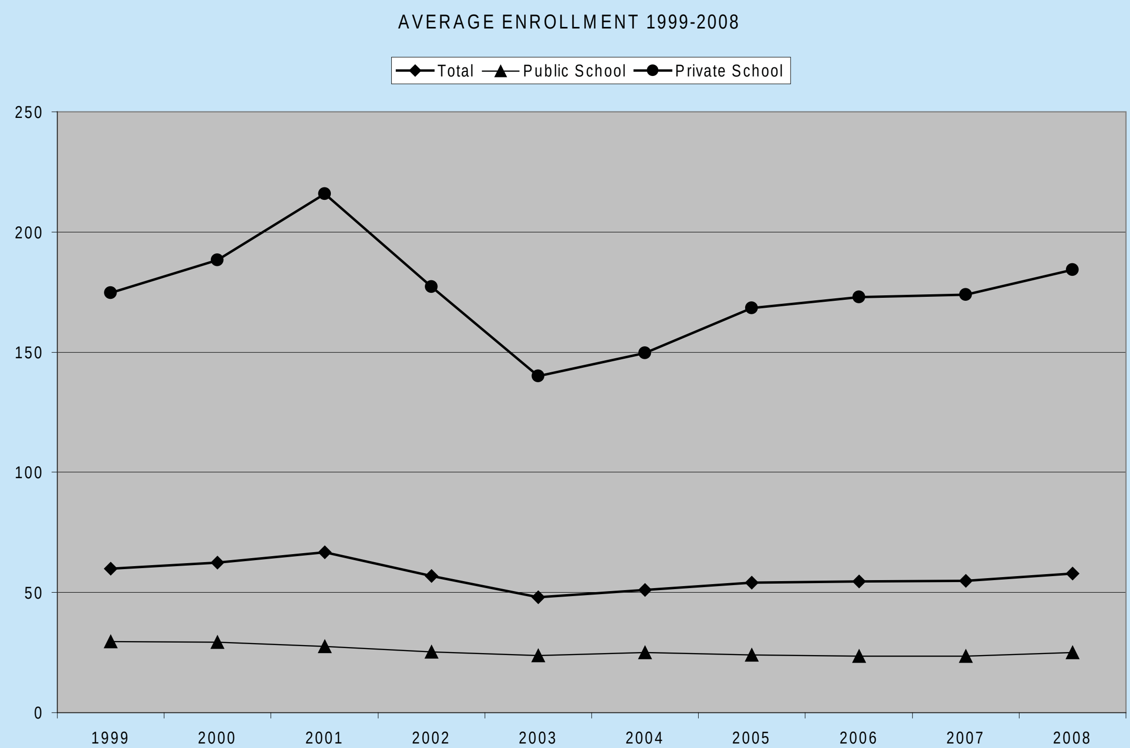


Table 9. Average Enrollment 1999-2008

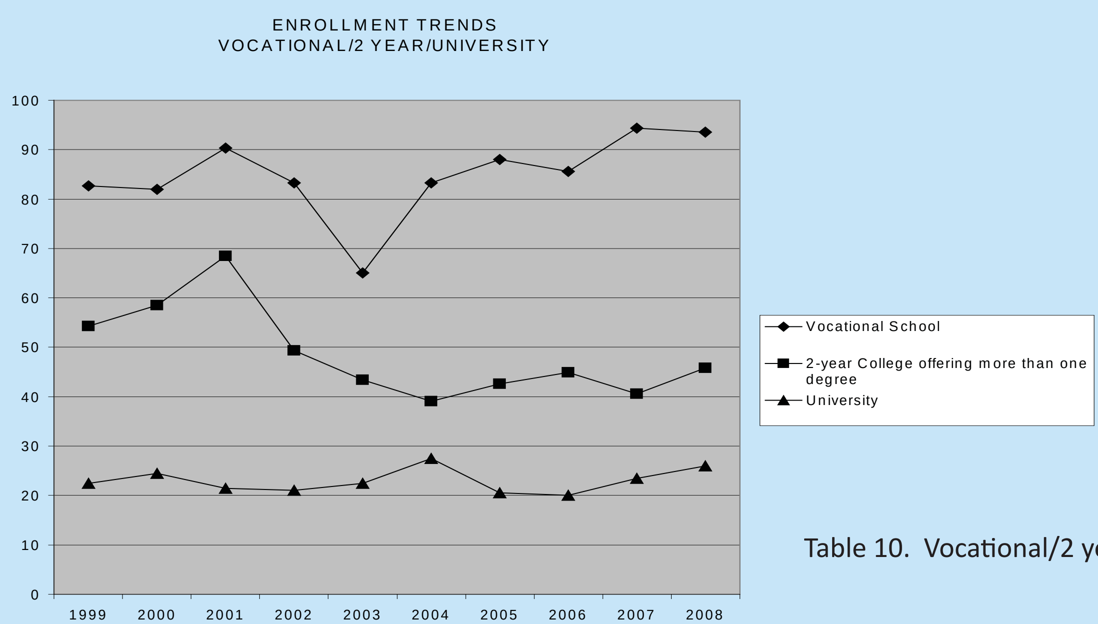


Table 10. Vocational/2 year/university

Of the above graphs, it should be noted that there were four schools that had enrollment numbers which greatly exceeded those of the other survey respondents. Of these four schools, the numerical range of incoming students was between 92 and 341. The success of these schools should not be minimized, but the reader may be interested in enrollment numbers excluding these schools. The four schools were all private, leaving only one private school to be considered for enrollment trends. These four schools also represented two vocational and (2) two-year colleges. Tables 11 and 12 show the enrollment numbers without those four schools.

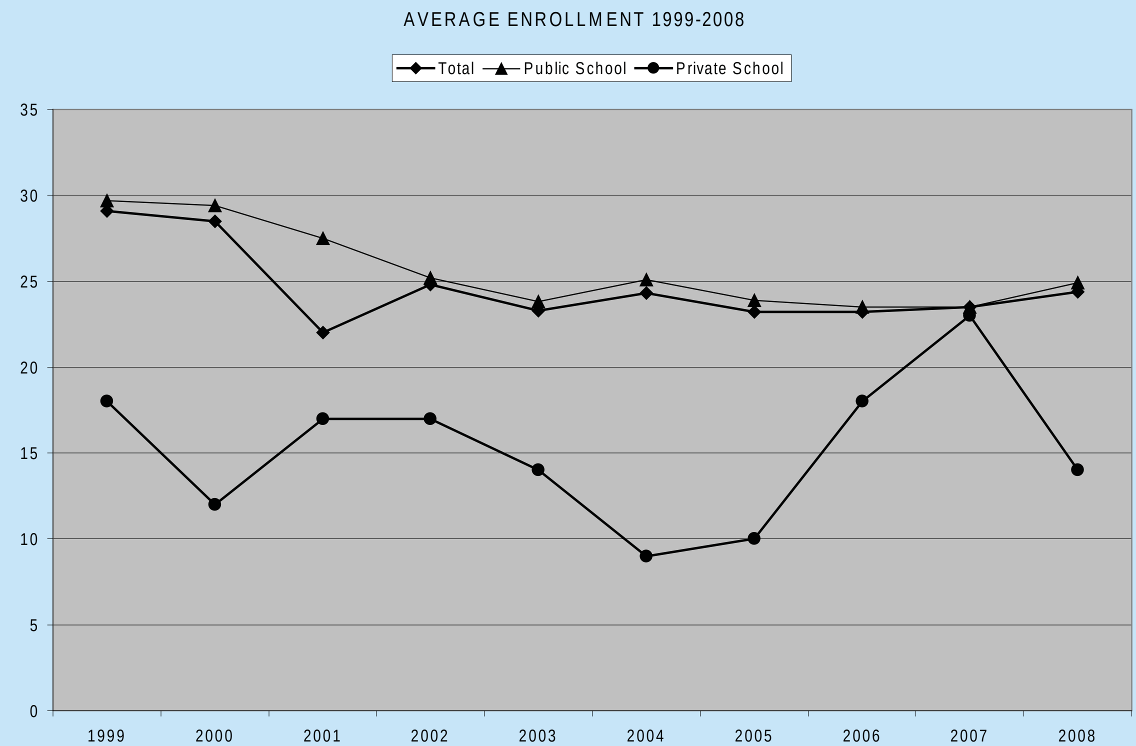


Table 11. Average Enrollment 1999-2008, excluding the above four mentioned schools

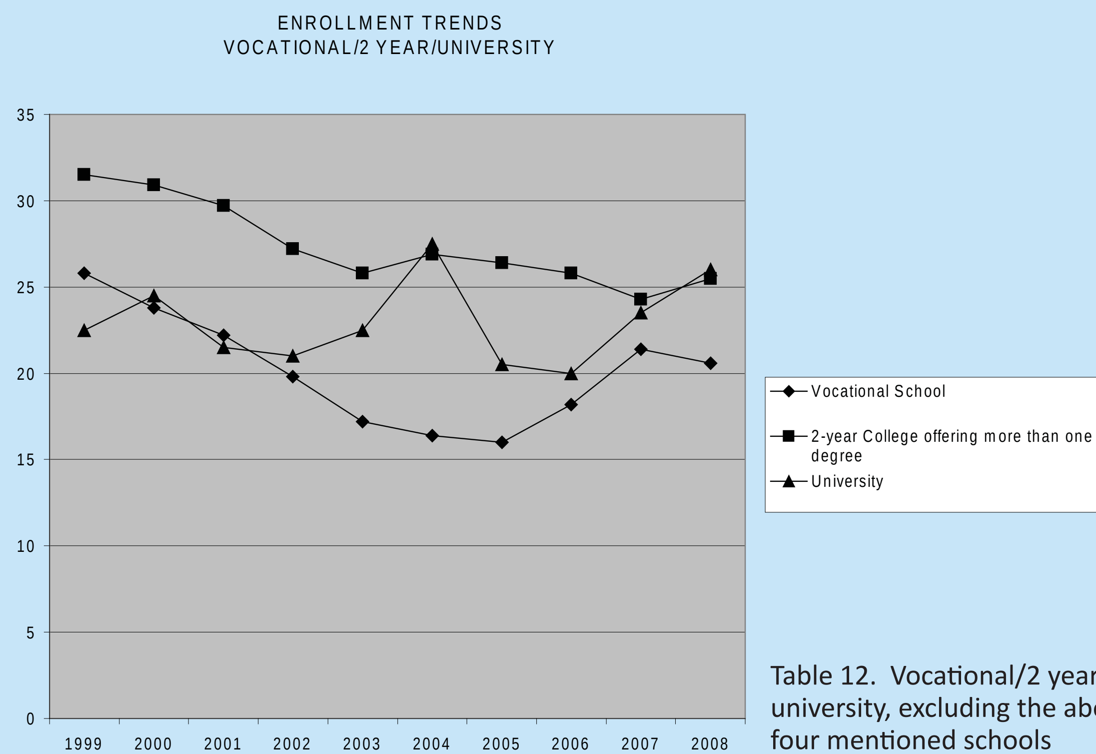


Table 12. Vocational/2 year/ university, excluding the above four mentioned schools

CONCLUSION

It is hoped that this research paper might give A&P schools a basis of comparison for their enrollment data. The results of this survey showed the struggle of balancing recruiting, advertising, and faculty commitments. Schools that have the ability to offer college credit while students are still in high school may greatly improve the chances to increase their student numbers. It is also interesting to note that one vocational school complained that high school counselors were encouraging students to go to college, and some colleges complained that students are more interested in a higher dollar career than a hands-on technical career. Another prime audience could be military personnel stationed near a particular school. One school, that is familiar to this researcher, designed their curriculum in two week blocks; the advantage was that military personnel could fit these two week blocks into their schedule of deployment and training.

Another issue that seems to be common is the ability to get the right people in administrative positions that understand and appreciate the AMT training programs at their institutions. There needs to be a commitment from these personnel to make the effort to not only understand the program, but know the advantages and career opportunities that are open for AMTs. A&Ps can find employment in areas other than aviation; it is interesting that there is no mention of this in any of the schools' essay answers. This researcher has personally known A&Ps who left the industry to find jobs in other areas. One example is a mechanic of fifteen years that left an airline A&P position for a maintenance job in a biotech company, for a substantial increase in pay. At the UAA conference in San Jose CA in 2007, an airport manager stressed the difficulty to keep A&Ps as the local dealership was hiring them away. Other job areas that are lucrative to a person with an A&P are city mass transport such as Bay Area Rapid Transit (BART) or subway systems. Amusement parks look at A&Ps to assist in the servicing of their animatronics. These additional employment areas could be used as a recruitment tool.

AMT schools should consider an open invitation to recruiters, counselors, and administration officials to sit in on classes. Further, they should invite faculty and advisors from other departments as well; students often change majors and this can give AMT programs located within larger organizations a chance to attract these students.

Lack of industry support was mentioned twice in the area of biggest challenges. Industry support can be an important area that can improve a schools' program and give students industry experience. Summer Internships give the student a chance to add to their resume and network with potential employers. Further, industry partnerships on projects can greatly expand a lab experience. Industry can also add to the students' experience by participating in their school clubs; which can add to the educational experience. These student clubs include such organizations as Women in Aviation, Skills USA, and can include local interest such as a rocketry club, unmanned aerial vehicle club and other clubs that are able to recruit local interest.

Does changing the image change the ability to recruit? At United Airlines, in the mid-90s, there was a question about whether A&Ps should be considered mechanics or technicians. When working on foreign contract aircraft, A&Ps were called engineers. This researcher personally felt more respected when working on foreign contract aircraft. Was that because of the name or a change in their culture? That is a potential topic for a future paper, but some schools are considering this issue now. There is more use of the term "Aviation Maintenance Technician" (as opposed to the old A&P terminology) or AMT programs, and some schools are redesigning their curriculum and adding the term "engineering". Brad Townsend, mentioned in the Literature Review of this paper, is working on a professional certificate; Aircraft Maintenance Technical Engineer Certificate (AMTEC) as a part of Operation Bootstrap. This certificate takes into consideration education and experience. Adding a more professional certificate to the AMTs portfolio is not a new idea, but Operation Bootstrap has out lasted other ideas and may be part of the solution for the field to earn more respect.

This study created more questions than answers, such as why were there four schools that far exceeded the numbers of the other twenty schools. What is the secret to the success of these four schools, or perhaps it is that these schools do not consider themselves to be successful. Two of these schools answered the question; if enrollments are declining, what is your plan to address that? The first responded: "We will continue to try to enroll students in our AMT programs, but if enrollments don't improve, soon, we will shift our efforts to our other associate degree programs." The other responded: "Increase marketing in various areas." One of those schools answered …your biggest challenges to increasing your enrollment? What is it? "Having the right quality people in our Admissions Department."

Further research needs to be conducted in order to ascertain what the enrollment trends are, taking into account other factors such as region, bases of employment, and graduates who seek jobs outside of aviation. Successful schools need to be examined to determine how they are accomplishing this success. Another question that remains is; will changing the name of an A&P to AMT, engineering, or something similar help with recruitment? In the essay portion of the survey, it shows that the career image does play an important part on how people outside of aviation view the aviation field.

APPENDIX A

SURVEY

Your school is a

_____private institution _____public institution

Your school is a

_____a vocational school

_____a two year college offering more than one degree

_____a university

In you're A&P program, how many times do you have an incoming freshman class in a calendar year?

Number of admitted freshman/new students for the daytime freshman class from 1999-2008.

	New Students	Number of Females
1999		
2000		
2001		
2002		
2003		
2004		
2005		
2006		
2007		
2008		

Do you have an evening A&P program? If not, please answer no and then go to the third page.

How often do you have an incoming freshman class?

Enrollment trends for the nighttime freshman class from 1999-2008.

	Enrollment numbers	Women enrolled
1999		
2000		
2001		
2002		
2003		
2004		
2005		
2006		
2007		
2008		

If enrollments are declining, what is your plan to address that?

Do you have a plan to attract female students, and if you do, what is your plan?

What do you think are your biggest challenges to increasing your enrollment?

- ☐ students choosing other majors
- ☐ lack of institutional support
- ☐ lack of money to advertise
- ☐ faculty does not help with recruitment
- ☐ too many A&P schools in the area
- ☐ students choosing a vocational school in the area
- ☐ tuition costs

If the above question did not include your biggest challenges to increasing your enrollment, what is it?

APPENDIX B

3. In you're A&P program, how many times do you have an incoming freshman class in a calendar year?

Raw Data

# of Freshman Classes	# of Schools
2	8
3	7
1	6
4	4
once	3
6	2
Twice	2
two	2
0	1
1 or 2 depends on transfer enroll	1
10	1
2 times	1
5-Apr	1
5	1
6-8 TIMES A YEAR	1
Every 8 weeks	1
four	1
four times	1
Once mostly, sometimes twice	1
one	1
One (1) or Two (2)	1
only in fall	1
three	1
Twice, but sometimes students stare related classes in summer too.	1

APPENDIX C

6. How often do you have an incoming freshman (evening) class?

Raw Data

# of Freshman Classes	# of Schools
2	4
1	1
10 times annually	1
2 times a year	1
3-Feb	1
4	1
5	1
6	1
annually	1
Do not offer evening classes	1
every quarter	1
Every Semester	1
every semster	1
four	1
four times a year	1
once a year in the Fall	1
once August	1
once each year	1
once yearly	1
one	1
Ongoing registration to keep classes full, fifteen students per class 5 to 10 classes offered per semester	1

APPENDIX D

7. Enrollment trends for the nighttime freshman class from 1999-2008.

	School #1	School #2	School #3	Average	% of Women
1999	14	8	25	15.7	6.4%
2000	12	5	23	13.3	7.5%
2001	21	3	20	14.7	4.5%
2002	14	4	18	12	0.0%
2003	11	2	23	12	5.6%
2004	15	3	20	12.67	10.5%
2005	13	2	18	11	0.0%
2006	16	2	22	10	6.7%
2007	12	3	25	13.3	5.0%
2008	14	2	20	12	11.1%

APPENDIX E

Percentage of women enrolled.

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
	16.0%	8.7%	5.0%	0.0%	8.7%	0.0%	16.7%	4.5%	12.0%	15.0%
	5.7%	4.4%	2.3%	2.4%	5.3%	3.4%	1.7%	1.7%	1.9%	3.4%
	15.6%	8.1%	0.0%	11.8%	7.1%	2.6%	2.8%	20.5%	9.4%	6.9%
	6.4%	8.4%	5.5%	13.1%	7.3%	6.2%	9.6%	11.3%	12.2%	6.3%
	4.3%	4.0%	5.0%	5.0%	5.0%	3.5%	3.8%	4.1%	5.1%	6.1%
	0.0%	0.0%	4.5%	3.6%	3.4%	6.3%	3.3%	8.7%	15.4%	4.5%
	0.0%	0.0%	4.8%	7.1%	6.3%	4.3%	27.3%	11.8%	4.8%	37.5%
	16.0%	10.0%	6.7%	4.5%	0.0%	0.0%	5.6%	5.0%	8.3%	20.0%
	7.1%	0.0%	0.0%	4.5%	0.0%	0.0%	0.0%	0.0%	9.1%	6.7%
	2.2%	2.0%	0.0%	4.3%	5.0%	0.0%	4.2%	2.0%	3.6%	5.8%
	5.0%	5.0%	5.0%	5.0%	5.0%	15.0%	12.5%	0.0%	7.5%	0.0%
	9.5%	0.0%	5.9%	4.8%	25.0%	7.1%	15.4%	0.0%	16.7%	0.0%
	2.2%	2.1%	4.8%	8.0%	10.5%	13.0%	14.3%	11.1%	7.1%	7.9%
	0.0%	16.7%	17.6%	5.9%	0.0%	11.1%	0.0%	0.0%	4.3%	0.0%
									13.3%	6.7%
			16.7%						11.1%	
	10.0%	14.3%	6.7%	11.1%	5.6%	6.7%	11.1%	4.0%	8.0%	12.0%
	0.0%	5.6%	0.0%	0.0%	5.6%	0.0%	0.0%	0.0%	5.6%	0.0%
	0.0%	3.0%	0.0%	4.3%	0.0%	5.6%	0.0%	0.0%	11.1%	0.0%
	11.8%	30.0%	7.1%	7.7%	10.0%	18.8%	40.0%	9.1%	5.0%	9.1%
	0.0%	2.9%	2.0%	3.2%	3.7%	6.8%	0.0%	0.0%	18.8%	4.2%
Average	5.6%	6.3%	4.7%	5.3%	5.7%	5.5%	8.4%	4.7%	8.7%	7.2%

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Humidity Effects on Glass and Plastic Core Fiber Optic Cable Transmissivity

Dennis R. Hannon, Southern Illinois University

ABSTRACT

As fiber optic cable finds its way in aeronautical applications, considerations as to the effects of the environment in which the cable functions is of concern to maintenance personnel. Previous research by the author indicated possible influence of humidity effects on the performance of 1 mm plastic core, multimode fiber optic cable as may be used in aircraft applications. Data collected over an extended period inferred that cable performance dropped slightly in transmissivity tests performed in a test environment with relative humidities above 30% where temperature was controlled at a mean of 70 plus or minus 3 degrees Fahrenheit. As the observed degradation in performance was approximately 8% (25 mW over a measured range of 300 – 325 mW); it was felt further investigation of this phenomenon was warranted. In order to attempt verification of the data, a repeat test run was performed over an eight month period under similar conditions. In addition, comparable lengths of glass core fiber optic cable were tested parallel to plastic core cable in an effort to determine if humidity effects on the performance of glass core cable were similar. The purpose of this paper is to discuss the results and interpretation of that study.

INTRODUCTION

In previous research conducted at the Southern Illinois University Department of Aviation Technologies, effects of short term exposure to common aircraft chemicals and solvents on fiber optic cable transmissivity were evaluated to determine the level of degradation occurring due to chemical activity if any. Test groups of cables and controls were prepared and baseline values of cable transmissivity measured and recorded. Following exposure to various solvents and chemicals including a standard 99% isopropyl alcohol cleaning solution, the cables were retested and the results recorded and evaluated. While a number of the chemicals tested adversely affected cable performance, the set of cables exposed to the typical isopropyl alcohol cleaning chemical for one week and subjected to the same standard regimen performed on all the test samples revealed no significant short term degradation of performance (Hannon and Ramsundar, 2007).

Since fiber optic cable ends in aerospace applications are cleaned and inspected prior to installation, at periodic maintenance intervals, or when problems arise, it was thought conceivable that the effects of repetitive cleaning may be detrimental to cable performance in the long term. The aerospace industry, through contacts with Boeing Aerospace in St. Louis, MO, desired information on the extent of these effects if any (Boeing, 2007). In order to satisfy this request, an evaluation of the long term effects of repetitive cable end cleaning was undertaken wherein cables were subjected to over 100 cleaning cycles over a seven and one half month period.

Cable transmissivities before and after cleaning at each test interval and over time were measured in microwatts and recorded. The data was then transferred to an Excel® spreadsheet and graphed for documentation, study and interpretation. Values representing the power transmitted through the cables prior to, after and throughout the successive cleaning regimens were recorded and statistical analyses conducted using both Excel® and SPSS® where thought relevant.

Based on the data collected in the study, it was apparent that repetitive thorough cable end face cleaning using the cotton swab and 99% isopropyl alcohol method had little effect on fiber optic cable transmissivity. Although minor ambient temperature variations occurred, no temperature related effects on cable transmissivity were evident in the study. It should be noted that the cable ends were not subject to environmental contaminants such as heavy dust, dirt, sand, volatile chemicals, etc. as may be present in an aircraft operating environment. While repetitive cleaning of the cable ends at the connectors to the extent examined in this study did not constitute a detriment to performance, it was noted that humidity variations in the testing environment did appear to have an adverse effect on cable performance.

During the seven and one half month test period, temperature in the testing environment was held at 70 +/- 3º F. Ambient humidity, however, was permitted to fluctuate as normally occurs in a temperate Midwestern U.S. seasonable environment. Relative humidity varied from less than 15% to a maximum of approximately 50% over the duration of the study. Humidity data was plotted along with temperature and cable performance.

Line plots, scatter plots and a linear regression of humidity versus transmissivity all suggested a statistically significant inverse relationship between relative humidity and cable transmissivity. Data are depicted in Charts 1 and 2 and Table 1 below. Since the variance was slight and correlated similarly both in before and after cleaning test samples and controls it was felt to be unrelated to the effects of the multiple cleaning cycles on transmissivity. Nevertheless, it was felt the apparent linear inconsistency did warrant further investigation.

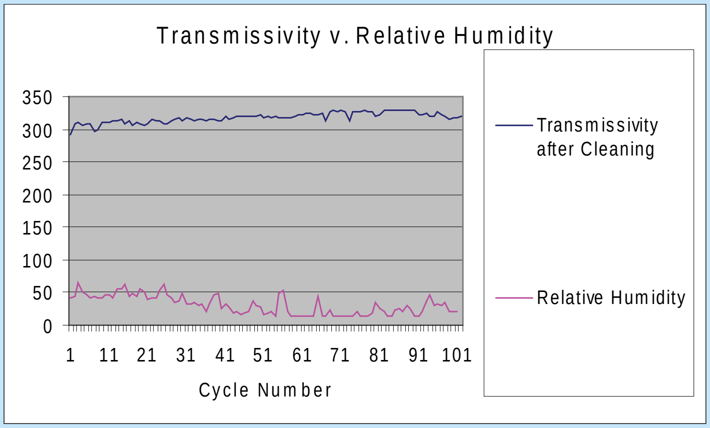

Chart 1. Transmissivity correlated with relative humidity

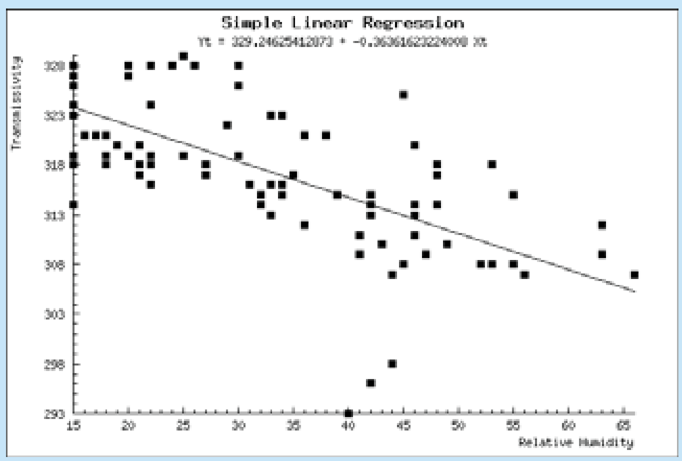

Chart 2. Original Data Regression Plot of Transmissivity v. Relative Humidity

Simple Linear Regression - Ungrouped Data				
Parameter	Value	S.E.	T-STAT	Notes
Constant	329.246254			
Beta	-0.363616	0.038444	-9.45837	H0: beta = 0
Elasticity	-0.035589	0.003763	-275.224526	H0: elast. = 1
Durbin-Watson Autocorrelation	0.97557			

Table 1. Original Coefficients of variants humidity v. transmissivity

A document search as to humidity effects on fiber optic cable performance revealed that, in addition to humidity induced micro-bend compression resulting in degradation of cables (Brininstool, 1993); little data on other humidity effects on fiber optic cable performance was discovered. As such, this study was undertaken to verify previous humidity effect data and to concurrently discover if common glass core 62.5/125 glass core fiber optic cable was likewise affected.

PROCEDURE

The study utilized 10 meter lengths of polymethyl methacrylate (PMMA), 1 mm plastic core and single mode 62.5/125 micron glass core fiber optic cable as may typically be used in aircraft installations. Cable ends were terminated with ST type connectors and the end faces polished, cleaned, microscopically inspected, and initially tested to establish a baseline transmissivity level (Figure 1). Cables with fractured, severely scratched or otherwise distorted end faces were rejected from the study (Figure 2). Appropriate controls were run in parallel with each testing operation. Testing procedures followed the guidelines outlined in Aeronautical Radio Incorporated Project Paper 805: Fiber Optic Test Procedures and repetitive cleanings were performed in accordance with ARINC Project Paper 806: Fiber Optic Installation and Maintenance Procedures (ARINC, 2005) and Cisco Systems brochure on inspection and cleaning procedures for fiber optic connections (Cisco Systems, 2006).

The cable samples and controls were examined at intervals not exceeding once per day over a period of sixteen months. An Industrial Fiber Optics #IF-FOM fiber optic transmissivity test set employing 650 M wavelength red light was used for determination of plastic core cable performance and 850 M light for determination of glass core cable performance (Figure 3 as recommended in the test set operating procedures (Industrial Fiber Optics, 2001). Ambient temperature and relative humidity readings were taken and recorded concurrently with each test cycle (Figure 4). All data were logged and documented in accordance with accepted research practices. The step by step procedure for inspection and testing of the cables was well documented and a checklist used to assure consistency and repeatability. Careful handling of the cable samples was employed to minimize errors due to inadvertent cable over-bending, mechanical abrasion or end compression. Dust covers were carefully placed on the ST connector ends after each test to minimize cable end contamination due to dust particles, handling, etc. Several transmissivity test readings were taken at each test interval and averaged to help alleviate any inherent test set measurement or interpretation errors. Data was then transferred to an Excel® spreadsheet, charted and graphed for documentation, study and interpretation (Charts 3, 4 and 6). Values representing the power transmitted through the cables were recorded and statistical analyses conducted where thought relevant (Tables 2 and 3). Regression plots with trendlines corresponding to data in Tables 2 and 3 are represented in Charts 5 and 7.

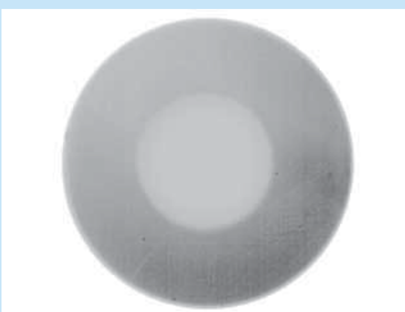

Figure 1. Photomicrograph of Acceptable Polished Glass Core End Face

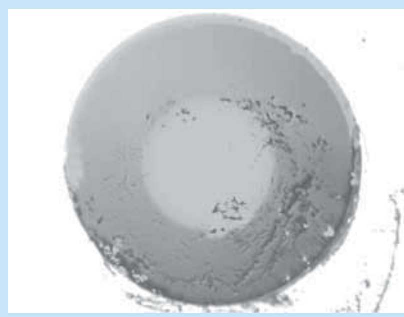

Figure 2. Photomicrograph of Unacceptable Cable due to Severe Fractures and Scratches

Figure 3. Test Set Up for Glass Core F.O. Cable

Figure 4. Transmissivity Control and Temperature Humidity Display

RESULTS

Repetitive cable transmissivity testing was conducted during the period of mid-August, 2008 through December, 2009. Chart 3 below depicts the parameters examined including temperature and humidity of the testing environment over the16 month testing period. As in the previous study, the ambient temperature remained fairly flat throughout the testing period. Humidity fluctuated from a low of 15% or less to highs of over 60%. Long term variances in cable transmissivity were noted which generally followed the fluctuating relative humidity levels as was noted in previous studies (Hannon, 2008). In the current study, however, short term day to day variance over sections of the reporting period caused both high and low spiking in the control as well as both the glass an plastic core samples which was not apparent in the original study. It was thought these occurrences resulted from variations in battery voltage affecting the luminance level of the light source of the test instrument, however, since transmissivity levels versus relative humidity were observed over long periods and the control sample followed these fluctuations, it was felt these occurrences did not affect the overall interpretation of the data. As noted above, the ambient temperature remained fairly constant (66 - 76º F; mean of 70.6º, Standard Deviation 2.99) over the 16 month period and appeared not to have an effect on cable performance. Humidity levels under 15% were below the range of the measuring instrument and therefore may have been actually lower than indicated. As indicated in chart 3, samples 47 – 110 and 185 to the end of the sampling period reflected readings taken during prolonged periods of low relative humidity.

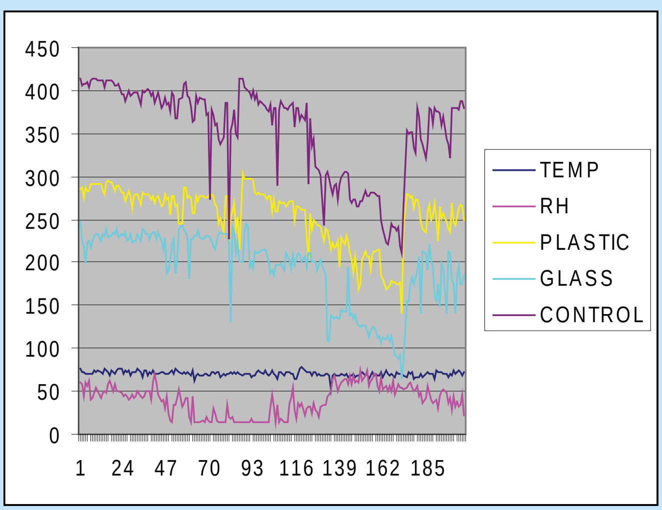

Chart 3. Cable Transmissivity, Temperature and Relative Humidity Levels (Y) during multiple test runs (X)

Statistical investigation using recognized simple bivariate analyses (Bermin, 2002) including linear regression, Durbin-Watson Autocorrelation and T-tests indicate an inverse relationship between humidity and cable transmissivity using Wassa Free Statistics Software (Wassa, 2009). These data correspond favorably to the original findings (Hannon, 2008). Results are as follows:

PLASTIC CORE CABLE

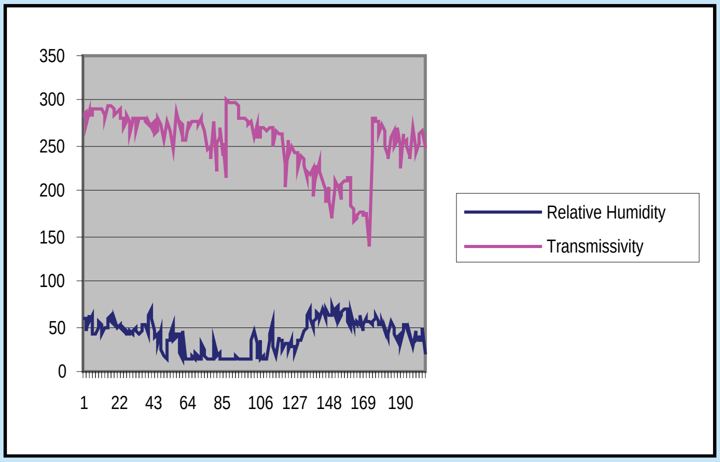

Chart 4 Plastic Core Cable Transmissivity and Relative Humidity

Simple Linear Regression - Ungrouped Data				
Parameter	Value	S.E.	T-STAT	Notes
Constant	286.73856			
Beta	-0.798203	0.127049	-6.282621	H0: beta = 0
Elasticity	-0.125886	0.020037	-56.189670	H0: elast. = 1
Durbin-Watson Autocorrelation	0.350788			

Table 2. Coefficients of Variants of Plastic Core Cable Transmissivity v. Relative Humidity

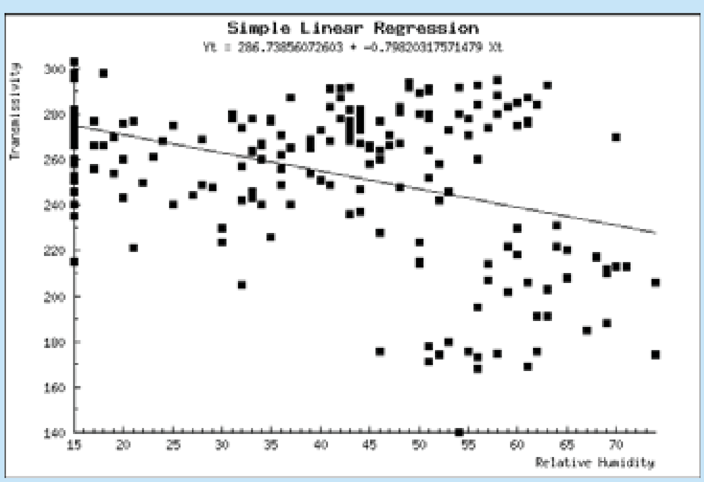

Chart 5. Regression Plot of Plastic Core Fiber Transmissivity v. Humidity

GLASS CORE CABLE

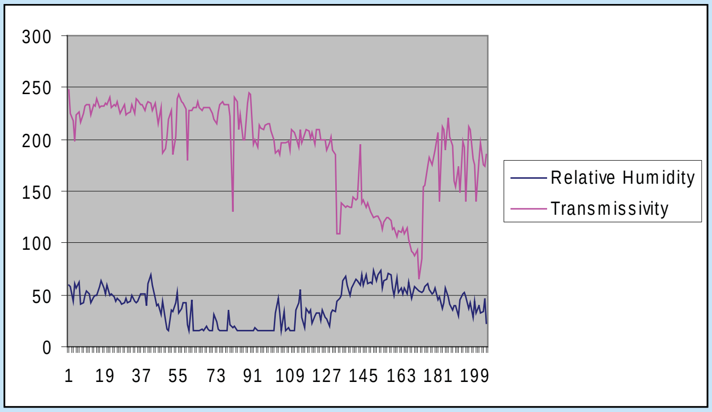

Chart 6. Glass Core Cable Transmissivity and Relative Humidity

Simple Linear Regression - Ungrouped Data				
Parameter	Value	S.E.	T-STAT	Notes
Constant	239.307594			
Beta	-1.169912	0.158293	-7.390804	H0: beta = 0
Elasticity	-0.244339	0.033060	-37638988	H0: elast. = 1
Durbin-Watson Autocorrelation	0.363556			

Table 3. Coefficients of Variants of Plastic Core Cable Transmissivity v. Relative Humidity

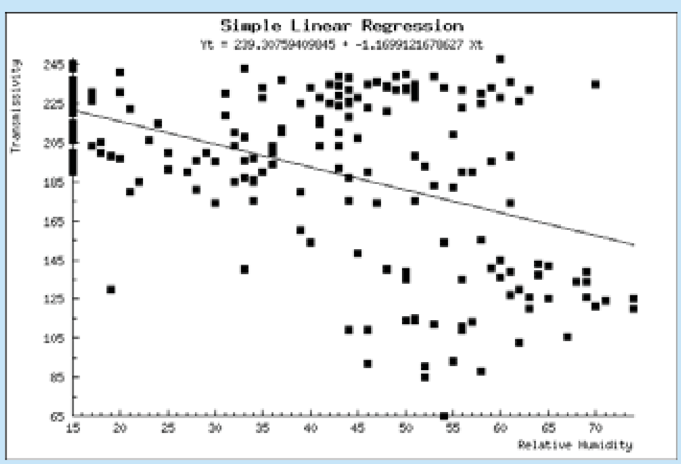

Chart 7. Regression Plot of Glass Core Fiber Transmissivity v. Humidity

CONCLUSION

This investigation was conducted over a longer period of time than the original study in an effort to verify data collected during the original study and to ensure that two dry to humid period cycles were observed and cable performance in-fact improved when again exposed to lower humidity environments. Glass core fiber optic cables were also included in the evaluation. Based on the data revealed in the original study and further investigation of linear variance related to ambient humidity in the current study, it is apparent that trends in variations of relative humidity affect cable performance over extended periods of low and high relative humidity. In both plastic and glass core cables, relative humidity levels above 50% appeared to have the greatest negative effect on cable performance. While the negative effect was not as pronounced as in the original study, an inverse relationship between relative humidity and cable transmissivity was evident.

As the test methodology used in this study revealed only relative power transmissivity variations, actual data throughput variations relating to frequency, volume of data and data error rates were not revealed. Additional studies are planned to include the transmission of digital data over the test cables to determine if data transfer rates and bit error rates (BER) are affected by changes in humidity using compatible data transfer protocols similar to those defined in ARINC and MIL-STD applications standards.

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This year's conference centered on presentations on emerging aircraft technologies, learning factors, employee health factors and Human factors with some review of basic maintenance practices given. Research and academic papers were presented that were informative and thought provoking. The various vender booths provided an excellent opportunity to get the latest teaching materials and make industry contacts. Many issues concerning the aviation maintenance community were discussed and shared from all points of the country. We all need to thank the conference venders and the ATEC Journal Advertisers as they really support the conference and the ATEC Journal in a huge way. If you didn't attend this year's conference, you missed an excellent chance to gain up-to-date knowledge and to share with other schools, industry and government. Even though travel funds are very tight, schools cannot afford to ignore involvement with the aviation industry through ATEC.

Next year's conference will have the normal benefits but will offer IA and DME renewal before and after the conference.

ATEC Conference 2011 Orlando FL April 10-12

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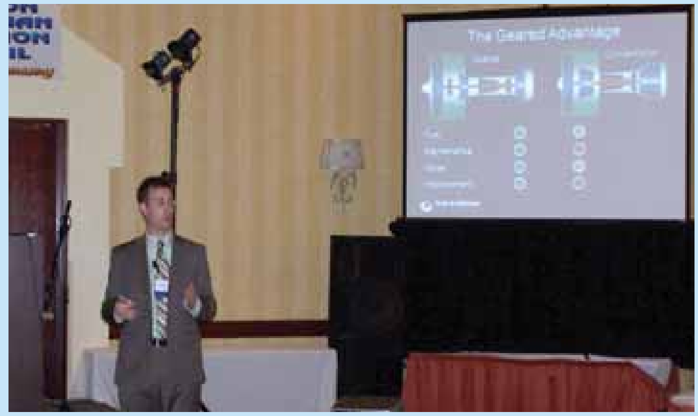
This will provide a great chance to attend the conference and take care of some renewals at the same time. Thanks to the conference committee members and the board of directors for another excellent and informative conference.

Tom Wild
ATEC Journal Editor

One of the many informative talks during the conference.



Nathan Hicks of Pratt & Whittney covered new technologies with turbofan engines.

Many useful teaching tools and text are always on display and made ready for schools to look over during the conference.

Dick Delegrange from the Goodyear tire company gave an excellent talk on tire care and maintenance.

James Lukins Northrop-Rice Foundation presenting the student of the year award to Mabel Hinton fron Middle Tennesse State while ATEC President Laurie Johns looks on.

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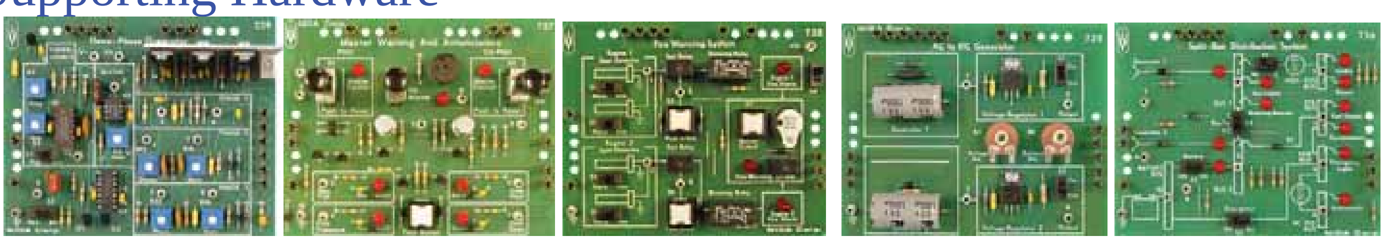

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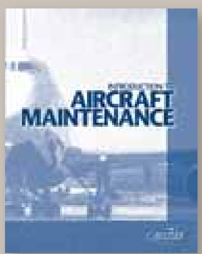

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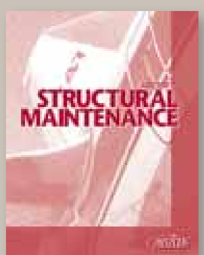

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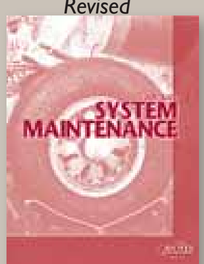

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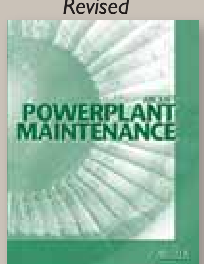

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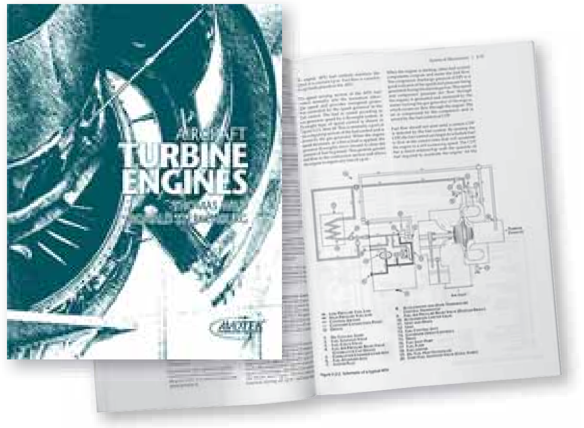

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ATEC Update

PRESIDENT'S MESSAGE

As another term comes to closure for your institution, I would like to reflect briefly on the past year. ATEC concluded another successful conference in April. Educators from all types of 147 programs were interacting and learning, providing each other with new ideas and energy. ATEC successfully advocated on behalf of several schools with the FAA. We anticipate a number of new industry technical training tools coming available soon.

However, with looking back comes looking forward. Over the next 12 months, ATEC will be reexamining its role and purpose, looking to better serve its member institutions. We seek to continue growing our relationship with the FAA and expanding our industry connections. We will be seeking feedback from each of you to understand how we can better serve your needs, what resources our website should provide, and what activities enhance our conference so it is at the top of your "must attend" list. In difficult economic times, ATEC wants to ensure that your membership provides a real benefit to your institution and faculty.

I look forward to interacting with many of you and seeing you in Orlando in April 2011. Best wishes for continued success.

Raymond Thompson, ATEC President
Associate Dean, Western Michigan University

ATEC 50TH ANNIVERSARY CONFERENCE – APRIL 11-13

Despite tight budgets and a difficult economy, the ATEC Conference showed surprising strength. There were 104 participants from 66 AMT schools and 28 exhibitors from 15 companies. Ten spouses and guests also attended the awards luncheon.

At the awards luncheon ceremony, several dozen scholarships and awards were presented to faculty and students at ATEC member institutions through a partnership with the Northrop-Rice Foundation.

The five top rates presentations at the Conference were (in rank order):

1. PART 147 ARAC and FAA Update
2. The PurePower PW 1000G (geared turbofan) Engine
3. Boeing and Emerging Technologies
4. New Trends and Technologies in Rotary Wing Aircraft
5. PART 147 Curriculum: Keeping AMT Learners in the Zone

One hundred percent of the attendees rated the hotel facility as Very Good (74%) or Good (26%).

The exhibit area was rated Very useful or Useful by 99.8% of participants.

MARK YOUR CALENDAR NOW FOR APRIL 10-12, 2011 WHERE ATEC WILL BE HELD AT THE INTERNATIONAL PALMS RESORT IN ORLANDO, FLORIDA. . . PLUS AT THE SAME HOTEL ON APRIL 9 THERE WILL BE AN IA RENEWAL PROGRAM AND ON APRIL 13, DME RENEWAL PROGRAM.

One trip…three professional activities.

April 9	IA Renewal
April 10-12	ATEC Conference
April 13	DME Renewal

147 ARAC

Based on meetings with the FAA, all indications point to PART 147 becoming an NPRM in 2010. Once the proposed rule is released, we will have a period of time, 60-90 days, to comment with any final suggestions.

ATEC will then be providing curricular suggestions and options to schools for adapting and fine-tuning A&P programs.

ATEC MEMBERSHIP AND FINANCES

After the first quarter of our 2010 fiscal year, ATEC institutional membership stands at 74. Industry membership is 22. A tight economy and institutional budget cuts have led to slow ATEC membership renewal this year.

Fiscally, in 2009, despite good cost controls, ATEC had a small deficit of $5,000. In 2010, however, we are projecting a $3,100 surplus if we meet all our revenue projections.

GOVERNMENT RELATIONS

The Government Relations Committee assisted four schools this past year with FAA issues that needed to be resolved.

If you have a school issue that does not seem able to be resolved at the local level, contact Andrew Smith at atsmith@ksu.edu.

NEW BOARD MEMBERS AND OFFICERS

Congratulations to newly elected Officers and Board Members:

President:	Raymond Thompson, Western Michigan University
Vice President:	David Jones, Aviation Institute of Maintenance
Board Member:	Clint Grant, Tarrant County College
Board Member:	Tom Hagovsky, Purdue University
Board Member:	Gary Hoyle, Pittsburgh Institute of Aeronautics
Board Member:	Andrew Smith, Kansas State University at Salina

The meeting of the ATEC Board is on May 26 at 3:00 PM EDT via conference call.

ATEC DVD LIBRARY – ADDITIONS COMING

Airbus recently agreed to provide ATEC with a new set of DVD's. We hope to have them in hand by this summer and will be offering them for sale as soon as they are cataloged.

Currently, ATEC has almost 200 instructional DVD's for sale at $10 and $20 plus shipping.

Go to www.atec-amt.org and click on Curriculum Resources.

INSTITUTIONAL CONTACTS

Check the website www.atec-amt.org then click on Members to be sure that your institutional information is correct along with your contact person. Send any corrections to ATEC at ccdq@aol.com or info@atec-amt.org or fax changes to (717) 540-7121.

STUDENT OF THE YEAR

The recipient of the 2010 Student of the Year Jim Rardon Award was Mabel Hinton from Middle Tennessee State University. The award was presented at the April Conference by the Northrop-Rice Foundation. The award included a small cash stipend, conference registration, hotel accommodations and air transportation to Mesa, Arizona.