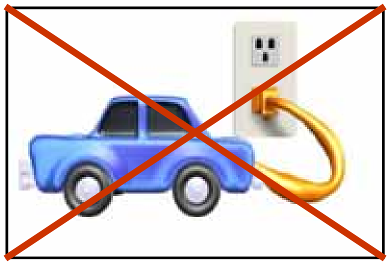
ATech AutoTeacher News
October 2006

Regenerative Braking

The rage of today is the hybrid vehicle primarily thanks to superb marketing. The OEs concerned have done an excellent job of involving the environmental groups, government, and the global warming crowd. The fact that the marketing has worked is a monument to the miserable state of science education in this country and the duplicity of the EPA. A few simple facts about present day hybrids:

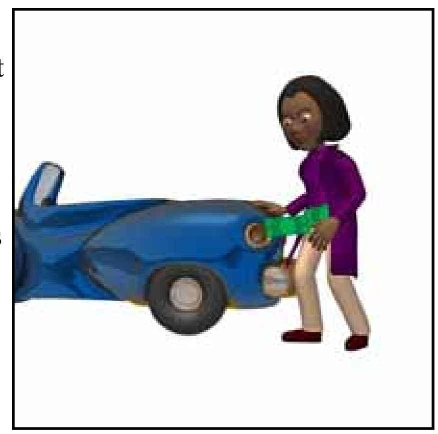


1. They cannot be connected to the electrical power grid, therefore almost all energy available comes from the gasoline engine.
2. They were not constructed to connect to the power grid primarily because the electrical generation in California can not support the extra load.
3. On the expressways, the batteries and motor-generator are dead weight. If they were removed, the vehicle weight would be reduced by 15 to 20%. What would the gas mileage be without that extra weight?
4. These are extremely small vehicles-5.5 feet wide. Two will almost fit side by side in an expressway lane. There has been some discussion as to the need for a "kickstand" on some hybrids. :^)
5. They were not designed for great gas mileage in spite of the hype.
6. Their primary purpose was to export pollution from the inner city areas as they can travel a reasonable distance in stop and go traffic without the gas engine running.
7. Small diesel engines in reasonably sized cars can achieve far better fuel mileage.
8. While claims are made as to their safety, I would not want my family in one on the expressway. A golf course or around town maybe, but not the expressway.

The one system that does make sense on the present day hybrid is the Regenerative Brake system. But even that has been hyped way beyond the actual performance numbers. Looking at the metal hydride battery, it's charge-discharge efficiency is only 66%. That means you have to put back about 40% more than you can take out assuming the battery is completely discharged. If it is fully charged, the charge-discharge efficiency is 0%

Only the drive wheels are involved in energy recovery. That means that at most approximately 50% of the energy used getting the vehicle up to speed is all that can possibly be recovered. Could you stop the vehicle using only the regenerative system on the front wheels? Not completely but the regenerative system could do most of the work except for safety issues. How well does any vehicle stop with only front wheel braking?

The motor-generator assembly has about an 85% efficiency in either mode. Putting the rough numbers together; 66%(battery charge-discharge eff.) X 85%(motor-generator eff. in generator mode) X 50%(front drive wheels recovery only) X 85%(motor-generator eff. in motor mode) = 23%. That 23% assumes the battery is storing the entire recovered energy which means the battery will have to be fairly low in charge. Using the "best case" 23% number, the vehicle will have to stop 5 times to recover enough energy to accelerate the vehicle 1 time. Ultracapacitors could help these numbers considerably but that is the subject for a later newsletter.



Regenerative braking is a new concept to the automotive field but the characteristics have been seen for years. What device in the vehicle demonstrates this effect? Automotive technicians have been working with them for years - generators/alternators. If the headlights are turned on when the engine is idling, does the engine slow down and the idle speed control compensate? The additional load placed on the generator by the lights requires more energy from the engine. This loading effect acts to reduce engine speed by making it more difficult for the engine to spin the generator, a good description of electric motor braking.

Another illustration that is very closely related to regenerative braking is starting the engine. Energy from the battery is used to run the starter motor. When the engine starts, the energy used to start the engine will then be recovered by the generator and returned to the battery. Build on what the student already knows. This is "Structured Skill Development".

ATech's R&D group built a quick prototype that could be used for regenerative brake demonstrations. It is shown in Figure 1. The flywheel used is from a prototype for a 3.5 liter trainer we built for General Motors. It is 3/8

Regenerative Braking cont'd

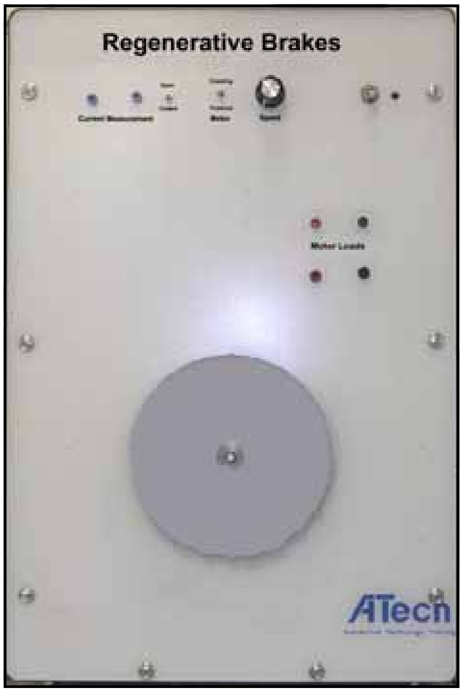


Figure 1

inch thick and 7 inches in diameter. The flywheel gives additional inertia to produce longer coast down times; simulating the vehicle weight. A sleeve bearing motor was used because ATech builds many trainers that use this one motor. For example, it is used on the ignition trainers, the Antilock Brake/Traction Control Trainer, and the Toyota Engine Control Trainer. It is a standard inexpensive General Motors permanent magnet blower motor. The sleeve bearings add considerable friction as will be seen later but it works great for our demonstration purpose.

"Permanent Magnet" means the field windings have been replaced with permanent magnets. This results in higher efficiency as no current is needed for field windings. Motors can be generators and the effect is demonstrated very well by this motor. The flywheel can be constructed of plate steel by your school's machine shop. It should be fairly well balanced as it will need to turn at about 2500 RPM to duplicate our setup.

Figure 2

Figure 2 shows the control center of the demonstrator. The motor speed potentiometer controls the speed of the motor when the motor switch is set to the "Powered" position. When the motor switch is set to the "Coasting" position, the motor power leads are disconnected from the power source and connected to the Motor Loads jacks shown in Figure 3. The motor becomes a generator converting the energy stored in the spinning flywheel to electricity. The

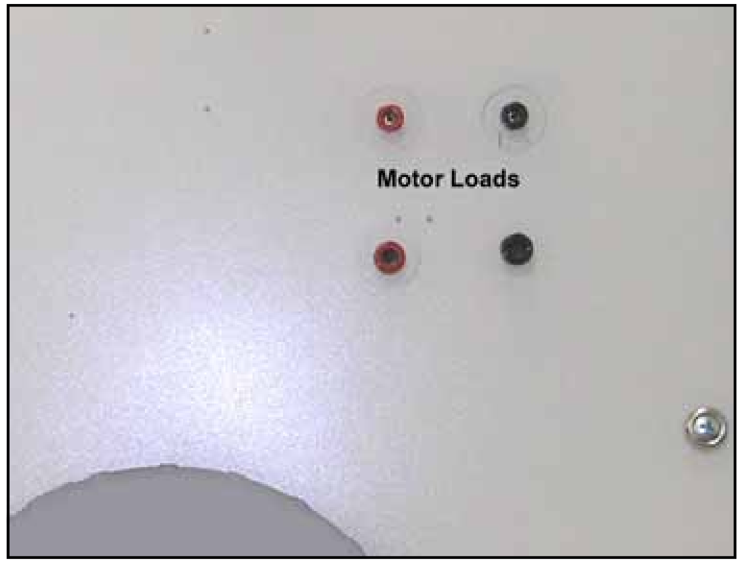


Figure 3

operational sequence is to connect a load device to the motor load jacks, run the motor up to top speed, and then flip the Motor switch to the coasting position. The loading (braking) effect can be observed by measuring the coast down time of the motor.

Current can be measured at the Current Measurement jacks when the switch is in the open position. Connect a meter to measure the current or connect a jumper or shorting bar between the two jacks and use a current probe. All of the waveforms shown were captured with a PicoScope™.

Figure 4 shows the voltage and current waveforms for the motor/flywheel ran up to 2640 RPM - the Motor switch is then set to the coast down position and the waveforms for the voltage and current output from the motor are captured. The motor is a permanent magnet motor and will

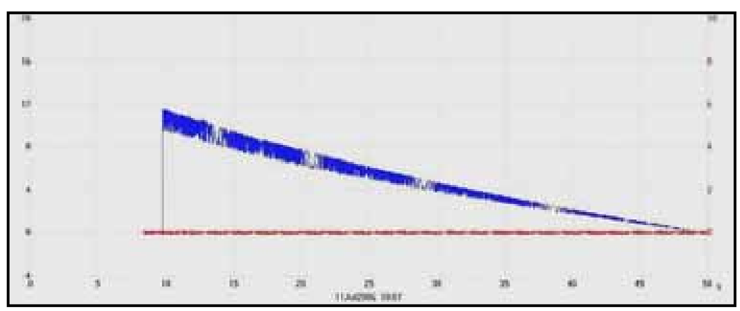


Figure 4

become a generator to supply power to whatever is connected at the Motor Loads jacks. By placing different loads on the motor and recording the waveforms, we can determine the amount of power recovered and the braking effect (regenerative braking). In Figure 4, the maximum voltage generated is approximately 11 volts and the current is zero. In this case no energy is recovered as there is no load. The objective is to determine the coast down time of the motor/flywheel from 2640 RPM with no load. From the wave-

Regenerative Braking cont'd

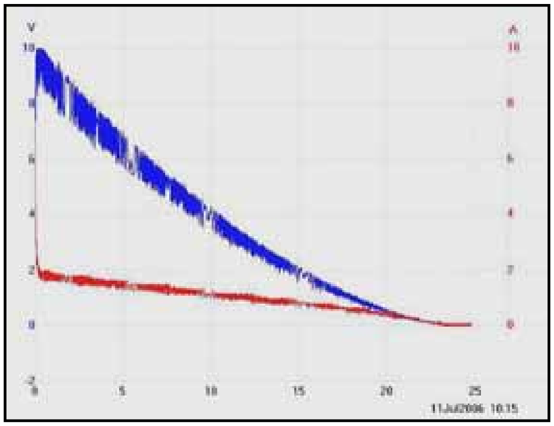


Figure 5

forms, it is about 41 seconds.

Figure 5 illustrates the output of the motor during coast down with a typical brake light for a load. Notice that at the 2 sec point on the waveforms, the motor is actually producing 8 volts at 2 amps which gives 16 watts of power. The coast down time is 22 seconds. The increase in load has reduced the coast down time to one half of the no load value. If the energy being dissipated as heat and light were

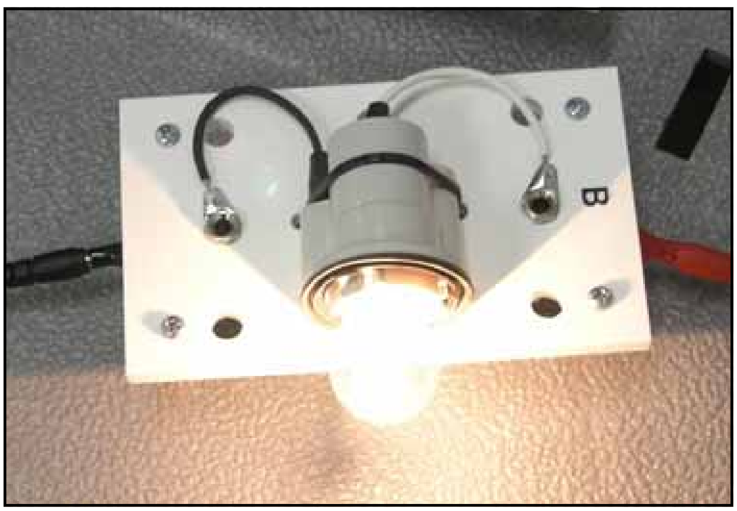


Figure 6

stored, it would total approximately 130 watt-secs. Figure 6 shows the light at the 2 second point of coast down.

The waveforms in Figure 7 are the result of running the motor up to 2640 RPM and then switching to a jumper wire (short) for the load. The resistance of the jumper wire and connections totals about .15 ohms. The initial outputs are 2.8 volts and 18 amps as shown on the graph. The coast down time is reduced to 8 seconds. The energy available for recovery with these load parameters is approximately 60.5 watt-secs. Our energy numbers are approximations. Probably close, but their use in this article is for comparison.

Figure 8 shows the voltage and current input to spin the motor up to 2640 RPM. The 25 second point will be considered as the reference point for our calculations. An interesting observation is; to maintain the motor speed at 2640 RPM requires a constant input of 12 volts and 2 amps of current (24 watts). If the motor were a ball-bearing motor, the current would probably be around a quarter of an amp. The input energy required to get the motor/flywheel to 2640 RPM in 25 seconds is approximately 1,450 watt-secs or 1.45 kilowatt-secs.

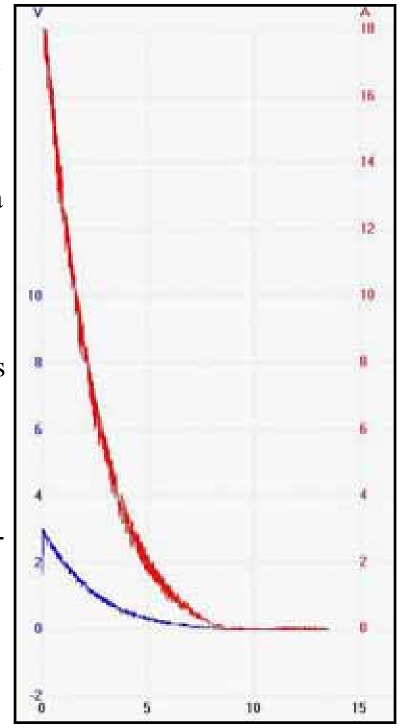


Figure 7

The energy available for recovery from the stop in Figure 5 is 130 watt-secs which would give an efficiency of 130/1450 = 9%. The energy available for recovery from the jumper wire shorted stop in Figure 7 is 60.5 watt-secs

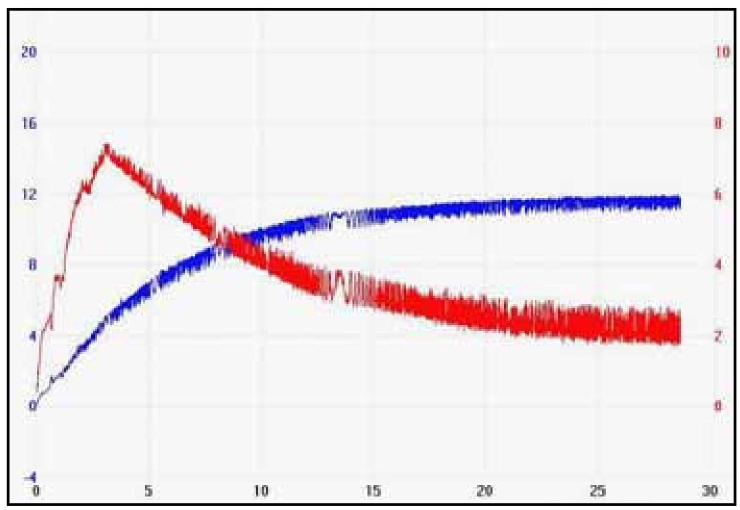


Figure 8

which would give an efficiency of 60.5/1450 = 4.2%. Our recovery efficiencies are not equivalent to those in the vehicle but the basic process is as described.

Kentucky Workshop "Top Gun" Winners

Dave Gerhardt – Marion County ATC, Gene Brown - ATech, and William Randall Adams – Letcher County ATC

ATech Visits Dubai and Oman

At the request of the Ministry of Manpower of Oman and Snap-on Tools International, ATech Training President - Fred Hines gave a presentation on the structure and techniques of Automotive Training in the United States. A lengthy question and answer session followed the presentation.

"I must admit that I had some reservations about traveling to the Mideast with the present state of world affairs. But in the case of the United Arab Emirates, Dubai, and Oman, my concerns were completely misplaced. The people were fantastic, the Countries were beautiful, and the hospitality was overwhelming. I truly enjoyed the discussions and was very impressed with the implementation plan for automotive training developed by the Ministry of Manpower in Oman." Fred Hines—ATech President.

Left to Right
Sainath. R, Divisional Manager - Khimiji Ramdaas L.L.C.; Pankaj K. Khimji, Director - Khimiji Ramdaas L.L.C; Fred Hines, President - ATech Training Inc.; Takis Voliotis, Division Manager - Snap-on Tools International

A few of the attendees

The Presentation of Flowers Tradition

ATech and ASA Aftermarket Training Projects

Earlier this year Bill Haas from the Automotive Service Association and ATech Training struck a deal to develop a training program that is aimed at helping working automotive technicians improve their electrical troubleshooting skills. Research shows that this is the area that technicians have the most trouble with. The program titled "Hands-on Advanced Pinpoint Automotive Electrical Troubleshooting" was developed as a hands-on computer based troubleshooting skill development program using ATech Training's 3631 Troubleshooting Skill Development Program. This program presents more that 80 faults across 5 circuits common to engine control circuits. This course and its implementation were designed using the ASE CASE standards. ATech Training is a CASE certified training provider. The content of this 4 hour course is practice in developing a troubleshooting strategy and perfecting the skills needed to carry it out.

With the cooperation of Dr. Marshall White Jr., President and Dr. Luegina C. Mounfield, Vice President for Career Programs at Midlands Technical College in Columbia, SC. Carson Connor was able to facilitate this group.

ATech Training and ASA jointly held a train the trainer session in March of this year with 5 instructors from all around the country. These instructors were hand picked based on their demonstrated skills in implementing hands-on discovery learning techniques following the ATech Training model. The five are Doug Andrews from Robert Morgan Educational Center, Miami FL.; Dan Beeson from Bellingham Technical College, Bellingham, WA; Carson Conner from Midlands Technical College, Columbia, SC; Ron Downing from Pittsburg State University, Pittsburg, KS; and Lance David from College of Lake County, Grayslake, IL.

The "train the trainer" session was a grueling 2 days held at The Belterra Resort and Conference Center near ATech's home office. Once the 5 were comfortable with the content and the approach they were sent home to practice and select dates that they would teach a pilot class at their schools.

There were 5 pilots with a total of more than 50 participants held in the month of May. The participants were each signed up to take an online pre-assessment from Melior Online Training. This was used as a bench mark. The training consisted of a 4 hour session held at various times of the day or night. Bill Haas and Gene Brown were present at each pilot to observe and conduct a debriefing of the participants and the instructor. About one month after finishing the pilot each participant was signed up to take a post assessment from the Melior site. The pre and post assessments were then compared to see if there was any significant improvement. By all measures the pilot course hit the target.

Bill Haas states that ASA is planning on offering this course to the working technicians this fall. If all goes well he will spread it to other parts of the country. Stay tuned for more news about this training. All indications are that this is what the doctor ordered for working techs to hone their electrical troubleshooting skills.

Gene Brown - ATech Vice President

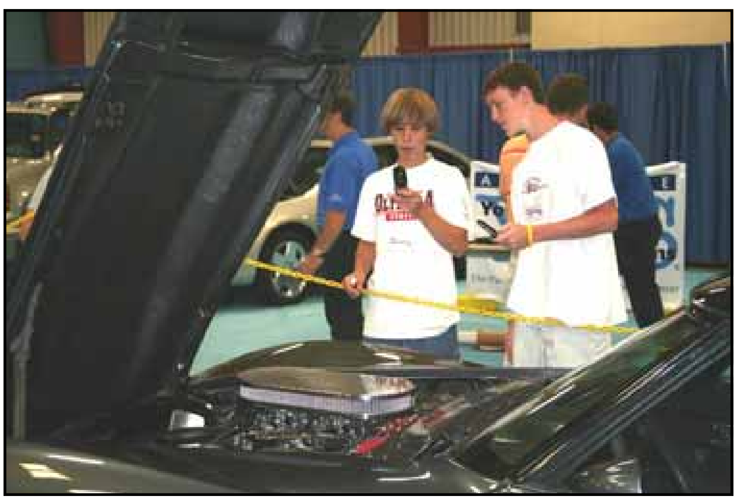
Bill Haas working hard at Robert Morgan Educational Center in Miami, FL

ASA

July Kentucky Invitational Workshop

Left to Right
Larry Helphinstine – Kentucky Department of Education, KY; William Randall Adams – Letcher County Area Technology Center, KY; Dave Gerhardt – Marion County Area Technology Center, KY; Scott Plumlee – Northwest Technical Institute, AR; John Bradley – Ashland Community & Technical College, KY; Keith Day – Whayne Supply Company, KY; Steven Johnson – Bluegrass Community & Technical College, KY; Roc Moore – Harrodsburg Area Technology Center, KY; Tim Jervis – Jefferson Community & Technical College, KY; Richard Burnett - Ashland Community & Technical College, KY; Mike McClure – Bowling Green Technical College, KY; Jack Kinner – Boyd County Career & Technical Center, KY (not in picture)

Student Recruitment



Chevy Holley and Tony King check out a Chevrolet Camaro

More than 40 area teens participated in the "Driving Your Future" Automotive Technology Camp held at Piedmont Technical College, Greenwood, SC. The second annual camp introduced students to the world of automotives. "We've been so overwhelmed by the interest we've seen in just our first two years," said Mike Rodgers, automotive technology program director at PTC and camp coordinator. "We were excited to be able to offer this to these kids," said Rodgers

The first day of the camp included an orientation for both campers and parents. Local dealerships brought vehicles for display. Area automotive businesses were on hand to answer questions about the industry. "Our purpose is to enlighten these teens and their parents about the industry," said Rodgers. "We're aiming to dispel the grease monkey and shade tree mechanic images," he explained. "Automotive technicians earn the fifth highest salaries in the transportation industry in South Carolina."

Throughout the week, campers had the opportunity to hear about the automotive industry, learn automotive shop safety, visit local dealerships, learn the basic principles of automotives and build their own fuel-cell cars.

On Thursday, students toured the BMW facility in Greer and took a ride in a high performance vehicle on the BMW test track. The camp concluded with an awards ceremony, and participants took home camp t-shirts, bags, the fuel-cell cars they assembled and numerous goodies from camp sponsors.

Sponsors for this year's "Driving Your Future" camp were Advance Auto Parts; ASE (National Institute for Automotive Service Excellence); AYES/ SCADA (Automotive Youth Educational Systems/ South Carolina Automobile Dealers Association); Ballentine Ford-Toyota; BMW; Cooper Chrysler, Dodge & Jeep; Firmin Ford; Gary Russ Chevrolet-Cadillac; Jim Satcher, Inc.; NAPA Auto Parts; O'Reilly Auto Parts; Pendarvis Chevrolet-Oldsmobile; Quality Chrysler-Dodge-Jeep; Snap-on; and Stokes Trainor Chevrolet-Pontiac-Cadillac-Buick.

For more information:
Laura Garrett, Assistant Director - (864) 941-8542
Mike Rodgers, rogers.m@ptc.edu - (864) 941 8468

June 2006 ATech Invitational Workshop

Front Row: Left to Right

Damon Friend – Monroe High School, MI; Tim Campbell – Eastmont High School, WA; Brent Downing – Ben Barber Career Tech Academy, TX; Jackie Bishop - Ben Barber Career Tech Academy, TX; Tony Longtin – Creekwood High School, TN; Joe Carbon – Central Piedmont Community College, NC; Michael Cobb – Breithaupt Career & Tech Center, MI; Dave Seidel - Central Piedmont Community College, NC; Mike Rodgers – Piedmont Tech College, SC; Michael Thompson – Branford High School, CT; Butch Webeck – Aims Community College, CO

Back Row:

Richard Williams – Baker College of Owosso, MI; Phillip Smith – BJ Skelton Career Center, SC; Don Haining – Davies Career Tech High School, RI; Robert Anderson – Broward Community College, FL; Del Brandenburg – Rockdale Career Academy, GA; Russell Carrigan – Texas State Tech College, TX; Robert Oswald – Kaw Area Tech School, KS; Russell Ferguson – Washtenaw Community College, MI; Randy Nussler – Midlands Tech College, SC; Kennedy Phipps – Lincoln Technical Institute, NJ; and Tom Shelton – Amarillo College, TX

AIPC 2006 Winners

Secondary—National Winner

Eastside Technology Center
2208 Liberty Road
Lexington, KY 40509

Secondary—National Runners Up

Ramona High School
1401 Hanson Lane
Ramona, CA 92065

Caddo Career & Technology Center
5950 Union Avenue
Shreveport, LA 71108

Post—Secondary Generic National Winner

Automotive Training Center
114 Pickering Way
Exton, PA 19341

Post—Secondary Generic National Runners Up

University of Alaska Southeast
11120 Glacier Highway
Juneau, AK 99801

Riverland Community College
2200 Riverland Drive
Albert Lea, MN 56007

June "Top Gun" Winners

Mike Rodgers, Gene, and Kennedy Phipps

Post—Secondary Mfg. Affiliated National Winner

Seminole Community College
100 Weldon Blvd.
Sanford, FL 32773

Post-Secondary Mfg Affiliated National Runner Up

Milwaukee Area Technical College
5555 W. Highland Road
Mequon, WI 53151

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Fred Hines

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