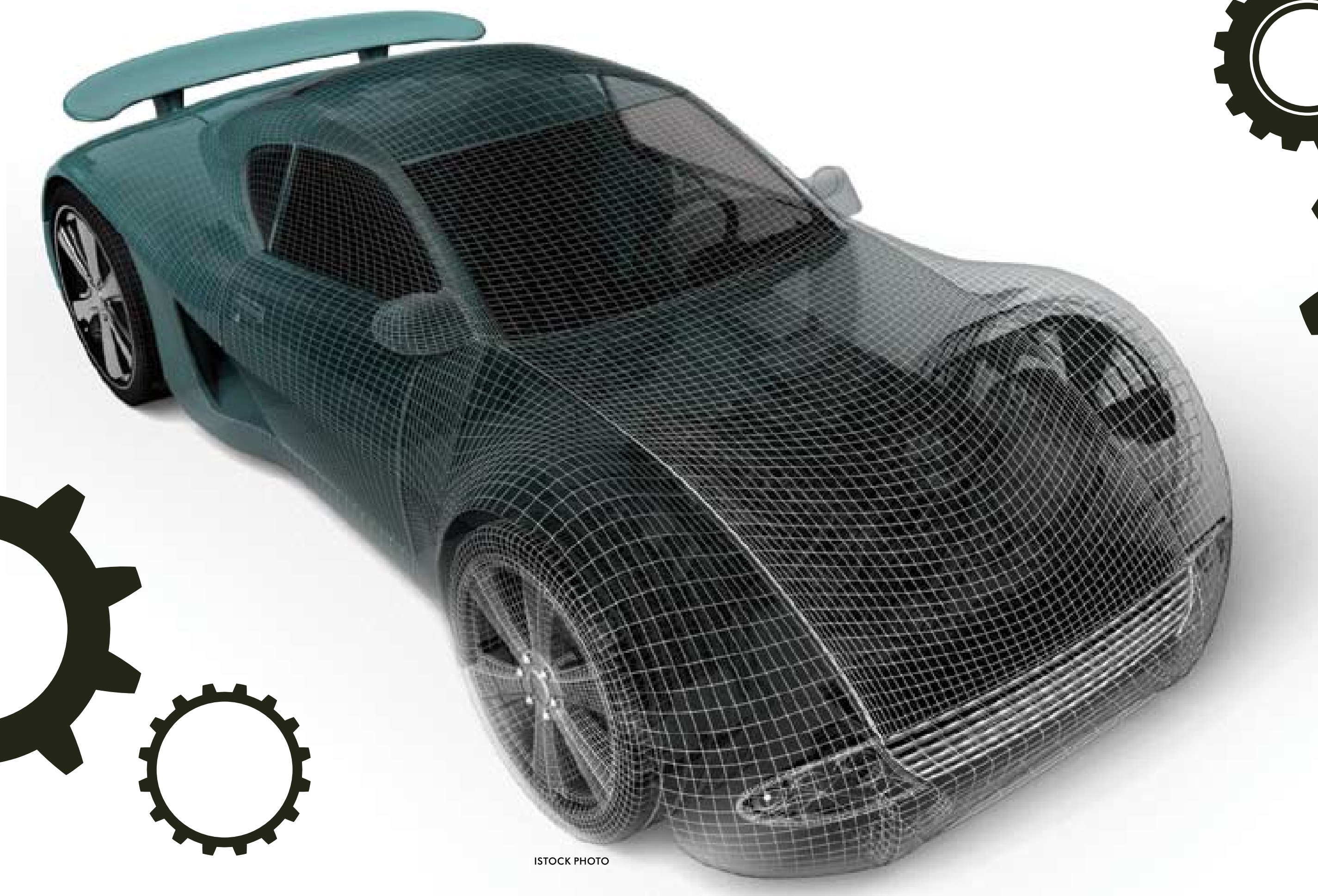
Academics in CTE Programs:

Fully Preparing Students for Their Next Step



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BY DAVID L. MACQUARRIE

An echo can often be heard in career and technical education (CTE) hallways, "How am I going to fit academic skills into this program." They have a choice! They could pick up a math or English book and start selecting something to separately add in. Perhaps an academic consultant could be tapped to separately add to the task list. Another option could be to add someone else's separate remedy of academics into the content and schedule mix.

However, a CTE educator could opt to find a solution to solve several coexisting problems in a natural way. For instance, the educator could look at some of the problems that are preventing students from being successful in their current program curriculum and look for missing links to a common solution. This article will relay several natural solutions to the academic problem.

It is not a secret that there is a growing concern about CTE students' academic preparation as can be verified by the shear number of hits possible in any Internet search engine invoked by entering: "CTE academic integration." (Academic integration often focuses on math, literacy and writing.) There are many routes a CTE educator could take concerning the integration of academic skills. One route is to focus on an academic area that naturally merges the three primary academic areas.

Let us focus on automotive for a moment: cars are designed and produced using science and require a level of science skills to perform diagnostic related repairs. Mechanical aptitude can be defined as the ability to learn mechanical and physical principles through experience and formal training (APR, 2008). The science area that is most related to mechanical aptitude is physical science and physics.

Physics can be defined as science content related to matter, energy and their interactions, relationships of processes, and properties of a system. From this definition we can educe that just about anything engineered or working on a car could be described using generalized physics principles. For instance, force and motion are used on every moving part on the vehicle. If a customer's steering wheel is stiff to turn in cold weather, then it is important to realize the relationship between hydraulic components as well as fluid, temperature and mechanical relationships on the system. The only other way to solve this problem is either through previous experience, such as a technical bulletin, or from another person's experience. I learned long ago that the latter method won't help much with new vehicles and new systems.

Force and motion are listed on Michigan's fifth grade science expectations (Michigan Department, 2008). However, my experiences indicate that typically 50 percent of automotive students indicate a poor knowledge and understanding of these principles on internal automotive pretests. Similar findings are true for Michigan's sixth grade science expectations for energy and changes in matter. In order to understand internal or external engine combustion processes, or to heat or cut steel, the related science principles can provide a deeper understanding of the processes and the dangers involved. (Note that the National Automotive Technicians Education Foundation's electrical and electronics tasks for automotive is aligned with 41 of Michigan's physics standards.)

It isn't contested that there is math involved in performing science projects as we use math to explain the relationships of physical relationships and systems. For instance, typically less than 50 percent of the students in my classes know or understand that an object gripped deep inside of a pair of pliers' jaws will apply more pressure than the outer part of the jaw. Additionally, students have a hard time transferring leverage principles to authentic levers, which exist in multiple forms on every vehicle, prior to understanding the mathematical relationship.

Today's students are in need of knowing and understanding mechanical aptitude and using physics contextually in an authentically verifiable manner that could simultaneously and naturally help them understand math, science and automotive skills better. It should also be realized that there are multiple methods of teaching and learning physics principles with various levels of mathematical models. It is important to stress a variety of skill levels mathematically in order to increase students' ability.

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Some processes of ensuring variety in math skill levels include: becoming familiar with physics formulas and contextual problems, which are often technically correct in an applied context compared to pure math contexts; mathematical transposing can serve the teacher well as problems often involve mathematical computations from a general formula, but actual problems require solving from many different aspects; and acquiring accurate and authentic physics resources. One resource that has been very useful over the years for general mechanical principles is a set of **Principles of Technology** books for high school students developed by the Center for Occupational Research and Development.

The latter processes enabled me early in my career as an educator to assist students in performing authentic tasks. For instance, most automotive math books publish an oversimplified and incorrect formula for calculating compression ratios. A student brought this to my attention during his argument with a parts distributor over the purchase of a set of high performance pistons. The student had discovered that the calculations were different from the performance product's specifications.

The following formula is often theoretically presented and interpreted as:

$$CR = \frac{V_{cyl}}{V_{CC}}$$

Where:

CR = Compression Ratio
V_{CC} = Volume of the Combustion Chamber
V_{Cyl} = Volume of the Cylinder

However, authentic use of this formula will result in an underestimation. Although engine repair skills have faded, students still express a personal interest in learning how to accurately calculate compression ratios between an engine's cylinders, as could be done with high performance race engines. This expressed interest provides the motivation for a more complex mathematical problem if they acquire the measures for themselves from actual engines. The formula I provide is as follows:

$$\frac{V_{BDC} + V_{CC} + V_{TDC}}{V_{TDC} + V_{CC}} = CR$$

Where:

CR = Compression Ratio
V_{BDC} = Volume displacement of a cylinder converted to cubic centimeters
V_{CC} = Volume of the Combustion Chamber in cubic centimeters
V_{TDC} = Cylinder Volume above the Piston when it is at Top Dead Center (including head gasket)

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A person's skill ability can restrict or broaden career options—an educator's philosophy can also restrict or motivate themselves and their students to perform. The described method of employing academics in an authentic way provides synergy to the CTE educator and students' skill area of passion, instead of an 'added in' separate academic unit or pullout course.

To ensure student success, students are structured in learning teams and the group project relieves deficient students a little while still ensuring the processes are reinforced by their peers. The project is then presented to the class. The above formula results can be validated with data using the following Web site: **www.csgnetwork.com/compcalc.html**. Some educators may wonder why I would have students learn this skill instead of learning to use the Internet resource. The reason is because the process builds student ability of transferable lifelong learning skills in science, math and communication in an authentic way. I have seen enough students over the years change their minds about their "dream career" and it is precisely at that point that transferable skills open doors of opportunity. It is a disappointment to both the teacher and the former student when they choose a career because that is all they think they can do.

A person's skill ability can restrict or broaden career options—an educator's philosophy can also restrict or motivate themselves and their students to perform. The described method of employing academics in an authentic way provides synergy to the CTE educator and students' skill area of passion, instead of an 'added in' separate academic unit or pullout course. Perhaps the skills the CTE teacher learns will also open opportunities for them as well. T

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References

APR Testing Services. (2008). *WTMA Content: What is Mechanical Aptitude?* Retrieved September 20, 2008 from **www.aprtestingservices.com/business/wtma/content.php**.

ASE. (2008). NATEF: Program Standards. Retrieved September 20, 2008 from **www.natef.org/program_standards/auto.cfm**.

Grubb W. N. & Lazerson M. (2004). *Education Gospel: The Economic Power of Schooling.* Cambridge: Harvard University Press.

Michigan Department of Education. (2008). "Grade Level Content Expectations." Retrieved September 20, 2008 from **www.michigan.gov/mde/0,1607,7-140-28753_33232---,00.html**.

Michigan Department of Education. (2008). "High School Content Expectations." Retrieved September 21, 2008 from **www.michigan.gov/mde/0,1607,7-140-38924---,00.html**.