AN ABSTRACT OF THE DISSERTATION OF

Stuart Savin for the degree of Doctor of Education in Education presented on December 4, 2007.
Title: *Autotronics*: Implications for Automotive Related Training Programs Standards Based Upon Emerging Technologies.

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Larry D. Roper

The purpose of the study was to provide a method for evaluating the effect, impact or role that (as perceived by automotive, diesel, automotive collision faculty and administrators) the nationally recognized industry training standards developed by Automotive Service Excellence (ASE) and National Automotive Technicians Education Foundation (NATEF) have on the currency of a given program or program's curriculum, thus determining what role the NATEF standards have in keeping automotive programs up-to-date with current and emerging technology. Automotive-related programs were the main focus; however, as applicable, medium-duty/heavy-duty truck (diesel) and automotive collision programs were incorporated, due to the significantly higher number of post-secondary automotive programs in contrast to the diesel and auto collision-related programs across the nation.

The design of this research utilized a qualitative multi-case study methodology. Three community colleges were selected using purposeful sampling.

The guiding questions which framed this research study were: (1) What do community and technical college automotive programs use as a basis for their automotive curriculum? (2) If community and technical college automotive programs use the NATEF standards as the basis for their curriculum, how much of their curriculum exceeds the NATEF standards? (3) How are recent and anticipated advances in automotive technology incorporated into the curriculum? (4) Are the NATEF standards perceived as being sufficient to maintain program quality, relevance, and currency with respect to technological advances?

After reviewing the data, eight common themes were identified. Recommendations to both colleges in this study and to NATEF addressing the identified themes were presented based on review of current NATEF procedures and through the evaluation of other accreditation processes.

Autotronics: Implications for Automotive Related Training Programs Standards Based Upon Emerging Technologies

by
Stuart Savin

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APPROVED:

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Dean of the College of Education

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Dean of the Graduate School

I understand that my dissertation will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my dissertation to any reader upon request.

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Stuart Savin, Author

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DEDICATION

Für meine Frau Wera, und unsere wunderbaren Kinder Annyka und Stefan.

To my parents who never gave up on me.

To all those who help me along the wonderful journey of life!

Autotronics: Implications for Automotive Related Training Programs Standards Based Upon Emerging Technologies

CHAPTER 1

INTRODUCTION

A major issue for community and technical colleges today is keeping professional technical programs up-to-date, and current with industry standards and technical needs.

> The contemporary vocational curriculum must be responsive to a constantly changing world of work. New developments in various fields should be incorporated into the curriculum so that graduates can compete for jobs and, once they have jobs, achieve their greatest potential. (Crunkilton & Finch, 1999, p. 17)

This is not a new issue, according to Halfin and Nelson (1982): "Providing education and training consistent with business and industry practice is a major challenge for vocational education" (p. 1). An issue they stated as a major hindrance to keeping programs current is the time lag between the development of vocational programs and when the curriculum is updated and approved. Too much time has elapsed during this curricular life cycle and topics become obsolete or new technology has surpassed the program (p. 1). The issue of "providing education and training consistent with business and industry practice" (p. 1) was still evident 14 years later, according to Parks in his 1996 paper *Technical Education & Training in the 21st Century*: "The challenge facing technical education is how to design

standards that satisfy the needs of business and industry, while simultaneously addressing the expectations of the academic community" (p. 20).

Parks (1996) takes the issue of keeping curriculum current one step further than Halfin and Nelson by recommending that external standards, which are developed by industry and business, be used as the basis for developing and updating technical curriculum. Keeping the curriculum current, as well as current external standards, which can form the basis for the curriculum, can be difficult. Technology changes so rapidly that during the typical life cycle of a curriculum in a professional technical program, the program and its curriculum could be surpassed by technology. This issue of curriculum currency, with respect to technological advances in professional technical fields, can potentially affect many programs in which students are educated at community and technical colleges across the country, today, tomorrow, and beyond.

A variety of methods are used to develop, maintain, and update professional technical curriculum throughout the curricular life cycle at community and technical colleges. These methods include seeking advice and input from advisory boards, conducting program reviews, DACUM's (Developing a Curriculum), and basing the curriculum on national business and industry standards (which can be in the form of specialized accreditation, certification and/or curricular recommendations). Program advisory boards, which are made up of representatives from local business, industry, labor and consumer groups, are one of the most common methods used to keep curriculum up-to-date and responsive to the needs

of local businesses and industries. Soliciting local business and industry input is so important that some colleges and state education boards require a minimum number of advisory board meetings per year. In Washington, the requirement for advisory boards for vocational programs is a state statute. According to the State Board of Community and Technical colleges: “We still require advisory committees to meet at least twice each year. The full advisory committee policy can be found on our website at http://www.sbctc.ctc.edu/docs/policy_manual.pdf (Chapter 4, Appendix G)” (P. Ward, personal communication).

The 1991 Revised Code of Washington and Washington Administrative Code states:

> Districts offering vocational educational programs—Local advisory committees—Advice on current job needs.
>
> (1) Each local education agency or college district offering vocational educational programs shall establish local advisory committees to provide that agency or district with advice on current job needs and on the courses necessary to meet these needs.
>
> (2) The local program committees shall:
>
> (a) Participate in the determination of program goals;
>
> (b) Review and evaluate program curricula, equipment, and effectiveness;
>
> (c) Include representatives of business and labor who reflect the local industry, and the community; and
>
> (d) Actively consult with other representatives of business, industry, labor, and agriculture.

The Washington State Board for Community and Technical Colleges Policy Manual (2002) prescribes the composition of advisory boards:

> Professional-technical advisory committee membership that will strive to ensure representation of gender and cultural diversity and

> include equal representation of business and labor, with the committee chair elected from the lay members.

In evaluating the effectiveness of a program, the utilization of an advisory board by said program is cited as an effectiveness indicator, and in some cases a requirement. The program review process at Gilford Technical College in Jamestown, North Carolina cites "Advisory Committee meetings (must meet three times annually…)" as one of the effectiveness indicators in a program review (Guilford Technical College, 2002).

The program review process provides an opportunity to evaluate a program as a part of an institution's ongoing self-assessment and improvement process and is another method that can be used to help keep curriculum and program outcomes current. Having an ongoing program review process is recognized by the Northwest Association of Schools and Colleges as a means to "provide a wealth of outcomes assessment data" (Northwest Association of Schools and Colleges, 1999, p. 38). Depending on the institution, a program review can rely upon numerous methods to gauge the effectiveness of a program; a review can also include input from advisory boards, national certification standards and/or result from a DACUM as part of the program review process. Program reviews can also demonstrate the importance and effectiveness of national certification standards as a valuable method for keeping professional technical programs current. In a program review at Portland Community College, the Diesel program review included a rationale for a curricular content change because of a need "to keep us current with industry and

our NATEF/ASE certification…We are working to increase time in the Brakes and Suspension Course" (Portland Community College, 2003, p. 2).

Another method used to ensure curriculum matches industry needs is the Developing a Curriculum (DACUM) process. This process has been widely used to develop new programs and to review existing programs. The DACUM process is a method by which the needs of local community, businesses, and industries are assessed. The DACUM process provides high quality information in a minimum amount of time from local businesses and industries (Samuelson, 1987). The DACUM process requires the creation of a committee of "expert workers" (Norton, 1997, p. 2) in a certain field, to identify local industry needs. Their experience as practitioners should range between at least six to eight years (Shears, 1985). This committee of experts is then facilitated through a two or three day workshop to identify core competencies necessary for a respective program or trade (Norton, 1997; Shears, 1985). While this can be beneficial when looking at a regional change or trend, it is not the most successful method for changes and advancements on a national level. Specifically, "Information available from local businesses and industries may not include the state-of-the-art technology" (Halfin & Nelson, 1982, p. 14).

One of the more common methods used by community and technical colleges to make sure programs are up-to-date is to use a specialized accreditation, certification, or national standards as the curricular foundation for their program. There are many different accreditation and certification agencies for professional

technical programs. For automotive, medium and heavy-duty truck (diesel) and automotive collision repair programs, certification is available through the National Institute of Automotive Service Excellence (ASE) and the National Automotive Technicians Education Foundation (NATEF). Veterinary programs have the opportunity to seek accreditation through the Committee on Veterinary Technician Education and Activities of the American Veterinary Medical Association. The Accreditation Board for Engineering and Technology (ABET) is another organization that offers accreditation for technical and engineering related programs at the post secondary level. In some curricular areas there are no certification or accreditation agencies, but there are accepted industry standards that can be incorporated to guide the program. In the computer and information systems curriculum, the Association for Computing Machinery (ACM) "is a major force in advancing the skills of information technology professionals and students worldwide" (Association for Computing Machinery, 2003). ACM sets the national standards for curriculum, facilities and equipment; however, they are not an accreditation or certification body. NATEF is the accreditation agency used for certification by the colleges in this study.

> NATEF was founded in 1983 as an independent, non-profit organization with a single mission: To evaluate technician training programs against standards developed by the automotive industry and recommend qualifying programs for certification (accreditation) by ASE, the National Institute for Automotive Service Excellence. (NATEF, 2007)

The use of external accreditation or certification is not new to higher education.

> Accreditation stands as a distinctive American innovation to assure quality in higher education. It was founded more than 100 years ago on the principle of peer review, meaning that those within the academy are best able to evaluate the quality of higher education institutions. In the past decades, however, both institutions and the challenges of defining and evaluating quality have become significantly more complex and come under more scrutiny. (Western Association of Schools and Colleges, 2001, p. 2).

As accreditation has evolved and changed over time, there has lately been a push to move away from a evaluation of a set of institutional standards and infrastructure towards a measurement of student outcomes.

From the academic perspective "The accreditation process functions to promote and sustain this special role for higher education, while providing assurance to the public that institutions of higher education continue to warrant public trust and support" (Western Association of Schools and Colleges, 2001, p. 4). Like its industry counterpart, accreditation and certification in education needs to focus on the process leading to the final product or output. In industry this is done using numerous quality control measures throughout the production cycle, eventually verifying success by examining the final product. Examples of how this quality control process is achieved in industry can be found in the International Standards Organization (ISO) 9000 series of certifications and the Total Quality Management (TQM) processes (New Zealand Qualifications Authority, Wellington, 1993, p. 4). The ISO standards were developed in 1987 as a tool for a

manufacturing facility and its management to gauge whether their plan for quality was, in fact, being achieved. This provided both an internal and external assurance of quality (New Zealand Qualifications Authority, Wellington, 1993).

In education, the method of measuring the processes leading up to the final product output—student learning—is a relatively new approach. For example, in the Western Association of Schools and Colleges (WASC) Handbook of Accreditation, this new approach translated into a new statement of principal: "Principle 3: Greater emphasis is needed in evidence of educational effectiveness and student learning" (Western Association of Schools and Colleges, 2001, p. 3). This approach shifted away from the old process of simply evaluating against a set of institutional standards and infrastructure when reviewing a college for accreditation. Now, testing and measuring the actual success in meeting overall student, program and institutional outcomes (developing their product) were taken into account as part of an accreditation review, as well as meeting a set of required institutional standards. "Thus, to become and remain accredited, each intuition is expected to demonstrate that it is committed to developing and sustaining Institutional Capacity and Educational Effectiveness" (Western Association of Schools and Colleges, p. 5). This is an instance where industry was several decades ahead of education. "Ongoing quality is assured through evaluation and review of quality systems once they are in operation" (New Zealand Qualifications Authority, Wellington, 1993, p. 22).

> In industry, quality is generally defined in relation to 'products' and 'services.' Internationally those definitions are being adapted to the educational culture… In the education and training context the product is: the new skills and knowledge acquired by the educated or trained person. (New Zealand Qualifications Authority, Wellington, 1993, p. 6)

Providing the service of quality in education is "the provision of an environment that enables the new skill and knowledge to be acquired" (Ibid). Program certification or accreditation in education, like its industry counterpart, provide a way for consumers (and stakeholders) of the product, which in this case are the students, parents and greater community, to "seek quality among various educational program offerings" (Industrial Engineer, 2006 p. 60).

Receiving accreditation and certification through nationally recognized standards is used as evidence for success and to demonstrate educational program effectiveness and quality. In a 1998 college accreditation self-study at South Seattle Community College (SSCC), the goal of NATEF certification by SSCC's automotive collision program was cited as part of their self-study's analysis and appraisal. "As a strategy to improve program recognition and enrollment, in 1998 extensive effort was made by the department, instructors and support staff to obtain National Automotive Technicians Education Foundation (NATEF) certification" (South Seattle Community College, 2000, p. 83). Aside from the significance colleges place on national standards in recognizing the benefits they have for their programs, some state education agencies ask if national standards exist for a program that is being proposed. In Oregon, the *State Community College*

Handbook (2000) detailed the process for a college to start a new professional technical program. One of the required forms asks: “Do national/regional standards exist for the program?” and “Is industry/association certification available for the program?” (Oregon Department of Community Colleges & Workforce Development, 2001, p. 74).

Aside from the curricular impact external standards, certification or accreditation can have on a program, by reviewing the web page and/or catalog of community and technical colleges, one can see other examples of how these accreditation, certification, and standards are utilized. In many cases, colleges use these certification- and standards-sponsoring organizations to demonstrate that they keep their programs current, and their programs are “recognized.” This recognition also can serve as a marketing tool for the programs. The web sites for Gateway Community College (http://www.gwctc.commnet.edu/about.html), Bates Technical College (http://www.bates.ctc.edu/eo/CareerTraining/pdf/ auto_mechanic.pdf), and Shoreline Community College (http://success.shoreline.edu/automfg/) are examples of how schools use specialized accreditation and certification to help market their programs by demonstrating they are certified.

Each of the agencies or organizations that offer accreditation or certification for instructional programs must keep their respective standards up-to-date. This is done through constant evaluation of the standards as changes occur in professional technical fields. However, it can be several years between the time a given change or innovation occurs in a technical field and when the standards are revised to

reflect these changes. This “time lag” can create a disconnect between industry practices and instructional programs based on these potentially outdated standards.

The time lag between innovation and changes in standards is further complicated by length of time the agency or organization accredits or certifies programs. A program may be accredited or certified for two, three, or in some cases, five years, which means that the once the standards are changed, the program may be two to five years away from their next recertification or accreditation date. The combined affect of this time lag and the length of time programs are accredited/certified could impact instructional programs, with respect to keeping their curriculum current. It also influences how students are being trained for industries experiencing rapidly changing technology. This relates back to Halfin and Nelson’s (1982) concern that program curriculum may be outdated as soon as it is developed or implemented.

Purpose of the Study

This study will focus on the industry standards developed by NATEF for Automotive, Automotive Collision and Medium-Duty (commonly called Diesel) programs, primarily at community and technical colleges. In this study these programs will be referred to as transportation-related training programs. NATEF is currently the accepted national standard and the certifying entity for transportation-related training programs. The potential impact of how these standards influence the curriculum in relation to sudden and rapid advances in automotive technology

will be studied. Industry standards are designed to reflect technological changes; the question arises as to how effective these standards are in keeping community and technical college automotive program curriculum up-to-date with technology advances. The purpose of the study is to provide a method for evaluating the effect, impact or role that (as perceived by automotive, diesel, automotive collision faculty and administrators) the industry standards—NATEF—have on the currency of a given program or program's curriculum, thus determining what role the NATEF standards have in keeping automotive programs up-to-date with current and emerging technology. For this study, automotive-related programs will be the main focus; however, as applicable, medium-duty/heavy-duty truck (diesel) and automotive collision programs will be incorporated. This is due to the significantly higher number of post-secondary automotive programs in contrast to the diesel and auto collision-related programs across the nation.

Research Context: NATEF Standards

Like many industries, the automotive industry has seen rapid changes in technology. As educationally based training programs responded to the changes and evolution in the automobile industry with curricular changes, industry also began to respond. In the 1970s, a major push was made to address the need for some method of technician certification because industry and consumers had no way to distinguish between competent or incompetent mechanics (Automotive Service Excellence, 2002). In response to this need, the independent, nonprofit,

National Institute for Automotive Service Excellence (ASE) was jointly established in 1972 by the National Automobile Dealers Association (NADA) and the Motor Vehicle Manufacturers of America (MVMA) (ASE, personal communication, February 10, 2002).

When ASE began the certification of technicians in 1972, there were only four areas of certification. Over time, the areas of certification grew to meet the changing needs of industry.

> The program has grown from a pilot of four single tests for automobile mechanics to a comprehensive offering of 40 exams for automobile, medium/heavy truck, school bus, and collision technicians as well as engine machinists, parts specialists, damage estimators, and alternative fuels/Compressed Natural Gas (CNG) technicians. (Ibid)

National Standards for Automotive Technician certification were developed in the early 1970s through the creation of ASE. Within a few years, there was a move by industry to develop certification standards for automotive training programs. In 1978, not long after ASE was created, the Industry Planning Council (IPC) determined that due to the technical changes occurring in vehicles, automotive training programs needed to be significantly improved in order to provide competent qualified entry-level technicians needed by the industry (Karbon, 1995; NATEF, 2002). By 1983, the Industry Planning Council's desire for better training evolved into the National Automotive Technicians Education Foundation (NATEF, 2002). NATEF is now the national standard by which automotive, medium-duty/heavy-duty truck, and automotive collision training

programs are certified. Secondary, post-secondary, public, and private programs request evaluation for program certification with the goal of being awarded ASE/NATEF certification.

The ASE/NATEF certification program and process was so successful that the automotive collision industry, and later the medium- and heavy-duty truck industry, asked to become part of the process (NATEF, 2002). The NATEF certification requirements have evolved over the years to address the changes in technology and the skills necessary to meet these changes (NATEF, 2002). One example of this evolution in the standards was in 1992, when NATEF began developing standards for light/medium-duty Compressed Natural Gas (CNG)/ Liquefied Petroleum Gas (LPG) programs. This initial development was funded by the U.S. Department of Energy (NATEF, 2002). By 1996 the program was fully developed and available as an optional certification area for training programs.

NATEF, which is highly regarded by both industry and education, is now the basis by which automotive training curricula are developed and measured. This high regard evolved as the recognition of NATEF evolved. A report to the NATEF board, *Report to NATEF Board of Trustees on Certification and Update Training* by Shoemaker (1989), called out the importance of state leadership in placing an emphasis on program certification to aid in improving program quality at the secondary and post-secondary level. As this was a report to the NATEF board, it was clearly in support of the NATEF certification process to meet this need to improve programs. As the momentum grew for skill standards in education in the

1990s, NATEF promoted their standards as the recognized national skill standards for automotive related curriculum. In a 1995 publication/guide, NATEF promoted very directly the adoption of their standards as the National Skill Standards—their mission stated as "Encourage state policy makers and local boards to implement the ASE/NATEF National Skill Standards in high schools, technical schools and technical/community colleges" (NATEF, 1995, p. 1). The goal of becoming the "standard" was realized by NATEF and by the mid 1990s there were a number of states that had revised their curriculum to align with the NATEF standards. An example of this was Ohio. The State Department of Education began to develop statewide recommended curriculum through a modified DACUM process. This work was done out of Ohio State University–Columbus in a Occupational Competency Analysis Profiles (OCAP). One of the curricula guides they developed in 1996 was for Commercial Truck/Equipment technician. The development of this guide was clearly based on the NATEF standards: "The Task list of the National Automotive Technicians Education Foundation (NATEF) forms the bulk of this OCAP (units 1-8)" (Ohio State Department of Education, 1996, p. 1).

The clearest example currently of this industry wide recognition of NATEF is the fact that the major automotive manufacturers, which sponsor training programs at community and technical colleges, require those colleges programs to be NATEF Master certified as a core requirement of their sponsorship. Without the NATEF master certification in the respective areas, the colleges could not offer programs like the General Motors Automotive Service Excellence Program

(ASEP), the General Motors Body Excellence Program (BSAP), Toyota's T-Ten, or the Daimler-Chrysler College Apprenticeship Program (CAP). The benchmark that NATEF certification represents also reaches into the secondary school automotive programs. The Automotive Youth Education System (AYES) program, which is a partnership for automotive education between most of the major automotive manufacturers and participating high schools, requires high schools to be NATEF certified in at least the four base certification areas to even apply for acceptance into the AYES program (Automotive Youth Education System, 2003).

Presently, NATEF master automotive certification includes eight areas that are the basis of curricular content in automotive training programs (NATEF, 2002).

- Brakes*
- Electrical/Electronic systems*
- Engine Performance*
- Suspension and Steering*
- Automatic Transmission and Transaxle
- Engine Repair
- Heating and Air Conditioning
- Manual Drive Train and Axles

*These four form the base certification that AYES requires for gauging a program's eligibility for AYES partnership.

Research Context: Technological Advances in the Automobile

Over the past 40 years, most of the change and evolution of the automobile revolved around the same core propulsion technology—that of the internal combustion engine. From the inception of the horseless carriage, the basic principles and fundamental technology have not changed. An entire transportation industry has been built around the internal combustion engine. Now this very paradigm is beginning to shift right before our eyes. For the first time in almost 100 years, mainstream mass-produced automobiles that are not powered entirely by the internal combustion engine are available. This represents a dramatic shift away from petroleum-based fuels as the main source of power to alternative systems of power generation and utilization. Given the vehicles that are now being driven on our roadways, this is a change that will only become more dramatic and impressive as the technology evolves.

By 2002 there were at least two highly sophisticated alternatively powered vehicles available for consumers—the Honda Insight and the Toyota Prius. These two vehicles operate on a hybrid power system. Both of these vehicles utilize a gasoline/electric powertrain to propel the vehicle. At the time, as Honda stated on their website (Honda Motors USA, 2002):

> The Honda Insight is the first gasoline-electric hybrid vehicle to be sold in the United States. The heart of the hybrid system is Honda's innovative Integrated Motor Assist (IMA™), which couples an all-new 1.0 liter, 3-cylinder engine with an ultra-thin electric motor for outstanding performance and efficiency. (¶ 1)

> Batteries are recharged by regenerative braking. Specifically, energy from forward momentum is captured during braking. This energy is then used to recharge the batteries. (¶ 3)

At the same time, Toyota discussed their advanced technology on the website dedicated to the Prius (Toyota USA, 2002):

> Take the Toyota Hybrid System (THS). The THS combines a highly efficient VVT-i engine with an advanced electric motor to not only power the Prius, but also recharge the vehicle's batteries, thanks to an ingenious generator and regenerative braking system. This means the Prius never needs to be plugged in for recharging. Overseeing all this is Prius' Advanced Control System (ACS) which monitors each system component to maximize fuel efficiency and minimize emissions. Add in an electronically controlled continuously variable transmission (ECVT) and you'll wonder how all this technology fits under the hood. (¶ 1)

The Honda and Toyota vehicles are just two examples of the technological advances in the automotive industry. Other examples are the fuel cell vehicles being tested by Chrysler, GM, Ford, Toyota, Nissan, and Honda in some fleets across the U.S. (CNN, 2007; Stoffer, 2003). Electric, hybrid, and fuel cell powered vehicles use a combination of either internal combustion, mechanical, or chemical electrical generation and/or storage batteries to fuel the propulsion of the vehicle. The prototype trials of totally electric vehicles powered by fuel cells are based on technology that comes directly from developments in the space programs. Presently, major automotive manufacturers are testing some form of fuel cell powered vehicle (CNN, 2007; Stoffer, 2003). The advances are not just in automotive; they are also in the other areas certified by NATEF. One recent example in the medium-duty/heavy-duty (diesel) area is the recent use of

diesel/electric Hybrid busses by King County transit in Seattle (King County Transit, 2004).

For many years there has been research into proposed changes in the fundamental basis of automotive propulsion, as well as talk of alternative fuel sources. But until recently, nothing has been presented to the mainstream automotive public in the form of a mass-produced, readily available vehicle, and alternatively powered vehicles have only been released as limited prototypes and trials. However, by 2002 this was no longer the case, thanks to Honda and Toyota two mass-produced Hybrid automobiles were available to the public. At the time this dissertation was completed in 2007 there were Hybrid vehicles lines available from Ford, GM, Mazda and others. This increase in popularity of the Hybrid automobile resulted in Hybrids accounting for 2% of the total vehicles sold in the U. S. in 2007 (WGAL, 2007, retrieved from the internet). While Hybrids are becoming popular, they are just a step in the progression of automotive technology. According to Thomas Stephens, General Motors Powertrain Vice President: "Hybrids are a medium-term bridging strategy to the hydrogen economy" (Truett, 2003, p. 41). The hydrogen economy Stephens is referring to is fuel cell technology. The next phase in the evolution away from internal combustion as the sole power source for the automobile is fuel cell technology. Stephens stated that "hybrids will carry the load until fuel cell vehicles are viable around 2010" (Ibid). By 2003 both Honda and Toyota had already placed a limited number of prototype fuel cell vehicles in California fleets (Stoffer, 2003, p. 4). In late 2007 GM and

Honda were testing hydrogen powered internal combustion vehicles in a few U.S. markets (CNNMoney, 2007a).

If we look at the impact of these new technologies, the focus on where technology is taking us becomes apparent. With the recent examples of the Prius and Insight, conventional hydraulic brakes are no longer the main braking system. Regenerative braking systems have already taken a prominent place on the new electric and hybrid cars. They have not replaced hydraulic brakes, but they do perform a significant portion of the braking. The regenerative braking system does not rely on conventional hydraulics to slow the vehicle, as discussed in an article by Morrison and Eccles (2001): “Another tool available to HEV’s (Hybrid Electric Vehicles) is regenerative braking. It recovers the energy used to slow down or stop a vehicle” (p. 2). The regenerative braking system operates by creating resistance to motion (wheel turning) through magnetic forces, which in turn creates an electrical generator. The generator converts braking energy back into electricity that is directed into the storage batteries. Therefore, the hydraulic brakes, brake lines, brake pads, brake calipers, and rotors are no longer the only braking system; rather they have become a secondary system to aid in stopping the vehicle, backing up the regenerative braking system. Instead of just a hydraulic braking system, one now finds sophisticated circuitry and computer controlled magnetic inverters alongside the conventional hydraulic braking system.

On these Hybrid vehicles, and many prototype vehicles slated for production over the next five to ten years, one will find quantum leaps in

technology. According to Automotive Engineering International (2000), Delphi Automotive, a major manufacturer and developer of automotive control systems, envisions an influx of even more advanced technology. In a few short years there will be advances in technology leading to:

- Radar based collision avoidance systems
- Mobile multimedia
- Advanced thermal comfort
- Drive by wire

The collision avoidance system Delphi referred to is a radar-based system which is well out of the norm for traditional technology encountered by automotive technicians and students repairing and diagnosing vehicles. According to Sperling, head of the Institute for Transportation Studies at the University of California, Davis “We’re on the cusp of a technological revolution in the automotive industry” (Evarts, 2000). In part, it is the potential effects this cusp could have on training programs that are addressed in this study. As we lead up to the research questions in this study, some of the questions addressed are: (1) how is this “cusp” being addressed in the curriculum of transportation programs that are NATEF/ASE certified, and (2) what role do NATEF standards have in keeping transportation training programs up-to-date with current and emerging technology.

Significance of the Study

There are almost 2,000 schools in the U.S. using NATEF certification for their training programs, and out of those 2,000 almost 700 are post-secondary automotive, medium-duty/heavy-duty truck, and automotive collision programs. Out of that 700, over 500 are certified specifically in automotive (NATEF, 2003, personal communication), with only about 200 total certified in medium-duty/ heavy-duty truck and automotive collision. With the technology advancing as rapidly as it is, there is a need to determine what role the NATEF standards have in keeping automotive training programs up-to-date with the current and emerging technology. What currently exists in the literature only relates the effects NATEF has on the outcomes of automotive programs with respect to job satisfaction and success by students on the voluntary national technician certification exams—the Automotive Service Excellence exams (and will be discussed in Chapter 2). There is nothing readily available on the relationship between the ASE/NATEF standards and if, or how, the ASE/NATEF standards aid in keeping the curriculum for automotive programs current, including the issue of keeping programs up-to-date with current and emerging technology.

There is no doubt that technological advances expected in the next 10 years will require community and technical college training programs to adapt, develop, and enhance their curricula to meet new developments in technology. One could easily surmise that, to diagnose and repair new braking technology, drive systems, and power systems, a student might need to understand the basics of

electromagnetism, direct current (DC) motors, as well as DC generators, inverters, and the chemistry behind fuel cell technology. As we move into the age of Hybrid vehicles, fuel cell powered vehicles, and electric vehicles, the next challenge to the automotive and transportation training community is how to meet the new training needs presented by these modern technologies, which are taking us away from internal combustion as the sole source of power.

The need for a study that evaluates how these national standards influence the curriculum in relation to sudden and rapid advances in technology comes about because of the dramatic paradigm shift that is just beginning in the technology which propels the modern automobile. The transportation training community needs to insure that the standards for training curriculum keep pace with current shifts in technology. Of the almost 700 post-secondary programs across the nation certified by ASE/NATEF, many of them state, or imply, that the NATEF standards are the established curricular base for their programs. This is evident in their literature, marketing materials, catalogs, and websites. These materials state that their programs are either based on the ASE/NATEF standards or certified by ASE/NATEF. In Oregon and Washington alone, there are 29 community and technical college programs that are ASE/NATEF certified and according to their websites, most all of them use it (ASE/NATEF) as a foundation for their curriculum. The significance of this study relates to how effective these standards are in influencing the curriculum and its perceived currency. As noted above, this

issue has not been addressed by the automotive industry or the educational institutions affiliated with NATEF.

With respect to the need for this study, it is not a question of "if" the predicted and prototype technology will come to pass, but when. Already, some predictions of an impending technological innovation from the early part of the 1990s have been incorporated into present vehicles. Garfinkel (1993) related the fact that in 1993 designers and engineers were developing electric vehicles that use individual "switch reluctance hub motors, which double as regenerative brakes so that slowing the car down would recharge the battery" (p. 12). This very advance, which was predicted in 1993, has already been implemented in both the Honda Insight and the Toyota Prius. That leads to the questions: Has this advanced technology been addressed in community and technical college automotive training curriculum? And, have technological advances been incorporated into the national standards?

Broader Implications for Community and Technical Colleges

As discussed earlier, the transportation training programs are just one of many disciplines in professional technical training programs at community and technical colleges that face constant technological change. Professional technical programs like computing technology, electronics technology, veterinary technology, and building construction must work to keep their programs current as changes occur. In this study, the researcher will extrapolate out from the program

and curriculum level and take the concerns of Halfin and Nelson (1982) for "Providing education and training consistent with business and industry practice is a major challenge for vocational education" (p. 1) one step further with respect to the possible implications on the accreditation and certification standards themselves. One might ask, "Why do this?" The answer is that with so many programs across the nation training future transportation technicians, computer information technicians, veterinary technicians, aviation mechanics, and many other various fields, there is a need to determine if the industry standards, against which they measure themselves, are keeping their programs up-to-date. Are they meeting the needs Halfin and Nelson (1982), Parks (1996) and Crunkilton and Finch (1999) stated? This research project tries to answer that question using the focus on automotive certification standards as a vehicle for this process, and incorporating medium-duty/heavy-duty truck and automotive collision as available or applicable. The outcome of this study could be a model for further research in other technical fields. Part of the premise behind this study comes from recommended future research in a study entitled, *Attitudes of full-time and adjunct electronics instructors in Texas community colleges towards technical skill standards* (Davis, 2002). Davis suggested that future research "should be conducted to determine attitudes towards skill standards established within other technical areas" (p. 100). While Davis is suggesting that "attitudes" be studied, this study suggests that rather than "attitudes," experience with and perceptions of the

national standards (which in the case of automotive are the skill standards) in keeping their curriculum current, be studied.

Research Questions

- What do community and technical college automotive programs use as a basis for their automotive curriculum?
- If community and technical college automotive programs use the NATEF standards as the basis for their curriculum, how much of their curriculum exceeds the NATEF standards?
- How are recent and anticipated advances in automotive technology incorporated into the curriculum?
- Are the NATEF standards perceived as being sufficient to maintain program quality, relevance, and currency with respect to technological advances?

Researcher's Perspective

My own personal experience draws me towards this research. I have spent over 25 years in various roles within the automotive and transportation industry. These roles have ranged from automotive technician, truck technician, automotive specialist, automotive trainer, community college automotive instructor, department head, technical services manager, Associate Dean, Division Dean and Campus Vice-President & Dean. I am ASE certified as a Master automotive

technician and a Master truck technician, as well as an evaluation team leader (ETL) for NATEF. In the ETL role for NATEF, I've led certification teams that have visit automotive and truck programs seeking NATEF certification for the past decade. For five years I was a Division Dean of the Mathematics, Manufacturing and Transportation division in a large multi-campus urban community college district. Currently I am the Campus Vice-President & Dean for a regional campus in a multi-campus institution. My background gives me a focused perspective on the transportation industry. My expertise in this field is an integral part of this study. It is in part due to my own "personal and professional experience" (Corbin & Strauss, 1990, p. 35) that I am undertaking this research. As I have interacted with automotive training programs over the years, I have often wondered about the relationship and/or effect the NATEF standards have on curriculum development in respect to advances in technology.

CHAPTER 2

REVIEW OF RELATED LITERATURE

The literature review covers six core areas, with a primary focus on automotive literature and a secondary focus on non-automotive related literature. The bulk of the initial literature review will focus on "automotive and technology matters." Then the literature review shifts from reviewing what brought us to where we are today, and the literature review broadens out to research the issues with respect to other professional technical and curriculum related literature. The following areas of literature are reviewed in this chapter are: (1) the last 40 plus years of history related to automotive technological change and development; (2) the history and development of the current automotive certification standards; (3) how professional technical programs keep their curriculum up-to-date; (4) how, specifically, technological advancement and change have effected automotive program curriculums; (5) examples of what the literature says drives curricular change at community and technical colleges; and (6) the measurable effects of ASE/NATEF certification for automotive programs.

A History of Automotive Technological Change and Development

The introduction of the automobile a little over 100 years ago radically changed the face and ecology of the world. You can now get into your car and drive across the United States in as little as three days, something that once took

wagon trains months to accomplish. In the short lifetime of the automobile, it has changed dramatically as technology has advanced. The automobile, once known as a horseless carriage, appeared in crude forms in the late 1800s (Allen, 1984). Its development was made possible by the 1876 invention of the four-cycle internal combustion engine by N. A. Otto. The four-cycle engine went on to propel the gasoline powered automobile (Aldrich, 1955). This type of engine is still the main power source for today's automobile.

Since those early times, there have been advances in the construction of the car, its manufacture, and assembly of the major components (Allen, 1984). For example, tires evolved from wooden wheels to today's run-flat tubeless tires capable of over 150 miles per hour operation. The mass produced car of today is nothing like those which first rolled off Henry Ford's assembly line in the early 1900s; it has evolved into a very sophisticated machine. When the first cars rolled out of the small factories that produced them, only a few actually came equipped with a windshield, heat, a roof, or windows. It was little more than a horseless carriage with crude seats, doors, wheels, and if you were really fortunate, electric headlights. Now, a little over 100 years later, cars have advanced dramatically, both in the powertrain and the auxiliary systems throughout the car. Some of these auxiliary system advances include integrated computers and communication, satellite navigation, heated seats and mirrors, as well as satellite radio.

Not all of the advances have just been the incorporation of newer creature comforts for the driver and passengers. Over the last 40 years, advancement has

been very fast-paced, in part to meet tougher environmental requirements. “The EPA has mandated numerous air quality programs” (Watson, 2001, p. 2), programs that have forced the automotive industry to design and build more sophisticated vehicles to meet the tougher EPA standards. According to Henich (1986) “The automotive industry experienced the introduction of microprocessors to control both ignition and fuel systems” (p. 18). The computer, which was used for fuel, ignition, and emission control was introduced in the early 1980s (Henich, 1986). Prior to the introduction of the microprocessors in the automotive industry “changes in the industry were slight, but afterward changes were rapid and intense…” (Henich, 1986, p. 19). However, since the early beginnings of the automobile, the majority of the technology that powers the car is still very closely related to its earlier cousins. The engine is still very similar in principle to Otto’s engine, and the principle and components of the braking system and drive train are also very closely related to past cousins. As these changes and advances in automobile technology took place, they had an impact on automotive training. Automotive training and curriculum has evolved along with many of the major technological changes in the automotive industry.

As the automobile evolved, automotive training and training categories also changed and developed. Automotive service training has been a part of both secondary and post-secondary education almost since the introduction of the automobile. As many of the changes in automotive technology discussed in Chapter 1 have progressed, there have been a number of studies and projects related

to the effects of automotive technology changes on education, which are discussed in this chapter. The earliest study this researcher was able to find is Aldrich's 1955 thesis, *A Study of Automotive Mechanic Education with Suggestions for Improving Industrial Arts Automotive Programs in Oregon Secondary Schools*. This study examined issues of advances in automotive technology faced by automotive training programs. Aldrich made an observation that still echoes today:

> Many school programs have lagged behind the technological development of the industry they are attempting to serve. New buildings and expensive equipment are not the answer. The solution is largely a matter of what is taught and the manner in which it is presented. (Aldrich, 1955, p. 5)

This speaks to the heart of the issue—even during today's automotive technological evolution, the industry standards for curriculum and training must change. Aldrich also reviewed the history and time line for change in automotive training, starting with a discussion of A. L. Dykes' automotive instructional materials, which originated in Detroit, Michigan in 1903. One of the first automotive training programs was established in Detroit for the Army in 1918. This program was created to assist in the training of mechanics for the Army's new ambulances. By 1920, Cass Technical High School in Detroit had organized a four-year curriculum around automobile mechanics. In Oregon, the oldest training program for automotive started in 1914 at Portland's Benson High School (Aldrich, 1955).

Across the country, automotive training developed to keep pace with technological advances in the automotive industry and to "standardize the

education of apprentices" (American Association of Community Colleges, 2001). Some programs were based in the public secondary school systems, and were later transferred to community and technical colleges. Wisconsin's automotive training began in 1913 at vocational schools in Marionette and Green Bay (American Association of Community Colleges, 2001). For many years, local secondary schools, preparatory training institutes, and colleges offered some form of automotive service training program. Today these programs "train students to be dealership and independent technicians, service managers, vehicle and equipment sales people and machine shop operators" (Ibid).

By the 1960s, a period of rapid growth, the community, technical and junior college mission had expanded to include transfer, vocational/technical, developmental, community service, and economic development functions (Wallin, 1996). "At the Community/Junior College occupational education included courses two years in duration or less" (Thorton, 1972). Examples of this growth can be seen in both Washington and Wisconsin. In 1967, Seattle's Edison Vocational-Technical Institute, part of the Seattle Public Schools District #1, was incorporated into the newly formed Seattle Community College District. Many of Edison's "Trade/ Vocational" programs and courses were folded into the newly forming community college system (South Seattle Community College Office of Instruction, Memorandum: C.A. Bradley, 1977). Washington's community colleges were taking on the role of career and technical training during the 1960s and soon they were issuing terminal degrees and certificates for the vocational/technical fields.

Three schools in Wisconsin (Green Bay, Marionette, and Sturgeon Bay) began as vocational schools. Later, they became core campuses for Northeast Wisconsin Technical College (American Association of Community Colleges, 2001).

As educational training programs evolved and changed, industry-based training also changed. According to Jim Akin, the former Training Manager for the General Motors Tarrytown, New York, training facility, "The onslaught of microprocessors and computers has changed our training dramatically over the past four decades" (Laabs, 1995, p. 12). As the implementation of tougher emissions standards were phased in, the technology levels increased in automobiles to meet these stricter regulations; thus, many of these advances came about to meet environmental concerns. These regulations began in the late 1960s and evolved through the 1980s (Ross, 1998). In the 1990s, the EPA enacted rules requiring even stricter emissions requirements. This was called the Clean Air Act of 1990. The act had major technological ramifications on the automotive industry—it called for the drastic reduction in noxious emissions from automobiles. This act set forth a strict implementation timetable for 1992 through 2001 (CheckChart, 1994).

Most of the changes and significant advances in automotive technology were driven by the need to meet the strict requirements of the Clean Air Act. The fundamental principles of Otto's internal combustion engine as the power source for the automobile had not changed; rather the technology that controls the operation of this type of engine was significantly advanced to meet the tougher environmental laws and requirements. These advances in technology took the form

of sophisticated computer systems, as previously discussed. The purpose was to control the emissions and output of the internal combustion engine. The computer systems precisely control the gasoline vapors that accumulate in the fuel system, keeping the vapors from escaping. The actual combustion in each cylinder of the engine is controlled to minimize the harmful emissions and increase the efficiency of combustion, thus increasing fuel economy and decreasing environmental impacts. In order to incorporate such controls and computer systems, the typical under-the-hood technology had to advance significantly. Most of the technologies involved were not part of mainstream thought in automotive circles just a few decades ago. The advances did not stop with the powertrain systems under the hood. Besides the traditional, under-the-hood technological advances, 21st century cars are often equipped with “heated seats and windshields, cell phones, computers with internet access” (Siuru, 2001, p. 8), and that does not include modern computerized control systems operating the various other systems of the car, which will be discussed later in this study. With such advances, the fundamental framework for how automotive training was conducted had to change.

Until the 1960s, not much had changed in the basic automotive technology and training arena. The car still had the same basic components, and training programs reflected this in their training categories and curricula. As far back as 1955, Aldrich, in his thesis, discussed a core curriculum and training approach that revolved around very similar areas, such as [then] current automotive standards. The study covered the following main automotive systems: Engine, Transmission,

Fuel, Electrical, Brakes, Steering and Suspension. A later breakdown of suggested curriculum content areas for automotive training published by the U.S. Department of Health, Education, and Welfare (1965) covered Electrical, Fuel, Steering, Suspension, and Brakes. Over time, the content of automotive training and curriculum adapted and grew slowly to meet the changes in vehicles and the technological evolution of systems on these vehicles. At the time of Aldrich's thesis, the specific units which made up automotive training were: Tools, Automotive Equipment, Automotive Components and Physical Principals; the Engine; the Fuel System; the Electrical System; the Clutch and Transmission; the Powertrain; Brakes, Steering and Suspension; Body Work (which became its own training program area); Service Station work; and Tune-up/Complete analysis. The subsections of these categories in his thesis showed the minimal nature of these "areas" in respect to today's technology. In its time, this study was considered "cutting edge." Yet, the suggested guide for a training course put out by the U.S. Department of Health, Education and Welfare in 1965, a decade after Aldrich's thesis, had a very similar curricular training unit category approach. The main headings for training categories in 1965 closely matched Aldrich's 1955 categories. Up to this point, with slow technological advances, training categories changed little.

The rapid speed of technological change and innovation in automobiles began at the end of the 1960s in response to a variety of circumstances, including

fuel economy, environmental concerns, and passenger safety (Allen, 1984). Many advances in the 1980s and 1990s were “driven by the market preference of customers, by regulatory requirements related to clean air, safety, and fuel consumption; and by the powerful progress of technology” (Ross, 1998, p. 92).

As these advances occurred in the automotive industry, training programs had to adapt to the new technologies. “As early as 1970 the National Automobile Dealers Association (NADA) recognized that changing automotive technology created a need for more technically skilled mechanics to repair and maintain newer model cars” (Cantor, 1993, p. 6). Until the mid 1970s, the curricula of very few automotive training programs included topics such as emissions controls, electronics, and exhaust gas emissions analysis. Prior to this time, most training programs taught the basics, such as engines, brakes, transmission, air conditioning, body, electrical, fuel, and steering and suspension. There was no need for anything beyond the core technical training.

By the late 1970s, electronics and computer systems began showing up on a few automotive product lines. Domestically, some of the first engine fuel management systems went into production on California engines in 1978. This electronic control system controlled the fuel metering in the carburetor (Allen, 1984; CheckChart, 1994, p. 161). According to CheckChart (1994), European manufacturers were ahead of the United States in this electronic engine and fuel control systems. By 1977, Bosch introduced an electronically controlled fuel injection system on a Volvo. In 1981, General Motors began producing passenger

cars with the first generation of full-fledged computer-controlled engine and emissions systems, known as the CCC, or C-3 (CheckChart, 1994). The production of these vehicles began the integration of advanced electronics within the automotive service and repair business, making them more challenging to service and repair. The need to keep abreast of technological change in the automotive industry became pressing. By the late 1980s, most passenger cars had more computing power onboard than the Saturn V rockets used for lunar missions. (Apollo Guidance Computer, 1966; CheckChart, 1994). The advances in technology kept coming. By the 1990s, according to the former CEO of General Motors, Jack Smith, “Education programs are not keeping pace with the ambitious auto engineers” (Dykman, 1997, p. 36). In a speech delivered to U.S. automobile dealers in 1997, Smith expressed his concern about the lack of skilled technicians to service all the rolling computers on the road today (Dykman, 1997). Smith went on to say that “education programs are not turning out graduates for the jobs of the future” (p. 36). He was referring to the tremendous leaps in technology the automotive industry was (and still is) taking. At the time of Smith’s speech, California’s mandate for low emission and zero emission vehicles was scheduled to come into full effect in 1998 (Keyzer, 1995). In part, this mandate jump-started the drive toward the advancements we are now seeing in the automotive industry.

The Development of the Automotive Certification Standards

It was the rapid technological advancements and the strain they put on the ability to find competent and qualified technicians that caused the development of certification standards for automotive technicians, standards which later became the foundation for the NATEF standards. As education dealt with the changes in automotive, the automotive industry also began to respond to changes. In the 1970s, an effort was made to address the need for some method of certification for technicians. In 1972, the National Automobile Dealers Association (NADA) and the Motor Vehicle Manufacturers of America (MVMA) joined forces to found the National Institute for Automotive Service Excellence (ASE) (ASE, 2002). Until the early 1970s, consumers and industry had no way to distinguish between competent and incompetent mechanics. In response to this need, the independent, nonprofit National Institute for Automotive Service Excellence (ASE) was established (ASE, 2002). When ASE was created, there were only four areas of certification. Over time, the areas of certification grew to meet the changing needs of industry. At present, there are over 40 areas of ASE certification available (M. Lawson, ASE, personal communication, February 10, 2003).

At this point in the 1970s, there was a growing, nationally accepted standard for technician certification. Shortly thereafter, a movement began to develop certification and curricular standards for automotive training programs. In 1978, the Industry Planning Council (IPC) determined that, along with all the technical changes occurring in vehicles, automotive training programs needed to be

improved significantly in order to provide skilled entry-level technicians. By 1983, the Industry Planning Council's desire for better training evolved into the National Automotive Technicians Education Foundation (Karbon, 1995; NATEF, 2002). NATEF, as it is called in the industry, became the national standard by which automotive training programs are certified. In some states ASE/NATEF certification is required for state funded automotive programs — Ohio is one example of this (Wiblin, 1993).

The NATEF certification requirements and standards have evolved since their initial inception to address changes in technology, and the skills necessary to meet these changes (NATEF, 2002). The original NATEF certification specialty areas (which were only in automotive) are listed below. They are followed by a list of the current NATEF automotive, medium-duty/heavy-duty truck, and automotive collision certifications. As NATEF developed and grew, standards for medium-duty/heavy-duty truck and automotive collision were added (NATEF, 2003, personal communication).

Original NATEF automotive certification areas:

Engine Repair

Automatic Transmission/Transaxle

Manual Drive Train and Axles

Suspension and Steering

Current NATEF certification areas:

Automotive –

- Brakes
- Electrical/Electronic Systems
- Engine Performance
- Suspension and Steering
- Automatic Transmission and Transaxle
- Engine Repair
- Heating and Air Conditioning
- Manual Drive Train and Axles

Medium-Duty/Heavy-Duty Truck –

- Diesel Engines
- Suspension & Steering
- Brakes
- Electrical/Electronic Systems
- Preventive Maintenance
- Gasoline Engines
- Drive Train
- Heating, Ventilation & Air Conditioning
- Hydraulics

Automotive Collision –

- Paint Refinishing

Non-Structural Damage Repair

Structural Damage Repair

Vehicle Mechanical and Electrical System Repair

Many present day automotive, auto collision, and truck training programs design their curriculum around the NATEF/ASE standards. As of June 2003, there were 1,995 schools using NATEF certification for their training program, and out of those, almost 700 were post-secondary automotive, truck, or auto collision programs (NATEF, 2003, personal communication).

The NATEF standards and tasks for each area of program certification (i.e., auto, collision repair and medium-duty/heavy-duty truck) are collaboratively developed by NATEF, industry professionals, technicians, and educators. Every three years, representatives from the major manufacturers and aftermarket suppliers are invited to participate in a seminar to upgrade the standards.

NATEF invites a group from industry and education to meet in seminar format to review and update the standards. In these seminars, which are three days long, some participants from the last revision seminar three years ago are brought back to keep continuity, and new representatives are brought in for fresh perspective.

> All major manufacturers related to the standards being reviewed and aftermarket suppliers are sent an invitation to participate. Not all who are invited send a representative. Technicians are also selected and invited. ASE provides the technicians' list for

> invitation. The representatives from education are NATEF ETL's. There are also representative from the NATEF and ASE boards at these seminars.
>
> The group reviews the current standards and evaluates where changes might be necessary in the task lists. This is done by referencing the existing ASE certification category tasks that are used to generate the ASE test questions. These tasks are then compared to the NATEF tasks. This forms the basis for how NATEF tasks are updated. As older, less important items are identified they are moved from higher priority task requirements to lower priority. Thus a Task that might have been a P-1, moves to a P-2 or P-3. As new technology is introduced by the group it usually starts as a low priority task (P-3). Part of the role of the education representatives at this seminar is to balance the needs of industry with the realities of education. While industry might desire a task or training, it might be out of the fiscal realm for education, or it might not be prevalent enough yet to merit inclusion in the standards/tasks. Let's say Honda had a specific technology that they wanted an item or task for, but no other manufacturer incorporated it in their products. Then it might not be included. (M. Hutchinson interview, January, 24 2003)

Since the basis for the development of the tasks is based on the ASE test question tasks, there is an inherent two-year time lag built into the process. Both ASE and NATEF use a similar format for developing their test questions. The process is described by ASE President Ronald Weiner:

> ASE test questions are created in workshops all across the nation, with content specialists—including working technicians, trainers and OEM representatives—whose specialty is dealing with advancing vehicle technology. ASE's tests are designed to reflect a national fleet of about two years behind the most current model year. This is so the independent technician is not disadvantaged, as they might not see a new product for several years, until it is out of the warranty cycle. (ASE, email memo, February 2003)

Keeping professional technical programs current in a world of technological change

Adapting to change and keeping professional technical programs and their curriculum up-to-date is a difficult task for community and technical colleges. Technological advances which drive curricular changes are not just an automotive issue; many other fields have experienced rapid technological advancement. While this study focuses on the issues within the automotive programs, there are many other disciplines that face similar issues. In a 1987 paper titled *Developing a Curriculum in Response to Change*, Samuelson offered a guide to post-secondary educators for adapting technological changes into curriculum. She stated: "If vocational-technical education is to remain relevant, educational institutions must be responsive to change in technology used by business and industry. Processes for monitoring new and emerging skills must be refined" (p. 1). She identifies ways that post-secondary institutions can respond to change. One of her questions was: "When should a post-secondary institution initiate a training program to meet the need for new skills and knowledge that emerge as new technology is used on the job?" (p. 23). She proposed three modes for adapting to technological change: The Early Response Mode, in which a school steps out ahead of the curve and begins developing curriculum and programs before the technology makes it to their region; the Fast-Follow Response Mode, where an institution responds soon after new technology is adopted by local users; and the traditional Delayed Response Mode. This Delayed Mode is very similar to the method used to develop the NATEF

standards and much of the curriculum development in the post-secondary setting. In the Delayed Mode, the educational institutions wait to respond with curriculum and programs until the technology is well established in the region (Samuelson, 1987).

When evaluating new technology and its possible impact on post-secondary programs, Samuelson (1987) suggests educators evaluate the potential impact on their region as a result of these technological changes, by asking the following questions (p. 25):

1. Is the technology generic or just for a few limited applications?
2. Are larger organizations or smaller firms going to be the early adopters?
3. How rapidly is the innovation being adopted in other regions?

Without such questions, the impact of technological change on a region and/or educational programs cannot be gauged.

From another perspective on change, one of the issues facing professional technical education is how we see ourselves. Our philosophy has been that "vocational education programs and curricula have been based on what workers presently do in their jobs" (Halfin & Nelson, 1982, p. 23). As educators, should we do what Samuelson discusses in her Early Response Mode? Does the curriculum of professional technical programs need to be on the forefront, incorporating the latest technology into our programs? Should programs also take this approach with the standards on which they base their curriculum? As Halfin and Nelson point out, our current methods of teaching what workers currently do will suffice as long as the

skills necessary on the jobs are stable (p. 23). What happens when the advances in technology greatly surpass the stability of the skills, the *status quo*? This situation risks not placing educational programs in a position where they can aid business and industry transition to new technology (Halfin & Nelson, 1982). This brings one back to the issues raised in the introduction of Chapter 1, to what Parks wrote about in his 1996 paper *Technical Education & Training in the 21st Century*: "The challenge facing technical education is how to design standards that satisfy the needs of business and industry, while simultaneously addressing the expectations of the academic community" (p. 20).

Studies done on keeping automotive programs current in a world of technological change and evolution

With all the change and advancement in the automotive industry over the past 40 years, a number of studies have been done to evaluate the potential curricular and training impact of these changes. In a study specifically focused on the impact of technology on Hawaii's automotive mechanics, Allen (1984) pointed out a number of reasons why changes and adaptations are necessary to keep Hawaii's automotive programs current. To ensure the continuing responsiveness of vocational and job training programs to employers' needs, "educators have become increasingly interested in understanding the impact of new technologies on the automobile repair industry" (Allen, 1984, p. 1). Allen asked, "What are the implications of these developments for the way in which automobile mechanics are

educated? What steps can secondary and post-secondary institutions take to meet the needs of a changing automobile repair industry?" (p. 1). Allen suggested that the University of Hawaii conduct "content identification and validations surveys… to reflect recent technological innovations in the field" (p. 25). This recommendation lead to the conclusion that there was a gap between the then current training categories and the technology that was on the road at the time of the study.

In a paper edited by Jaffee, Oglesby and Drewes (1982), the major and newly emerging technological advances expected to impact technical occupations were reviewed. One of the occupations covered was automotive technology. They looked for "evidence that the [new] technology is currently being used in the 'real world'… that is not 'still on the drawing board'... and must 'impact skills within the training domain of vocational educators'" (Jaffee et al., 1982, p. 14). One of the contributing sources to this project identified some of the changes that were to come. "The sweeping changes that are under way will be reflected in the need for new skills" for those who will be repairing the cars to come (p. 54). Some of these changes were going to be smaller engines, turbo charging, and greater emphasis on electronic control of engine, drive train, and entertainment systems (p. 55). Because of the modern technological changes and developments, the possibility of new curricular and training requirements for "the auto service trade" was discussed (p. 59). This discussion even reached to cover such topics as electric cars and alternative fuel.

In a more recent qualitative study, Keyzer (1995) studied the awareness of the impact that the California Air Resource Board (CARB) mandate for zero emission vehicles would have on community college automotive programs and their curricula. Specifically, he studied the level of awareness/impact of advances in automotive technology of this new mandate. From 1994 through 1995, 76 California community colleges with automotive programs were sent surveys; 49 usable responses were received.

The framework behind this study was that at the time of the research a mandate for zero emission vehicles was put into place by CARB. By 1998, 2% of all vehicles sold in California were mandated to be zero emission vehicles. Keyzer was trying to determine just how prepared the California community college programs were for this shift in automotive technology. He stated: “Our educational system must act immediately to adequately train mechanics to service electric vehicles” (p. 4). His study proposed researching the level of awareness community colleges had at that time about the impending change in the educational system with respect to the advanced technology on electric cars and low emission vehicles.

A major conclusion from this research was that the mandates from CARB would affect the California community college automotive programs, yet most programs were not even aware that this mandate existed. Those that were aware were not preparing to implement changes to accommodate the coming need.

The previous two sections discussed some of the reasons behind why professional technical programs need to incorporate changes based on

advancements in technology. These changes could in effect be curricular changes. That leads to the question “What does the current literature reveal about the driving forces for curricular change in community colleges?”

What is driving the need to change our curriculum in community and technical colleges

“The rate of technological change and its potential impact on vocational-technical curriculum are phenomenal” (Losh, 2000, p. 16). Because of the potential for change, Losh suggests that the curriculum must always be reviewed and revised on an ongoing basis. To do this, there are various reasons for curricular change and methods that can be used to keep the program curriculum current. The reasons for change can vary from a need to meet a new standard; the needs of industry; to build an articulation agreement with another school; as part of a periodic program review; or because a governmental agency mandates it. The tools to develop the change can range from Advisory boards, program reviews, DACUM’s, and the incorporation of specialized accreditation, certifications, and industry standards.

In reviewing the literature for outside factors that were driving curricular change, external standards were found to be a strong force in changing curriculum. This was evident in a dissertation studying curriculum revision. Hertel (1998) found that a driving force behind a curricula revision for general education curriculum was an impending change with the North Central Association of Colleges and Schools (NCA) standards. The “Revised NCA standards provided

incentive for the college to redefine its general education offerings" (Hertel, 1998, p. 36). This overt desire to change a college's curricular content of their degrees was driven by a standards change. Changing standards, for accreditation, industry standards or skill standards, can potentially exert a strong influence on the life cycle of a curriculum. The effect and/or outcome on a curriculum, regardless if it is an academic one or a professional technical one, can be the same.

> Implementing curriculum reform grounded in outcomes (with standards and measures) and integrated competencies (to integrate academic with technical knowledge and skills) provides a framework for reforming public community technical college education to align with individual, workforce, and social needs." (Miles, 1997, p. 28)

Legislative (State and Federal) processes can also have an impact on curriculum. Miles's (1997) dissertation studied *Factors Influencing Curriculum Reform In A Community College System*. In it, she studied the perceived internal and external (perceived by faculty and administrators) factors that drove and effected curricular reform. The actual driving force for change was the implementation of the Carl Perkins act of 1990. She found that in order to implement new standards (which would cause curricular change) "there needed to be a commitment from the institution" (Miles, 1997, p. 231). Further, the effect of so many internal and external factors driving curricular changes lead to what was termed "policy lurching" (p. 229). This lurching of policies affected the changes and development of the curriculum as the New Hampshire Community Technical

College System tried to implement legislative policies like the Carl Perkins act of 1990 (Miles, 1997).

In another study focusing on the State of Texas, Davis (2002) was looking at the perceptions of part-time faculty in respect to technical skill standards. He cited policy decisions within the state which drove curricular change and reform. He found that desire to build up the economic viability of Texas formed a policy change, which later became a legislative change. In Texas, it is said that economic growth and prosperity is highly dependent on an educated workforce and programs that are designed to educate workers (Texas Higher Education Coordinating Board, 2000), thus external factors certainly were effecting curricular change. This state mandate for better education using skill standards was a goal initially identified as a high priority by the Texas Strategic Economic Development Plan (Davis, 2002). Due to this state effort, Davis found that "to meet the needs of the electronics industry, education institutions must align their programs of instruction to validated technical skills standards" (Davis, 2002, p. 4). This alignment is clearly the external effect of a state policy aimed at driving curricular change and reform.

The changing of a community college mission can also drive curricular change. In his doctoral dissertation, Hertel (1998) found that in respect to curriculum development (which can be driven by need for change) "curriculum development topics included the changing role of the two year college mission…" (p. 20). Here the mission of a college, which is driven by the needs of its greater

community, are found to be a factor (external) effecting curricular revision and change.

The measured effects of ASE/NATEF certification standards for students and programs

Since the time the ASE/NATEF standards were created and implemented, a number of studies have been done on the measurable effects these standards have had on student learning and ability. The most easily measurable test has been student success on standardized automotive knowledge exams (such as ASE exams and others). In a third party summative evaluation of the standards established by the National Institute for Automotive Service Excellence (ASE), which is the foundation on which NATEF builds their certification standards for educational programs, Gill and Lewis (1995) found that the ASE standards have had a "positive effect on learning that takes place in an automotive repair programs" (Gill & Lewis, 1995, p. 10). In their study, they compared student results from ASE/NATEF certified programs to student results of non-certified programs. They found that "students from programs certified by ASE scored significantly higher on standardized tests of knowledge of automotive repair than students from similar non-certified programs" (Gill & Lewis, 1995, p. 11). Their study was a summative, not formative, evaluation of the factors and effects. They only alluded to some possible other positive effects that program certification might influence a program, including the possibility that the certification "ensure that the facility, equipment,

tools and instruction" are connected to the needs of the local industry (Gill & Lewis, 1995, p. 10).

Another study conducted which determined the effects of ASE/NATEF program certification and student test score outcomes was *The Relationship Between Automotive Service Excellence Certification and Ohio Vocational Education Achievement Test Scores* (Wiblin, 1993). In his dissertation, Wiblin studied the correlation between standardized tests high school juniors and seniors would take in Ohio. The two tests were the Short Form Test of Academic Achievement and the Ohio Vocational Education Achievement Test (OVEAT). Both of these tests were required for all juniors and seniors; the second test, the OVEAT, was required for students in vocational programs. Wiblin studied the data from 26 schools over an 11 year period, attempting to determine if students completing their junior and then senior year in a ASE/NATEF certified automotive program would score higher than students from non-certified programs on both Ohio standardized tests. Because of the time period sampled, data was available from the schools both before they had achieved ASE/NATEF certification and after. Wiblin found that "when junior and senior level automotive students were divided into pre-ASE and post-ASE groups… there were no significant differences" on the Short Form Test of Academic Achievement test results (Wiblin, 1993, p. 94). He did, however, find that the "comparison of the mean scores for both junior and senior students before and after ASE certification revealed that a significant difference existed between pre-ASE and post-ASE scores" on the Ohio

Vocational Education Achievement Test (OVEAT) (Wiblin, 1993, p. 94). Wiblin concluded that ASE certification was the main contributing factor to the increased vocational test scores. This study had the benefit of being in a state that adapted the ASE/NATEF certification as a requirement for automotive programs, and the time frame of 11 years spanned the initial implementation of ASE/NATEF in 1983 to the time of the dissertation in 1993. Part of Wiblins' suggestions for future study was to study the correlation between ASE certification and job placement rates, earning potentials, and ASE test results. What was not covered or suggested was the relationship between the ASE/NATEF certification and keeping the programs' curriculum current with new technology.

In a study conducted by Karbon (1995) the question of whether the resources invested into certifying automotive training programs was giving the desired results back to the very industry that founded the certification program. Automotive program certification can also have a measured impact on the very industry that created the standards. Being able to demonstrate that ASE/NATEF certification has increased the overall ASE test scores of automotive technicians is the very type of data of which ASE would be proud. ASE was created by needs that industry realized they had in the late 1970s, and shortly thereafter, industry again realized there was a need to bring standards to automotive education (which lead to the creation of NATEF). In his study, Karbon did find a relationship between students coming out of certified automotive training programs and higher ASE test scores. He also found a higher rate of job placement for students coming out of

certified programs. One area not covered by his study was the relationship between the current standards and possible redefinition of those standards in respect to the future; this was, however, part of his recommendation for further study: "…continuously improving programs beyond the standards as they are currently defined" (Karbon, 1995, p. 63).

Summary

This chapter reviewed the literature related to six areas in respect to the topic:

1. The past 40 plus years of history related to automotive technological change and development.
2. The history and development of the current automotive certification standards.
3. How professional technical programs keep their curriculum up-to-date.
4. How, specifically, technological advancement and change have effected automotive programs in respect to curriculum.
5. Examples of what the literature says drives curricular change at the community and technical colleges.
6. The final section reviewed the current literature on the measurable effects of ASE/NATEF certification for automotive programs.

It is clear that as technology, standards, accreditation criteria, and other developments continue to change, curricular and program changes must occur to

keep program curriculum current. What is not clear is the effect or relationship the ASE/NATEF standards have in that role. As one looks at the current research available, much is said regarding the effects the NATEF certification standards can have on measurable student outcomes from a certified program. Throughout this literature review, there was no substantial research found that studied what role/ impact or effect the NATEF standards have in keeping automotive, medium-duty/heavy-duty, and automotive collision programs up-to-date with current and emerging technology. However, the question remains as to what role, impact or effect the NATEF standards have in keeping automotive programs up-to-date with current and emerging technology. Additional research must be conducted to answer this question. The next chapter covers the methodology utilized to answer the research questions that are the core of this study.

CHAPTER 3

METHODOLOGY

The purpose of the study was to provide a method for evaluating the current perceived effect, impact or role that (as perceived by automotive, diesel and automotive collision faculty and administrators) the industry standards—NATEF—have in respect to the currency of a given program or program's curriculum with current and emerging technology. This study focused on publicly funded community (and technical) college automotive related training programs, when available, information from diesel and automotive collision programs was included. NATEF is currently the accepted national standard, and the certifying entity for automotive, diesel, and automotive collision programs. The potential impact of how these standards influence these programs in relation to sudden and rapid advances in technology was studied. Industry standards are designed to reflect technological changes; the question arises as to how effective these standards are in assisting community and technical college programs in keeping pace with advancing technology.

Throughout the literature review, there was no substantial research found that studied what role or impact the NATEF standards have in keeping automotive, medium-duty/heavy-duty, and automotive collision programs up-to-date with current and emerging technology. This study has been undertaken and designed to address this lack of relevant research. This chapter, which includes a discussion of

the design that was employed to conduct this research study is made up of the following sections: (a) research methodology, (b) research design, (c) sample selection, (d) data collection procedures, and (e) a closing summary.

For this study, a qualitative approach was selected, which allows the research to develop and evolve as the study progressed. Specifically, Maxwell (1996) wrote, a qualitative approach will give the researcher the advantage of "addressing three practical purposes…. Generating results and theories that are understandable and experientially credible, both to the people you are studying and to others" allowing the researcher to "Conduct formative evaluations, ones that are intended to help improve existing practice, rather then to simply assess the value of a program or product being evaluated," and it allows for "Engaging in collaborative or action research with practitioners or research participants" (Maxwell, 1996, p. 21). Another reason for the qualitative nature of the study was that the researcher has a focus "developed through practical experience" (Creswell, 1994, p. 2) within the area of automotive education. Finally, a study in which views, ideas, or perceptions are being gathered requires one to keep flexibility and adjustment in mind. The qualitative nature of the inquiry allowed for the initial study framework to be specified; however, the evolving nature of this study calls for flexibility. The study "design unfolds as the field work unfolds. The design is partially emergent as the study occurs" (Patton, 1990, p. 61). This design requires the researcher to have a "high tolerance for ambiguity and uncertainty as well as a trust in the ultimate value of what inductively analysis will yield" (Patton, 1990, p. 62).

Within qualitative research there are many methods, depending on the researcher's perspective and research need; any one of them might be appropriate for a study. The research methods could range among five traditions according to Creswell (1994). These include: Ethnography, Biography, Phenomenological, Case Study, or Grounded Theory. In this study a Case Study approach seemed most appropriate. Since the phenomenon being studied related directly to the NATEF standards, the study is in fact evaluating a "bounded system" (Creswell, 1998). This study spanned across the experiences of three separate institutions; thus in doing this research, a collective case study, which is also known as a multiple-case study, was used. As Stake wrote, one could choose several schools to make up a collective case study (Stake, 1995). Miles and Huberman (1994) point out that studying "multiple cases offer the researcher an even deeper understanding of process and outcomes of cases… and a good picture of locally grounded causality" (p. 26). Another reason for the selection of a case study was that "a case study involves the widest array of data collection as the researcher attempts to build an in-depth picture of the case" (Creswell, 1998, p. 123). In conducting this research, three case studies were utilized to identify the experiences of each institution with respect to the research questions. Three cases (institutions) provided rich information on the research topic and would keep the research to less than the upper limit of four case studies that Creswell (1998) typically suggests.

Design, Sample, Collection of Data, and Analysis

There were four phases in this research study: (1) selection of schools included in this study, (2) interviews to gather primary data from faculty and administrators at each school who agreed to participate in this study, (3) gathering secondary source data, and (4) data analysis and verification. The research participants from each of the three schools were the administrator in charge of the transportation programs, and at least one faculty member from each programs. The colleges asked to participate in this study were:

- Publicly funded community and or technical college
- Had at least one of the following: an Automotive, Truck (Diesel) or Automotive Collision program
- Hold ASE/NATEF Master Certification for the participating program at the time of the interview
- Have administrative approval that the school is willing to have their college participate in a doctoral research project that will focus on the perceived impact or role that the industry standards—NATEF—have to the currency of a given program or program's curriculum.

At the time of this study there were almost 700 post-secondary programs across the nation certified by ASE/NATEF; thus a method to narrow that down to a manageable number needed to be identified. In selecting the schools (cases) out of all those with ASE/NATEF certification a process akin to the "reputational case selection" (Miles & Huberman , 1994, p. 28) basis was utilized. In this process an

expert or key informant is utilized to aid in the selection of cases for the study (Miles & Huberman, 1994). The framework of the selection process is detailed as follows and allows for a very thoughtful and explicit (Miles & Huberman, 1994) sampling process.

While a specific expert was not used to identify the schools, the key informant was a listing provided by the Automotive Industry Planning Council (AIPC). Their listing of Award of Excellence in Automotive Technician Training Program's secondary and post-secondary winners and runners-up at both the state and national level from 2002-2006 formed the pool of potential candidate schools. Because of the nature of this study, this criterion was ideal, given that the only Automobile Technician, Collision Repair/Refinishing, and Medium/Heavy Duty Truck programs with ASE/NATEF certification are eligible to apply for this AIPC award competition (Automotive Industry Planning Council, 2007). For the purposes of this study, only the post-secondary programs were utilized.

> The Automotive Industry Planning Council is a national advisory group of industry leaders, vocational/technical educators, and educational policy makers whose mission is to promote communication, cooperation, and excellence in automotive service training programs. One of the methods they use to accomplish this mission is the Automotive Award of Excellence in Automotive Technician Training Program. Each year, all ASE/NATEF Certified Programs are invited to participate. (Automotive Industry Planning Council, 2007)

It should be noted that participation in the AIPC awards process is entirely voluntary: "Automotive Training programs from across the country are encouraged to enter the competition" (Ibid). In 2006, out of approximately 2,000 secondary and

post-secondary ASE/NATEF certified programs, a total of 23 programs participated in the AIPC award process and were identified as candidates for the national competition. Of those 23 participating programs, 18 were specifically post-secondary programs. In 2005, 18 programs participated in the process and out of those, 12 were post-secondary; in 2004 there were 20 participating programs, 14 of which were post-secondary; in 2003 there were 13 participating programs, 6 being post-secondary; and in 2002 out of the 19 participating programs, 13 were post-secondary. Due to the voluntary nature of this award process, it could be surmised that the programs applying for the award already regard themselves as some of the top programs in their respective states, and potentially, the nation.

Using the list of these competing programs (from 2002-2006), four schools from separate regions of the country were initially contacted for participation in this study. These four schools were selected by starting with the 2006 list, then working back through preceding years until schools responded positively about participating in the study. Out of the four initially contacted, only three replied and agreed to participate. Each of these schools had programs that were ASE/NATEF master certified for at least two certification cycles (certification cycles are five years in length). Part of the reasoning for selecting school utilizing a national listing was to broaden the potential perspective from just a local focus, to a potentially national level (this will be discussed in depth later). Once colleges had been initially identified, the individuals who were asked to participate (interviewed) at the sites

were: the administrative supervisor for the automotive related program(s) and one or two of the program faculty.

Given that part of the process for this research was identifying three schools (cases), and interviewing at least one or two faculty members and one administrator per school, having at least three schools contacted could have generated up to nine interviews. While this potential sample size was not large, “Qualitative researchers usually work with small samples of people, nested in their context and studied in-depth” (Miles & Huberman, 1994, p. 27). “There are no rules for sample size in qualitative inquiry. Sample size depends on what you want to know, the purpose of the inquiry, what’s at stake, what will be useful, what will have creditability and what can be done with available time and resources” (Patton, 1990, p. 184). Patton also suggests that qualitative sample size be specified to minimum samples “based on expected reasonable coverage of the phenomenon given the purpose of the study and stakeholder interest” (p. 186). Since the phenomenon being studied related to NATEF certified programs, studying a number of these programs (but not all) was sufficient. The schools included in this study were purposefully selected.

Purposeful Sampling

The schools from which these individuals were selected had been purposefully selected through a clear selection process. The reason for this purposeful selection is that “The logic and power of purposeful sampling lies in selecting information rich cases for study in depth” (Patton, 1990, p. 169). Since

these schools were selected from a list of schools with NATEF certification, they could potentially yield “a great deal [of information] about issues of central importance to the purpose of the research” (Patton 1990, p. 169). The research participants who were interviewed could potentially represent a cross-section of community and technical colleges, ranging from smaller rural schools to large multi-campus districts. Another reason schools (and thus, eventually the research participants) were purposely selected to be part of the pool is that “They are individuals who have special knowledge or perspective that make them especially important in obtaining academic perspective” (Gall, Borg, & Gall, 1999, p. 294). In setting up the selection criteria and process, Creswell stated, “the investigator chooses participants based on their ability to contribute to an evolving theory” (Creswell, 1998, p. 118). This purposeful selection process is further supported by Maxwell’s (1996) statement that the “most important consideration in qualitative sampling decisions” is to select the “individuals that can provide you with the information that you need in order to answer your research questions” (p. 70).

The justification for the NATEF/ASE Master certification criteria was: (1) NATEF certification expires five years after it is granted, thus to continue the certification of a program, a recertification process must take place and the school must apply for recertification. A school that has had NATEF certification for more than five years has had at least two certification visits by a NATEF evaluation team. (2) The reason for seeking schools with NATEF master certification is that since their program(s) are Master certified, their program is certified in all the main

categories for that certification area, unlike schools with only NATEF certification (not master level). As detailed in Chapters 1 and 2, attaining non-master level NATEF certification in Automotive only requires four base areas of certification while master requires eight; in Diesel, the non-master programs can be certified with as few as five areas, while master certification requires eight; and automotive collision and repair programs only need three areas for certification, with six needed for master level. Having less than master certification could impact the currency of a program's curriculum since each area of certification correlates to a curricular area. Some of the areas they are not certified in could represent areas where there is the potential for rapid technological change. An example of this is the fact that under base NATEF certification for automotive, only NATEF certification in four areas need to be covered by a program's curriculum; this leaves four other areas unaccounted for, and technological advancement could be happening in any of the four areas not covered by the programs certification or curriculum. Given that this research is looking at the curricular implications of the NATEF standards with respect to new and emerging technologies, schools with fewer areas of certification could have fewer opportunities for curricular impact.

In this purposeful sampling process, part of the reasoning behind seeking input from a potentially nationally representative group of respondents came about from reviewing process utilized by Greenan, Jarwan and Munn (1992) in their study *The Status and Needs of Secondary Trade and Industrial Education Curriculum: A State and National Study*. While they conducted a local survey "to

determine the current status of secondary trade and industrial education curricular needs as perceived by local vocational education personnel" (p. 24), they also sought out a broader representation by conducting a national survey where they attempted "to determine the current status of secondary trade and industrial (T&I) education curriculum in each of the 50 states" (Greenan et al., 1992, p. 25). The purposeful sampling process in this research study will combine parts of Greenan et al. methodology, specifically the concept of seeking to identify the effects on a curriculum through the perceptions of local professional technical (vocational) educational personnel, and for this study by selecting schools in various regions of the nation the total input will come from a more nationally representative group of education personnel. For the purposes of this study, a survey was not used; instead, telephone interviews were conducted.

Data Collection

For the second phase of the process, primary data was collected by interviewing faculty and administrators at the selected schools. In a qualitative study where perceptions and impressions from individuals are being sought, interviews offer the best method for obtaining this data. Further, according to Patton (1990), one method of qualitative data collection is the use of "in-depth, open ended interviews" (p. 10). Utilizing interviews, which is a form of data gathering, also follows with Haig's (1995) writings "…research begins by focusing on an area of study and gathers data from a variety of sources, including

interviews…" (Haig, 1995). According to Siedman (1998) interviewing provides a completely sufficient method "to better understand the meaning people involved in education make of their experience" (p. 4) and allows "the participant to take any direction he or she may want" (Siedman, 1998, p. 69). Janesick (1998) related interviewing to "a meeting of two persons to exchange information and ideas through questions and responses, resulting in communication and joint construction of meanings about a particular topic" (p. 30). Interviewing also provides a method to gain valuable and reliable data, one must ensure that the data sources (in this case, respondents of an interview) are provided with the opportunity to tell it (their story) as it is happening through their respective points of view. Specifically, "The task for the qualitative researcher is to provide a framework within which people can respond in a way that represents accurately and thoroughly their points of view about the world" (Patton, 1990, p. 24).

The interviews took place via telephone due to the geographic distances between the researcher and the interviewees. Fiscal limitations and time constraints limited the ability of the researcher to visit each school for in-person interviews. In order to gather the data for this portion of the study, open-ended as well as focused interview questions were used. "Open-ended questions, unlike leading questions, establish the territory to be explored while allowing the participant to take any direction he or she may want" (Siedman, 1998, p. 69). The reason for using open-ended interview questions was to gain insight from the respondent's perspective, specifically, as Patton (1990) stated, "the open ended response permits one to

understand the world as seen by the respondents" (p. 24). This open-ended process allows the researcher to understand and capture the perspective of the respondents without "predetermining those points of view" (Patton, 1990, p. 24). The more focused interview questions were used to build a base line of similar data for comparison between schools such as: number of students in a program, dates of certification, and number of faculty.

Another purpose for utilizing interviews was to provide the researcher an opportunity to "find out from them (the interviewees) those things we cannot observe" (Patton, 1990, p. 278). In seeking the perspective of faculty and administrators on NATEF standards and curriculum currency, the researcher was looking for their impressions and feelings on the subject, and their thoughts on a topic that cannot be observed. This (the impressions and feelings on the subject) was the most important information, considering the fact that this study seeks to understand phenomena viewed through the perceptive of faculty and administrators. Since this research was being done on a phenomena as it is perceived within education, then according to Siedman (1998) "Social abstractions like 'education' are best understood through the experiences of the individuals whose works and lives are the stuff on which the abstraction, are built" (p. 4). As discussed above, the interview questions were a mixture of open-ended and focused questions. The questions were designed to "request opinions" (Tuckman, 1999, p. 238) from the experts about their respective programs—opinions related to this study's research questions and purpose.

The primary data interviews were recorded with the participants' permission and these recordings provided the raw data for the initial analysis. Field notes were taken during the interviews to provide a framework for referencing back to the actual recordings to check for accuracy. Direct quotes were added to the field notes by reviewing the recordings. This process proved successful for Davis (2002) in her study, *Community College Faculty Experiences With Learner Outcomes*. In Davis's study audiotapes aided in augmenting field notes "by listening to the tapes using a transcription machine with a numerical marker. Direct quotes were added to the field notes to produce a narrative summary of the interview for each participant" (Davis, 2002 p. 64). This process allows the researcher "to trace interview data to the original source on the interview tape at all stages of research" (Siedman, 1998, p. 95). Patton (1990) also speaks to the ability of utilizing audiotapes without full transcription. Specifically, given the limits of resources, it is not necessary to fully transcribe interview audiotapes. "Only those quotations that are particularly important for data analysis and reporting [need to] be transcribed" (Patton, 1990, p. 350). Corbin & Strauss support this notion stating that "the general rule of thumb here is to transcribe only as much as needed" (p. 30). This notion of only transcribing what is necessary from the tapes is further supported by Stake (1995).

Secondary data sources

For the third phase, as data was gathered during the primary interviews, it had to be verified and compared to the available information sources and literature. This process utilized secondary sources of data. Much of the secondary data for this study came from research and literature review of technological advancement in the automotive industry, study of available institutional records (including curriculum and program related material) and websites from participating schools, through library research of trade publications, as well as research on current and emerging prototype technologies. This secondary data also came from information leads provided by the primary research participants. In some of these cases, the leads turned into non-recorded conversations with individuals referred to or related to the interviews and data being sought. Due to their capacities in, or for, the state education system, these individuals had specific information that could corroborate or refute the data gathered in the interviews. For these conversations, extensive field notes were taken for use in the study.

Initially, some of this secondary data was partially covered while doing the literature review but will continue to grow as secondary data sources are gathered throughout the research (Corbin & Strauss, 1990). This data analysis collected information on automotive service training program curriculum, state processes, history, standards, categories, and some examples of advances in the technology. Patton (1990) states that program documentation is a “particularly rich source of information about many programs…. all programs leave a trail of paper that the

evaluator can follow and use to increase knowledge and understanding about the program" (p. 233). Another reason for researching documents and publications was to better inform the researcher about some of the advances in the industry. This better prepared the researcher for later in the study as data was being analyzed, by helping to identify potential themes that came out during the data coding. While these sources of secondary data are not typically considered part of the data gathering of a study—many feel it more aptly belongs in the literature review section—it is considered a source for data by Glaser and Strauss (1967). Stake (1995) also considers document review as part of the data gathering phase. "Quite often, documents serve as substitutes for records of activity that the researcher could not observe" (p. 68). The fact that much of the data related to this study had to be found in various geographic locations across the nation, the field work required to conduct the data research would be costly, time-consuming, and potentially cumbersome. Utilizing materials available in a library or through a library loan service expedited the researcher's work. Glazer and Strauss (1967), in their chapter on new sources for qualitative data "point out ways that… can greatly extend the range of qualitative data serviceable for generating theory, and with relatively little expenditure of time, money and effort" (p. 161), and one of the ways to extend and further document data is through document research, as Glaser and Strauss point out (p. 161). This notion is also supported by Yin, "Because of their overall value, documents play an explicit role in and data collection in doing case studies" (Yin, 1994, p. 81).

Much of the literature review in Chapter 2 aided the researcher in understanding what the current (at the time of this study) NATEF standards were, what the curriculum typically covered at the schools, and some of the advances that were in production at the time of this study, or soon to be utilized. This information could potentially prove useful in the Conclusions and Recommendations section of the study: “it could be used as supplementary validation” in writing up the conclusions (Corbin & Strauss, 1990). However, some of the secondary data gathering focused on identifying some of the technological advances that are presently in production, or are in the prototype phase and slated for production over the next three to seven years. This data came from technical journals and observation of actual vehicle specifications (Halfin & Nelson, 1982). Observation of current vehicles and the prototypes, data on them or their specifications is, in essence, a form of field observation of the new and emerging technology.

The reason for this method of researching current and prototype vehicles and the advances in technology is “research often involves nothing more than reporting the characteristics of one sample at one point in time” (Gall et al., 1996, p. 376). Even though this method is a simple form of field observation, with the focus of this part of the study on technological advances, we need to “yield important knowledge” (p. 376) from the evaluation of current and prototype vehicles. This is very similar to a method used in a previous study done by Allen in 1984, on the impacts of technological change for Hawaii’s automotive mechanics. As the basis for part of his study, Allen used the latest prototype from Toyota to

represent the leading edge of technology—at that time it was the Toyota FX-1 (p. 3). In evaluating the technological changes the prototype contained, he found advances in electronics and computers, changes in body styling that increased air flow to cool engine components, advances in turbine technology, electronically controlled hydropneumatic suspension, the incorporation of Cathode Ray Tube displays in the passenger area, and advances in engine components (p. 12). Today, these items are commonplace, but at the time of Allen's study they were years ahead of their time. One final reason for studying prototypes is that they are utilizing technologies that have literally just left the drawing board and are now on the road. When seeking material and attempting to draw relevance from it, "there must have been evidence that the technology is currently being used in the 'real world'—i.e., that it is not still on the drawing board" (Jaffee et al., 1982, p. 14).

Data analysis

The fourth phase of the research was analysis of the data and determining the validity or trustworthiness of the data. Triangulation was used to verify data collected in this study. In nautical terms, triangulation is the process by which one gains a fix on their own or another's position. This is done by taking a fix (compass bearing) on at least three separate marks, then plotting those bearings on a chart. Once plotted on the chart, the intersection of those three initial fixes will be the point the navigator is seeking (Maloney, 1987). Thus, the navigator triangulated their location. This nautical triangulation is a metaphor for the triangulation needed

in qualitative data gathering and verification. In respect to this study, three separate methods for data gathering were used: (1) Initially, data gathered by interviewing faculty and administrators provided for multiple perspectives on the same questions. According to Patton (1990) “It is possible to achieve triangulation within a qualitative inquiry strategy by combining different kinds of qualitative methods, mixing purposeful samples and including multiple perspectives” (Patton, 1990, p. 188). (2) Feedback on fieldwork or data gathered is another method that can be used for verification of data. Patton (1990) suggested that giving feedback is a key to verification in fieldwork. After each initial interview for this study is completed, a summary of the interview, along with specific quotes or themes were sent back to the participants. This allowed each participant the opportunity to verify their responses and to correct any potential errors. This process is also called member checking (Stake, 1995). It is a system where the researcher is “systematically soliciting feedback about one’s data and conclusions from the people you are studying” (Maxwell, 1996, p. 94). (3) A third form of data verification for triangulation was comparing what was gathered in the interviews with available institutional records and other secondary data sources. Based on the answers given for the interview questions relating to curriculum, changes, and certification, institutional records such as curriculum guides, programs reviews or accreditation material or other sources were utilized to verify the information provided by the interviewee. “For case studies, the most important use of documents is to corroborate and augment evidence from other sources… documents can provide

other specific details to corroborate information from other sources" (Yin, 1994, p. 81). Throughout the study a wide variety of data sources were used to help gather data. "As we gather rich data, we draw from multiple sources—observations, conversations, formal interviews…. public records, organizational reports… and our own tape recorded reflections" (Denzin & Lincoln, 2000, p. 514). Having such data and sources assisted in how the data is analyzed in the study (Ibid). Throughout the data gathering process in this study, the information and data was reviewed and evaluated for common themes.

In seeking out a process to identify themes within the data, the within-case and cross-case analysis process was utilized. In the data analysis and reporting section, the data will be related in accordance with Creswell's (1998) recommendation for presenting the data:

> "When multiple cases are chosen, a typical format is to first provide a detailed description of each case and themes within the case,… followed by a thematic analysis across the cases,… as well as assertions or an interpretation of the meanings of the case." (p. 63)

By continually reviewing the research proposal and the data gathered to date, using the within-case and cross-case analysis process the researcher was able to focus on the prominent themes (or data discrepancies) that developed. So much information that is received can initially appear useful, but it is only after a research process is well into the data gathering process that common themes begin to emerge. These themes are identified through coding. "Codes are used to retrieve and organize chunks" of data (Miles & Huberman, 1994, p. 57). Coding of the data

is done by identifying common statements or themes in the data gathered. As the research progresses, these themes are coded or grouped to help develop emerging theories. This process also leads to further verification of the data collected. Another factor in the data analysis is that inherent with the design of a multiple-case study is the opportunity for trusting our findings: “Multiple-case sampling adds confidence to findings” (Miles & Huberman, 1994, p. 29).

The process of organizing this data and building a cross-case analysis require some form or method for categorizing the data in a way which can facilitate quick, easy clustering of common themes (Miles & Huberman, 1994). The initial themes for analyzing the data were developed based on the research questions and interview questions. However, this did not limit the extent of possible codes. While the initial themes or codes were based in foundational questions driving this research, “others are developed inductively by the researcher during the analysis, and still others (what are often called emic categories) are taken from the conceptual structure of the people studied” (Maxwell, 1996, p. 79). For this research, margin coding was initially used in the text of the field notes in combination with reviewing the audio recordings and the transcribed portions of the interviews This process of margin coding was nothing more than reviewing the data, watching for certain words, themes or ideas that stand out and are repeated (Bogdan & Biklen, 1998). From these reoccurring words, ideas and potential themes, the researcher develops coding categories. “These words and phrases are your coding categories” (Bogdan & Biklen, 1998, p. 171) for analyzing the data.

Coding and searching for themes for this research project will be complete when "no new or relevant data seems to emerge regarding categories… the relationship between categories are well established and validated" (Corbin & Strauss, 1990, p. 188).

This is also in keeping with Yin's Explanation-Building strategy. "To explain a phenomenon is to stipulate a set of casual links about it" (Yin, 1994, p. 110). This can allow a researcher to "build general explanations that fit each of the individual cases" (p. 112). While Yin, in the cited example, is describing a public policy matter in discussing Explanation-Building—"For example, the casual links may reflect critical insights into public policy process or into social science theory" (p. 111), for the purposes of this study the casual links were referenced to the perceived role or impact the NATEF standards have in keeping automotive, medium-duty/heavy-duty, and automotive collision programs up-to-date with current and emerging technology. This will be discussed in Chapter 4 where primary data as well as secondary data will be used in the analysis of each case studied. In the closing of Chapter 4 the lessons learned (Lincoln & Guba, 1985) will be presented as a summation of all three cases in the form of a cross-case analysis.

Strategies for Protection of Human Subjects

In conducting the research, this researcher abided by the *Oregon State University Human Subjects Handbook* and the highest ethical standards. In order to

protect the identity of the primary research participants, pseudonyms were developed for each participant and their school. Primary research participants were given an informed consent document and provided the opportunity to drop out at any time. A copy of the signed informed consent document is on file with the researcher. Prior to the signing of the consent documentation, participants were given the opportunity to ask any questions they might have about the study. Participants received a written copy of the informed consent document. The phone number and email address of the researcher, the principal investigator and the Institutional Review Board Human Protections Administrator's office are listed on the Informed Consent Forms should participants have questions about the study and their rights as participants in the study.

Summary

This study provided a method for evaluating the current perceived effect, impact or role (as perceived by automotive/diesel/automotive collision faculty and administrators) that the industry standards—NATEF—have to the currency of a given program or program's curriculum. The methodology employed gives wide latitude to fit this process into many different professional technical disciplines, which base themselves on a set of industry-accepted national standards. A researcher could potentially take this research design and employ many of its attributes to gain a further understanding of the effects that national certification standards have on a given program with respect to curriculum currency and

technological advance in the respective field. By seeking input from a potentially wide range of community and technical colleges, not just a few local ones, the opportunity for extrapolating what is occurring across the country is enhanced. Why should one take such an active role in considering the effects that national standards have on curriculum? Halfin and Nelson (1982) discuss changing the philosophy behind how we develop and change vocational programs. They propose the following ideas:

- "Perhaps vocational education should develop an approach that has an appropriate combination of proactive and reactive process for identifying and making decisions on content for vocational education programs" (p. 23).
- "Perhaps vocational education should also be responsible for developing skills that will facilitate transition into new jobs as technology changes…" (p. 23).

Halfin and Nelson (1982) also state a key question, one that is core to this study: "Should vocational education remain primarily reactive to the needs of business and industry relative to the knowledge and skills content of jobs" (p. 23). Halfin and Nelson suggest that vocational education is operating under the Delayed Response mode discussed by Samuelson (1987). Halfin and Nelson go on to suggest an idea similar to Samuelson's Early Response Mode: "Perhaps vocational education should develop an approach that has an appropriate combination of

proactive and reactive processes for identifying and making decisions on content for vocational educational programs" (p. 23).

This case-study research provides an insight on the perceived impact on curriculum in professional technical programs that are based on industry standards, in an industry facing rapid technological change and advancement. This methodology seemed most appropriate for this research due to the researchers' desire to generate themes and theories as the data was gathered and the study evolved.

CHAPTER 4

FINDINGS

This chapter presents the findings of this research study. It is divided into three sections. The first section discusses the colleges and participants involved in the study, and how each will be identified. The second section contains the details of the interview data, and themes which emerged from the research questions in Chapter 1 and from the interviews. This interview data was in response by the interviewees to the initial questions, and subsequent follow-up. The third section gives a summary of the findings. This method is in keeping with Creswell's (1998) recommendation for presenting the data:

> When multiple cases are chosen, a typical format is to first provide a detailed description of each case and themes within the case, . . . followed by a thematic analysis across the cases, . . .as well as assertions or an interpretation of the meanings of the case." (p. 63)

The Colleges

In this case study, three colleges were identified for participation in accordance with the process detailed in Chapter 3. Each school was in a different state. Two of the three schools are accredited by the same regional accreditation association, Middle States Association of Colleges and Schools, and one school is accredited by the Southern Association of Colleges and Schools. In order to keep the identity of the research sites and the participants anonymous, each college will

be identified by the pseudonyms “College A,” “College B” and “College C.” To identify the interviewees, the middle letter in the designation denotes “D” for dean/administrator, or “F” for faculty. The final numeral in the designation identifies the first or second individual in their respective position (administrator or faculty) interviewed at that college.

“College A” is an urban college in Georgia with an enrollment of 4,000. At this college, the Dean, who has oversight of the automotive program, and one faculty member were interviewed. For the purposes of this study they are referred to as AD1 and AF1, respectively. The most recent NATEF certification for this college was received in October 2004, and expires in October 2009.

“College B” is a suburban multi-campus college in Delaware with a total enrollment of over 14,000. At this college, the Dean, who has oversight of the automotive program, and two faculty members were interviewed. For the purposes of this study they are referred to as BD1, BF1, and BF2, respectively. The most recent NATEF certification for this college was received in November 2006, and expires in November 2011.

“College C” is a Technical college in Upstate New York which offers many technically focused associate degrees, as well as some baccalaureate degrees. This college has an enrollment of 3,500. At this college the Dean, who has oversight of the Automotive program, and two faculty members were interviewed. For the purposes of this study they are referred to as CD1, CF1, and CF2, respectively. At the time of this study this colleges was preparing to go through the NATEF

recertification process for their automotive program. Their previous certification was received in April 2003 and was due to expire April 2007; certification for Diesel was received in May 2004 and expires May 2009; certification for automotive collision was received in May 2003 and expires May 2008.

General themes from each interviewee will be presented, as well as selected direct quotes. These themes and quotes emerged from the interview notes and recordings. Supporting data and follow-up information will also be presented in this section. This follow-up information came from sources that some of the interviewees initially recommended, as well as through a review of institutional records.

College A Interview Findings

Community and Technical colleges in Georgia receive their curriculum standards and minimums from the Georgia Department of Technical and Adult Education (DTAE):

> Georgia Department of Technical and Adult Education (DTAE) provides the curricular standards for a programs curriculum. Thus, most of the courses at the colleges across the state are very similar in the curriculum they offer. DTAE is the body that updates the program curriculum for the state. (AD1)

"Georgia Department of Technical and Adult Education (DTAE) provides the curricular standards for a programs curriculum" (AF1). According to both the administrator and faculty member, DTAE is the body that can change the curriculum through a statewide committee which has impact on over 30 schools. It

can take two or three years for the final curriculum revision to be implemented after it is proposed. DTAE, which mandates the curricular minimum standards for the state, last did a full revision of the automotive curriculum in 1998.

While the DTAE standards form the basis of the curriculum all programs must follow, it is only a baseline for what must be covered. Individual schools can go beyond these standards if they desire to do so. The DTAE standards are based on NATEF standards, since most departments across the state seek NATEF certification for their programs and tasks. Therefore, NATEF plays a large role in curriculum updating and revisions. For a school seeking to attain master certification, the base curricular areas it can offer are designed around the existing eight areas of certification offered by NATEF.

> Our curriculum is driven by the state DTAE guidelines, which is based on the NATEF standards. Out of the eight certification areas NATEF offers, our school offers 18 courses of study, so they go above and beyond the NATEF standards in this respect. As an example they might use three courses to meet the one standard for automatic transmissions. (AF1)

Beyond the DTAE standards, a college can add to the curricular base of their program as needed through the direction of its advisory board. As faculty member AF1 expressed it: “A lot of feedback from the Advisory board on what else to incorporate above the DTAE guidelines.” According to AF1, the advisory board at College A meets at least every other month.

Both the administrator and the faculty member were asked about any changes that were necessary when their program initially applied for NATEF

certification. “When seeking [initial] NATEF certification, equipment and facilities needed to be upgraded to meet the standards” (AD1). However, when going for their first NATEF certification they were teaching everything NATEF required (per main topic areas), but needed to only rearrange the format of their classes to meet NATEF standards (AF1). AD1 stated, “We had purchased quite a bit of new equipment” for this certification, and he was quite proud of their new lab as a result of the certification efforts.

When asked if the NATEF standards are perceived as being sufficient to maintain program quality, relevance, and currency with respect to technological advances, the answer was a resounding “yes” from the program administrator, but the faculty member interviewed had a more cautious answer: “Right now yes, but this stuff changes every 6 months” (AF1). While NATEF forms the minimum curriculum guidelines via the DTAE standards, the current DTAE standards do not address anticipated advances in technology. To meet this need, the program seeks other means to add advances to the curriculum beyond the DTAE standards. This is done through partnerships with local dealerships and factory-sponsored dealership training. As examples, AF1 cited recently attending the Daimler-Chrysler training center for the “World Engine Seminar,” and local NAPA auto parts training seminars as valuable ways to meet needs above the NATEF standards. The administrator also believed that College A would quickly adapt to a change if NATEF made one. “If suddenly the NATEF standards changed, trust me, the state schools would act quickly to incorporate them” (AD1). The faculty member went

on to say that from his experience, one of the issues surrounding technological advances with respect to the NATEF standards was related to computer integration and vehicle scan tools. He expressed that NATEF did not meet the need of current technology in this area (Ie computers and scanners). As a final note from the faculty member, he stated that due to rapid technological advances, students coming into the program needed much higher levels of academic success as a foundation in order to be successful in both the program and in their future careers.

The interviews at College A led to subsequent information and data gathering based on the individual interviews. This resulted in contact via email and telephone with the state curriculum program specialist at the Georgia Department of Technical and Adult Education (DTAE), which identified that all Georgia college base curriculums are regulated by the state; thus, College A must follow state guidelines as their base curriculum.

According to the DTAE curriculum specialist responsible for automotive curriculum, standards are not created, as such, by the DTAE, but developed by a statewide industry advisory (state technical) committee made up of dealerships, independent shops and manufacture representatives. NATEF was, and currently is, an important factor in DTAE's curricular developments, as it is the only national certification for automotive programs, and DTAE wants their state programs to be eligible for NATEF certification. To aid the schools in meeting their goal of certification, the committee evaluates the curriculum under development to ensure that the minimum contact hours by NATEF are met by the DTAE curriculum.

While most of the NATEF tasks are not specifically focused upon while developing the minimum guidelines, the minimum hours are—they are the primary focus of their standards. This allows the local advisory board of the various schools to specify the tasks to be taught within the overall NATEF hour requirements.

The state curriculum specialist went on to explain that the state automotive curriculum goes through major revisions about every four years. Input is gathered for a program revision, and the curriculum is sent out electronically for input and review by the greater body of schools in the state through a process called a "PROBE."

When asked about meeting current and emerging technology in the curriculum, the state curriculum program specialist stated that their (DTAE) focus is to make sure that students from the over 30 various state schools are able to graduate as capable entry-level technicians. The DTAE focus is on basic entry-level skill areas, and not on areas that are still emerging or in their infancy, such as Hybrids on the road today. However, he went on to say, if the Hybrids or other emerging technologies became a large part of the needed training, their advisory board would accordingly seek to incorporate it. Currently, DTAE is in process of revising the curriculum; the last full revision was in 1998 (personal communication, May 7, 2007).

After further phone and email conversations regarding the DTAE tool list for the automotive program, the state curriculum program specialist suggested I contact the state chair for automotive curriculum. This gentleman chairs a group

that meets approximately four times per year. I contacted him by phone and email for follow-up data gathering. From these communications it was clearly determined that the NATEF standards formed the foundation of the curriculum adopted by the state (specifically including the tool and task lists). According to the state chair, the DTAE tool list is an exact duplicate of the NATEF tool list, and the foundation of the automotive curriculum is taken directly from the NATEF standards and tasks. However, he pointed out that they do not stop at the NATEF standards.

According to the state chair, it is only in the following courses—AUT 212 Advance Electronic Transmission Diagnosis, AUT 214 Advanced Electronic Controlled Brake System Diagnosis, AUT 216 Advanced Electronic Controlled Suspension and Steering System Diagnosis, AUT 218 Advanced Electronic Engine Control Systems and AUT 220 Automotive Technology Internship—that a departure from the NATEF standards and tasks forms a basis for their curriculum. These courses were added because more advanced technological areas were not yet well covered by NATEF. He did expect that at some future time NATEF would add the emerging and current technologies into the standards during one of the updates. To develop the curriculum for these additional advanced courses, he and his statewide automotive group drew from manufacture-specific training classes as the foundation (personal communication, May 21, 2007).

Summary of College A Interviews

Through the process of interviews and follow-up data gathering at College A, the following themes emerged. First and foremost is the strong relationship between the college and state with respect to curriculum implementation. DTAE is clearly the regulator of curriculum once it is developed. Curriculum, however, is jointly developed through input from all the stakeholders at the various colleges. The NATEF standards form the basis of the DTAE curriculum; this in turn forms the basis of College A's automotive curriculum. While NATEF forms the basis for each school via the DTAE curriculum, the state (and thus the schools) have an opportunity to go beyond the NATEF standards. This was well documented in the numerous courses identified by the statewide automotive curriculum chair. When asked about any changes needed in the program or curriculum to achieve their NATEF certification, both the administrator and the faculty member felt that for the most part the curriculum was already in line with the NATEF standards; however, it was in the area of facilities and equipment where there was a gap between the NATEF standards and what was onsite at the time. In the case of this school, they needed to update and add equipment and develop a new lab to meet the standard for certification.

As to whether the NATEF standards are perceived as being sufficient to maintain the program quality, relevance, and currency of technological advances, the administrator clearly believed this to be the case. The faculty member, however, felt that the current NATEF standards did not meet current needs, specifically in

the area of computer integration and scan tools. Another of the faculty member's perspectives was that since their curriculum is based on DTAE guidelines, which are based on NATEF standards, their curriculum (and DTAE's by association) do not address anticipated advances in technology. To meet this need (or perceived gap) within their curriculum, they sought other means to incorporate this information into their curriculum. This included partnerships with local dealerships, seeking out manufacture-specific update training, as well as aftermarket training seminars. The Advisory committee was also cited as a strong input to the curriculum beyond the DTAE guidelines (and thus NATEF).

While discussing the possible gaps between current and emerging technology, the administrator did feel that if NATEF were to make a change, the school would act quickly to incorporate such a change. In support of this statement, information gathered by talking with the state DTAE official and the state automotive curriculum chair confirmed that almost all of the curriculum, tasks and tool requirements for any of the schools were derived directly from the NATEF standards; thus, if the standards change, DTAE would also. It should be noted that building their respective programs on the NATEF standards did not inhibit the state nor College A from going beyond the current standards to meet a need they identified. Specifically, both faculty member AF1 and the state chair for the automotive curriculum committee identified that they did go beyond the current standards when needed. Both also pointed out that they had to go beyond because some of the more technological areas were not well addressed by the current

NATEF standards (but they expected it would be in the next NATEF standard update). However, from the conversation with the administrator, one wonders how such an endeavor would be funded (equipment-wise) without the NATEF, and subsequently, the DTAE requirement to backup or support the request. Through the interviews and follow-up, it appeared that "major" updating of the curriculum with respect to NATEF standards only occurred at the time of certification or recertification. While all those contacted confirmed that the DTAE standards are derived from the NATEF standards and are updated as NATEF updates, the fact remains that the last full DTAE update was done in 1998, based on the NATEF standards at the time. Only now is all DTAE curriculum undergoing a full review.

College B Interview Findings

The program at College B had recently undergone a full NATEF certification review. This college had phased out a manufacture-based program and begun a generic training program. "Their program recently had a manufacture-based program which was NATEF certified, but has since discontinued it" (BD1). At the time of the interview they had just received the NATEF certification for their new generic automotive program. According to the program head (BF1), who is also a faculty member in the program, they have been NATEF certified since 1995 and just completed their third certification process. Both the administrator and the faculty members were asked about any program changes that were necessary when their program initially applied for NATEF certification.

> When they first applied for NATEF certification they had been prepping for two years to attain certification, thus giving them a year or year and a half to revise and fine-tune their facility and curriculum. Because they had been working towards it for a few years they only needed to update about 10% of their curriculum. (BF1)

During his interview, the program administrator (BD1), added more detail about the most recent program certification effort because it was a full evaluation, not a recertification. In this case, they did not need to make many changes in the curriculum (since they were previously certified with another program); however, BD1 stated: “The bigger concern for our program was the facility. We did not meet the requirement for safety and facility.” During this last certification process (2005/2006 academic year), the school did not initially meet the requirements in the safety and facility area. It was only after a follow-up visit in the fall of 2006 that they met the standard and were later certified. BD1 also related that in preparation for applying for accreditation by NATEF, the program head looked at their curriculum to see if they were aligned, which is done on a continuing basis.

According to BF2, about 50% of the program’s curriculum needed to be changed to meet the NATEF standards at the time of their initial certification. “At the time, basically yes, that was in 1995” (BF2). Unlike either the administrator or the program head, BF2 has been with the program since 1987, long before the program sought initial NATEF certification.

While discussing the core curriculum and asked if it was based on the NATEF standards, administrator BD1 stated that College B values accreditation so

highly that “I can’t believe that they don’t use [the NATEF standards as the core of their curriculum].” BD1 was inferring that due to the college’s high regard for certification and accreditation standards, the program used the NATEF standards very actively.

When the program head, BF1, was asked about the foundation or basis of their curriculum, the response was: “It’s mostly abiding what NATEF wants as far as their tasks and standards. If you follow the NATEF tasks and build that in your curriculum you have a program.” The second faculty member, BF2, also related that NATEF formed the initial core. According to BF2, the last complete curricular revision for the program was done prior to their most recent NATEF certification application. It was done based upon the needs for the program certification. The foundation and basis of their program’s curriculum is “1) The input from the dealers, 2) the NATEF standards, and 3) the college curriculum guidelines” (BF2).

It should be noted that College B is a multi-campus institution with automotive programs at more than one campus. The procedure for curriculum development requires that once curriculum, standards or outcomes are adopted for a program, it must be followed at all locations.

> It [automotive] is a college-wide program. Some changes might originate at one of the other campuses and then their campus adapts/incorporates to the change so the outcomes of the programs at each campus are identical, not necessarily the courses, but the program outcomes. (BD1)

Each interviewee also shared perspectives that connected the core of the curriculum with the role of their advisory board.

> The basis of the program curriculum is developed by the advisory committee as well as the NATEF standards. In conjunction with the advisory board input, in any accredited program, of course the accreditation standards, and the process or recommendations that came out of a site visit are also part of the curriculum. (BD1)

BF2 shared that with respect to current methods and tools used to update and revise the curriculum, the advisory committee is their main means of input for ongoing program changes. Faculty also seek input during onsite visits to the various repair facilities at which their students are interning. Their curriculum is reviewed and revised every 2 to 2½ years. BF1 shared that to revise and update their program, facility, and equipment "the advisory board input has a huge impact on that." BF1 also related that their last full program curriculum update was about two years ago, when they shifted from a GM ASEP to a Generic program.

When asked if the NATEF standards are perceived as being sufficient to maintain the program quality, relevance, and currency of technological advances, the Administrator (BD1) answered that the NATEF standards and tasks assist their program in keeping current, and aids their program in addressing recent and anticipated advances in technology. With respect to program quality, relevance, and currency of technological advances, however, the program head, BF1 reflected on concerns about specific technology. The NATEF standards and tasks play a large role in the updates of curriculum developments.

> Most of it [the curriculum updates], I would say close to 90%, is done due to NATEF standard and task updates. I would hope that NATEF is keeping up with the technology to help us keep up with our curriculum. (BF1)

As an example, BF1 related:

> We have 42 volt systems coming at us, we have Hybrid cars out there right now that we need to add to our curriculum. Right now we don't have a vehicle here to teach something like that, but in the next year, two or three I'm sure that's going to be added to the curriculum.

BF1 went on to say that anticipated advances in technology were not addressed in the 2002 certification standards, nor were the current technologies, such as Hybrids, addressed by the standards, and "to tell you the truth I thought there were some gaps in what NATEF requires" with the current technology on the road today.

In talking with the faculty member, there seemed to be a large gap in time between the 2002 certification standards used for their certification process in 2005 and the subsequent granting of certification in 2006, especially with changes in the technology on the road at the time of their certification.

Instructor BF2 had a different perspective on this topic, but did share information that echoed some of the concerns about technological advances. When discussing the ability of the NATEF standards to address recent and anticipated advances in technology, BF2 expressed that for the most part, the NATEF standards met the need. He specifically pointed out that because of the process by which NATEF eliminates older and outdated tasks and replaces them with newer ones, they do a good job of keeping updated. Specifically, because of NATEF standards and their changes over the years, he felt that much of their curricular updates came about as a result of NATEF standards and guideline changes.

However, when discussing the NATEF standards in relationship to NATEF guideline updates, BF2 stated that their most recent program certification (2006) used the 2002 NATEF standards as their basis, and he felt that when the new (2005) standards come out, they will address alternative fuel and Hybrid technology. “I am going to assume that in the new standards there’s probably something geared towards them—that’s the upcoming future Hybrid and alternative fuel” (BF2). This information was corroborated by the program head, BF1, who related that as of the last academic year (2005/2006), when they applied to certify their new Generic program, all that was available from NATEF were the 2002 standards.

On the topic of curriculum updates and the role the NATEF standards play, BF1 shared that to revise and update their program, facility, and equipment “the Advisory board input has a huge impact on that.” The college also requires S.L.O.A. (Student Learning Outcome Assessment) evaluations be conducted through the use of a capstone project at the end of a program, to aid in gauging the success of the curriculum in meeting the stated program outcomes. This is in conjunction with input from the advisory committee, repair shops and dealerships to aid in determining how their program curriculum and equipment/tools/ technology are revised. BF1 also went on to say that the NATEF standards and tasks play a large role in the updates of curriculum developments. “Most if it [curriculum updates], I would say close to 90%” is done due to NATEF standard

and task updates. I would hope that NATEF is keeping up with the technology to help us keep up with our curriculum" (BF1).

When talking with BF2 about the specific role the NATEF standards and tasks have in their curriculum updates and development, the topic of the role of standards in equipment updating was mentioned, changes in tire and rim technology and their program's need for an updated machine to meet the NATEF task requirement for tire and wheel training. In this example, the required NATEF task, in concert with the advisory board input, made it possible for the program to justify the purchase of this newer technology. This, as well as other examples, were related by the program head, BF1. Every year major advances in technology are incorporated in their curriculum or their equipment inventory, based on the input of the advisory board. BF1 also mentioned the example of the tire machine.

As for other technological advances related to equipment, according to BF1, they want to add Hybrids to the curriculum but it is difficult to do without an actual Hybrid vehicle in their fleet. So they are constrained from incorporating some technological advances due to the lack of resources needed to bring in the technology, or the lack of corporate donations of such technology. They work to incorporate any updates or advances in technology into the curriculum every six months.

Summary of College B Interviews

Through the process of interviews and follow-up data gathering at College B, the following themes emerged. The program had undergone a change from a manufacture-based program to a generic one, thus requiring a full NATEF certification visit. During the last two evaluations they only had recertification visits. At the time of their most recent evaluation visit, it was the feeling of both the faculty and the administrator that for the most part the curriculum was in line with the standards. However, they did not succeed in the most recent initial certification visit. It took them some time to come into compliance with the NATEF standards, due to facility-related issues. Once these issues were remedied, certification was granted early in the next academic year.

While talking about their first certification process, both faculty members related that the curriculum needed to be changed to incorporate the NATEF standards. One faculty member (who was not at the school at the time of their initial certification) felt that only about 10% of the curriculum needed to be changed. The other faculty member, who had actually been at the school long before their first NATEF certification, shard that about 50% of the curriculum needed to be changed to achieve NATEF certification.

All three College B interviewees felt that the NATEF standards made up the core of their programs curriculum. All three also shared that curricular updates were made in conjunction with the NATEF standards, as well as the advisory board and college-wide curriculum process. Two interviewees felt that about 90% of their

curriculum updates came directly from NATEF changes. Both also felt their equipment updates were a result of changes in the NATEF standards, which address changes in the industry. One example that was cited related to changes in tire technology that had translated into NATEF standard changes, and thus enabled the purchase of needed equipment. Another example was the lack of any justification for Hybrid vehicles. In both cases, the NATEF standards (the inclusion or omission of an item in the equipment list or task list) could either enable the justification for a purchase or hold back the purchase of some technology. In reviewing the relationship between the NATEF standards and this program's equipment needs, program advisory board minutes were reviewed. Through this review, a clear connection to the then upcoming NATEF certification visit and a need to update equipment was identified. Thus, a school with a long history of NATEF certification waited until their latest certification preparations to start seeking compliance with the latest NATEF standards in the area of equipment.

Both faculty members shared that there is a gap in the NATEF standards between what is being taught and vehicles currently on the road today. While both felt that for the most part the NATEF standards meet curriculum needs, the 2002 standards under which they were most recently certified in 2006 did not address technology already on the road and was very commonplace at the time of their recent program certification. Both instructors felt that when the next set of NATEF standards came out the standards would address technologies such as Hybrids.

In reviewing the interviewee answers, institutional records were used to compare their answers to stated practice. Through this cross-checking, the researcher was able to verify that this college held a very high regard for the value of program certification (accreditation) standards. This was demonstrated by the following institutional documentation. As an overall program (and intuitional) effectiveness indicator, the program review process at College B has a goal to "Evaluate and update the currency and relevancy of learner competencies in associate degree, diploma, and certificate programs through the re-establishment of the program review process, accreditation, and consultation with advisory committees" (College B FY05 Campus Achievement Reports, 2005, p. 67). This was further supported by the following statement: "The Automotive Technology, Human Services, and Culinary Arts departments initiated the process for program accreditation" (p. 69) in their Achievement report. Internal documentation also corroborated the fact that the college, as a multi-campus institution, kept curriculum consistent between programs across the campuses (College B College-wide Deans of Instruction meeting minutes, March 22, 2007). Program advisory meeting minutes also verified that the S.L.O.A. benchmarking for the automotive program was in fact the NATEF standards (College B Automotive Advisory Board meeting minutes, March 22, 2005).

College C Interview Findings

College C has an automotive department which also houses the diesel and automotive collision program. It should be noted that the answers from the Administrator and program head refer to their Automotive, Diesel and Auto Collision programs. It should also be noted that the program head, CF2, is a NATEF ETL, and CF1 is an ASE test question contributor for the transmission and transaxle exams.

When asked what forms the basis of the curriculum, the administrator, CD1, shared that the faculty all work in industry during the summers, so their input from this real world experience is a large part of the method used to keep their program curriculum up-to-date. He also stated that the foundation for their auto, diesel and collision programs came from the input of industry and that the NATEF standards form a large part of their curriculum, “especially all the freshman courses have a very particular check-off sheet to make sure we have covered all the NATEF, plus, as far as the tasks are concerned” (CD1). According to the program head, CF2, their entire curriculum is based around the NATEF standards for the programs. They do use the NATEF tasks to guide them, and while they might go above it, as with the Hybrids, the foundation is based around the NATEF standards. CF2 related that curriculum and/or courses are updated annually. These updates are done by the instructors, each charged with oversight of a specific set of courses. Then, using the most current NATEF standards, faculty members’ real world experience

and contacts with the industry, and advisory council input, course curriculum updates are developed. This process then forms the core of their curriculum.

Both the administrator and the faculty members were asked about any program changes that were necessary when their program initially applied for NATEF certification. According to the program head, CF2, the initial program certification was in 1984. He has oversight of all three NATEF certified programs at the school—automotive, diesel and auto collision. At the time of their initial program certification for those three programs, it is his understanding that there was some curricular modification; however, this occurred before he was employed at the school. The other faculty member, CF1, explained that for the initial NATEF certification, almost all the curriculum needed to be modified to meet the NATEF standards and tasks. “Across the board. . . there wasn’t a single course untouched” (CF1). The administrator did not any have input on this topic, since he was not there at the time, nor did he have knowledge about it.

While discussing the topics of curriculum updates, the role the NATEF standards have in curriculum updates, and if the NATEF standards are perceived as being sufficient to maintain the program quality, relevance, and currency of technological advances, the administrator, CD1, shared that every time there is a NATEF standards revision the program revises what they teach. If there is an addition or deletion in the standards they will make the same changes in their curriculum. “We actually follow them (NATEF) pretty closely” (CD1). It is the perspective of this administrator that the NATEF standards aid in keeping the

curriculum current in his programs; however, he related that at times NATEF is sluggish in reacting to technological advances. An example of this slowness to update has been with the Hybrid vehicles and corresponding technology. NATEF has also not been as responsive to dropping outdated technology, an example of which is with carburetors.

The NATEF standards do work well as a basis for how the programs handle the curriculum. The faculty member, CF1, explained how NATEF impacted curriculum updates and technological changes. Currently, the method used to develop, revise or update their curriculum is through a standing curriculum committee in charge of reviewing courses, keeping track of the NATEF standards, making sure they are within those standards, and that they meet all the standards. Each instructor in the program is responsible for maintaining a course so that it meets NATEF standards, but key to all this is the curriculum committee. However, as to curriculum updates, the instructor also stated that "another component would be external review every five years. . . by NATEF" as the program is recertified (CF1). CF2 shared that course curriculum review and modification is constantly ongoing. As an example, their programs have incorporated training on the current Hybrids even though NATEF does not yet call for it. CF2 also noted that the NATEF standards are helpful in aiding his program with budgeting for purchasing the equipment needed to keep and meet certification requirements.

When discussing the timing for the program's overall revision or updates, the instructor CF1 shared that for their program there is no set time frame for this—

it is done according to NATEF revisions. “When NATEF revises standards, which only happens on occasion, that is a key period for us to review our curriculum” (CF1). Since they do review their program against NATEF standards annually, they do not end up with a full-scale revision at the NATEF update cycle time periods. But each time NATEF revisions come out, they take the opportunity to review and compare them. The advisory council also identifies updates based on real world needs and input. A major and critical part of their curriculum updates is to incorporate all three levels of the NATEF tasks: the P-1, P-2 and P-3’s. While the advisory committee is not as in tune with the NATEF standards, they are in touch with the daily needs of the various automotive employers.

When looking at how major technological advances are incorporated into the curriculum, the programs are typically constrained by budget matters. “Major technological advances into the curriculum are done as soon as budget allows. If you look at the electronic advances, the need for scopes and scan tools are an example of this” (CF1).

The NATEF standards do assist in keeping program curriculum current for areas that the program may not think is critical, but the NATEF ranking of these areas aids in keeping the program in line with need. But looking at the most recent technological advances on the road today, CF1 feels that the NATEF standards are a little bit behind. This is not necessarily the fault of NATEF. The only way to address this problem would be to have more frequent NATEF revisions. NATEF not keeping up with anticipated technology, specifically that which might not be on

the road today, does not hinder their focus for entry level technicians. CF1 “absolutely” felt that in general the NATEF standards would be sufficient to maintain program quality, relevance and currency with technological advances. He related that the NATEF standards are sufficient, with the caveat that only if NATEF continues to make more current changes to their recommended standards, because technology that has only recently been available is not currently reflected in the standards or tasks. This instructor cited some specific examples of curriculum changes as a result of NATEF standards directly impacting his specialty area, which is transmissions. While some of the standards have been in use for some time, NATEF has updated their electronic diagnosis standards to a suitable extent. Thus, what he teaches and how he teaches his own set of courses has been impacted.

According to the program head, CF2, the foundation for the entire curriculum is based on the NATEF standards for the programs. While NATEF tasks are used to guide them, they might go beyond these, as with the Hybrids. The advisory board also aids in guiding their programs; however, their input must be carefully weighed, so as not to slant the curriculum toward any one area. An example would be dealerships that still rebuild engines and transmissions, whereas many of the independent repair shops now exchange entire units instead of doing the actual component rebuilding. The instructors also watch the NATEF standards and review textbook changes to aid how they modify their curriculum to match the needs of their students to the programs. As an example of this for automotive, at

one time air bag tasks were rated P-3 by NATEF and were thus a lower priority task to teach, but they are now rated P-1 because almost every car now has them. The instructor also related that when looking specifically at equipment and its role in the curriculum, the equipment committee uses the NATEF equipment list as a guide. In the curricular area, the instructors make modifications as needed when the mid-point review for their certification comes up (every 2½ years).

When asked about meeting current and emerging technology in the curriculum, the conversation tended to look at the issues of gaps between the NATEF standards and the current technology being taught. According to the program head, CF2, course curriculum change is constantly ongoing. As an example, training on the current Hybrids is being incorporated even though NATEF does not yet call for it. From his perspective, the NATEF standards are commendable in keeping the tasks lined up to meet the current needs in their programs and with respect to industry needs. But NATEF is currently not meeting the need for some of the latest innovations, such as the Hybrid technology. CF2 did believe that the ASE exams are moving that way, but the current NATEF standards do not cover it. He did anticipate that during some future NATEF certification revision, this would be incorporated. He believes that his programs are meeting the NATEF standards and exceeding them both in tasks and time required for each respective NATEF area. Their guidance for exceeding the NATEF standards came from the major manufactures, book publishers, aftermarket training seminars and clinics. In his view, at this point no significant changes to the curriculum are being

made due to NATEF changes because the programs already follow the standards so closely that only minor updates are needed to match NATEF.

Another example given during the interview was in the diesel area. CF2 pointed out that major advances in technology are incorporated into their curriculum every year. In the diesel program, bio-diesel is now an important issue and has been incorporated into the program. In partnership with the college bus fleet and the culinary program, a reactor has just been built to teach students how to change vegetable oil into diesel fuel.

Summary of College C Interviews

Through the process of interviews and follow-up data gathering at College C, the following themes emerged. Both faculty members shared that at the time of the school's initial NATEF certification, curriculum revision was needed. One faculty member was not employed there at the time; the faculty member who was employed then related that almost all the curriculum needed to be modified to meet NATEF standards. It was shared during discussions that for all three programs—automotive, diesel and auto collision—this was the case. The faculty and administrator were also in agreement that the NATEF standards played a large part in the curriculum updates and formed the core of their curriculum in conjunction with advisory board input. Throughout the conversations, the topic of going above the NATEF standards came up with respect to Hybrid cars for the automotive program, and bio-diesel for the diesel program.

All three interviewees were in agreement that, for the most part, NATEF standards do a good job of providing a sufficient basis for the curriculum, both technologically and quality-wise. The administrator and faculty did relate, however, that in some areas beyond the basics, NATEF was slow to adopt or delete items in the standards. Hybrid technology was cited as in need of inclusion, and the deletion of carburetors were examples for the automotive area. In the area of diesel, the inclusion of bio-diesel above the NATEF standards was discussed. With respect to curriculum and NATEF, College C was very responsive to adjusting their curriculum as changes from NATEF were published. In fact, they task instructors with this on a yearly basis.

The theme of the program budget being connected to NATEF standards came out in the conversations. For the most part, through the NATEF standards, the department can justify needed equipment as it is introduced to the industry. In some cases, however, there are examples of technology currently on the road that are not reflected in the standards, and thus not easily justified for purchase. This left the faculty with the feeling that the NATEF standards lagged somewhat behind in this respect. However, it should be noted that this did not cause the faculty or administrator to think any less of the NATEF standards. Specifically, it was pointed out that as long as NATEF kept updating the standards as technology becomes commonplace after being on the road for a few years, the standards will continue to be sufficient. This conclusion seemed to come about due to a perceived gap

between commonplace technology on the road today and the standards available to the school at the time (Hybrids in this case).

Review of Common Themes and Cross-Case Analysis

Throughout the three separate study cases presented in this chapter, the following common themes emerged. These common themes will be presented initially as brief statements, and then presented within the context of each research question as a "thematic analysis across the cases" (Creswell, 1998, p. 23).

Common themes

1. In the research of each case for this study, it was identified that the NATEF standards and tasks form the core of each programs curriculum.
2. Each case studied identified that curricular change and or facility change was necessary to meet the initial NATEF certification standards at the time of their first certification.
3. All programs studied reported that as NATEF standards changes they seek to incorporate these changes in their programs when ever possible.
4. Through the study of the cases, a correlation between equipment purchase and the identification of such equipment in the NATEF standards or the inability to purchase if a needed item was not identified in the standards was established. While each set of interviews identified that some form of program-related updates (curricular) were done

regularly, there was a strong theme that connected equipment and facility changes to the time of certification or recertification. It was only in these five-year cycles that certain, more expensive, items related to newer technologies were then added to the program to meet the latest NATEF standards.

5. The research discovered that each program had in place a method or process to incorporate curriculum that exceeded the NATEF standards.
6. Advisory boards were identified as a key component for programs to identify needed tasks and curriculum beyond the NATEF standards.
7. The NATEF standards were identified as a being sufficient to maintain program quality and relevance for the most part.
8. During this study a gap was identified between the NATEF standards and task, and needs of the programs to teach curriculum reflecting the technology on the road at the time. The most common example was the prevalence of Hybrid technology on the roads at the time of this study and the lack of that technology being well represented in the NATEF standards. At least one person at each program interviewed expressed a concern or desire to see NATEF move faster to incorporate newer technologies into the standards.

Cross-case analysis

What do community college automotive programs use as a basis for their automotive curriculum?

The NATEF standards clearly formed the foundation of each program's curriculum. When developing programs or updating programs, NATEF was clearly a major component. Looking historically at each school's program when they sought initial NATEF certification, there was a common theme of curricular, facility and equipment changes. In each case studied, almost all of those interviewed shared how curricular changes were necessary in order to attain NATEF certification. In some cases this change was done over a few years, so at the time of actual certification only a small portion still needed to be changed; however, a high percentage of substantial curricular change was necessary to meet the NATEF standards, and some updating was necessary for subsequent NATEF recertification cycles. This also played out with respect to facility and equipment issues. For each case, there was some impact on needed equipment or facility changes to meet the standard for initial certification, and subsequently for continuing to meet the standards at their recertification.

If community and technical college automotive programs use the NATEF standards as the basis for their curriculum, how much of their curriculum exceeds the NATEF standards?

In all three cases studied, each of the colleges had presented examples of curriculum that exceeded the NATEF standards. Two of the colleges did this on

their own; in both of these cases they added Hybrid technology training to their curriculum. In one case, Bio-Diesel was added to the Diesel curriculum. While the college in Georgia did not directly add items into their curriculum above the NATEF standards, they were able to exceed the NATEF standards through the following courses developed by the statewide curriculum committee: AUT 212 Advance Electronic Transmission Diagnosis, AUT 214 Advanced Electronic Controlled Brake System Diagnosis, AUT 216 Advanced Electronic Controlled Suspension and Steering System Diagnosis, AUT 218 Advanced Electronic Engine Control Systems, and AUT 220 Automotive Technology Internship. These additional courses were added because these more advanced technological areas were not yet well covered by the NATEF standards and tasks.

How are recent and anticipated advances in automotive technology incorporated into the curriculum?

In each case studied, input from the advisory board and other industry sources provided the primary input driving the incorporation of advances in technologies into the curriculum. In only one study case, where faculty regularly returned to automotive shops for hands-on experience to their skills current, was this experience then used to aid in understanding revisions needed in the program curriculum.

Connected to this research question, each case studied had some budget issue related to items not in the NATEF standards. In each case there was some

discussion of how a change in the NATEF standard enabled them to justify a needed piece of technology to aid in instruction. There were also examples of how, due to gaps between the NATEF standards and current on-road technology, items seen as necessary by the faculty to meet curricular needs could not easily be justified for college purchase or acquired through donation since they were not yet NATEF requirements.

Are the NATEF standards perceived as being sufficient to maintain program quality, relevance, and currency with respect to technological advances?

The NATEF standards were clearly seen as sufficient to maintain program quality and relevance with respect to almost all technology on the road at the time of a school's certification; however, each school did share experiences in areas where the current standards did not address certain commonplace technology on the roads—the most pressing example being the Hybrid technology. Almost every person interviewed expressed some concern about the need for NATEF to be more in tune with the rapid advances of the technology. Many felt that by the next standards update, some of this might be addressed. The impact or effect perceived on the regular updating of curriculum at each school varied somewhat, according to which person was interviewed; however, regular program changes were clearly tied to any update or revision done by NATEF. Each interviewee related to the researcher that the NATEF standards were either the core or only second in

importance behind the input of their advisory committee with respect to curricular updates.

This chapter presented the findings of the individual cases researched in this study. The most pressing matter raised in the interviews, which came out clearly in the cross-case analysis, was the issue of technology lag, with respect to the NATEF standards adopting emergent technologies such as Hybrids. This will be addressed in Chapter 5.

CHAPTER 5

DISCUSSION AND IMPLICATION FOR FUTURE RESEARCH

This study has researched the perceived effect, impact, or role the industry standards of NATEF have on the currency of a given program, or a program's curriculum with respect to current and emerging technology. The study focused on three separate publicly funded college automotive-related training programs. This chapter focuses on the issues identified in the themes of the cross-case analysis in Chapter 4 using the initial research questions. These findings will be presented with their associated research question and the conclusion based upon the findings. Included in this chapter are recommendations based on the findings and implications for future research.

Discussion of Themes

Clearly, as evidenced by the common themes identified, NATEF has made a positive impact on the Automotive, Automotive collision and Diesel programs studied. However, there seem to be issues emerging which merit consideration with respect to both the perceived role NATEF standards have on a program's curriculum currency and the technology on the road at the time of a program's certification, as well as findings in this study.

The resounding answer to the first research question, "What do community and technical college automotive programs use as a basis for their automotive

curriculum?" was: "NATEF." In themes discovered for the second research question, "If community and technical college automotive programs use the NATEF standards as the basis for their curriculum, how much of their curriculum exceeds the NATEF standards?" one can begin to see where, on the positive side, schools are generally able to exceed the NATEF standards to better meet their specific needs. However, it was also discovered that additions to the curriculum which exceeded the NATEF standards were necessary. This is because these areas were not yet well covered by NATEF even though the technology in question was already commonplace on the road at the time of the interviews, and was recent in terms of the respective program's certification dates. There was a strong desire expressed by most of the faculty and administrators interviewed to see NATEF adopt the newer technologies much more quickly.

The findings from the third research question, "How are recent and anticipated advances in automotive technology incorporated into the curriculum?" demonstrated that each school was successfully utilizing other resources to incorporate anticipated advances into their curriculum. The most common method for incorporating advances was through their individual advisory boards. Other industry sources were also cited as ways to incorporate advances. Exceeding the NATEF standards came at a price, however. Each person interviewed expressed the strength of having something identified (typically newer technologies) in the NATEF standards as a requirement for their certification. This enabled their respective program to justify the additional expense or purchase, basing the need on

the NATEF standards, thus enabling them to teach a newer technology. So, where a school's curriculum exceeded the NATEF standards, purchasing or funding the additional required items became an issue. In some cases the programs could not afford to bring in the necessary training aids, like a Hybrid car, to meet the needs of their curriculum. Thus, the lack of a NATEF standard or task for something as commonplace as Hybrids could negatively impact a program's ability to acquire the equipment and teaching demonstrators for their training needs.

A deep concern was revealed from researching the fourth question, "Are the NATEF standards perceived as being sufficient to maintain program quality, relevance, and currency with respect to technological advances?" Here the NATEF standards were clearly seen as sufficient to maintain program relevance and currency at the time. However, the issue of NATEF failing to address the technological advances in a timely manner came up in the interviews. The most pressing example at the time of this study was the lack of Hybrids in the current NATEF standards. Almost every person interviewed expressed the need for NATEF to be more in tune with the rapid advances being seen in the industry. This reveals that a close examination is need of where their perceptions are rooted. To do this, one must first understand the NATEF time line and its implications.

It would seem that the timing of NATEF task development and the subsequent standards publications are at the heart of the issue of adopting technologies more quickly in order to meet the expressed need. To understand how this time lag issue, voiced by most of those interviewed, can impact a program and

the standards, we must first look at how the standards are developed. As discussed in Chapter 1, NATEF standards and tasks are reviewed and updated every three years by a national committee. The following is an example out of the Medium/ Heavy Truck manual but is mirrored in both the automotive and automotive collision manuals. “The committee consisted of individuals representing the major truck manufacturers, truck repair shop owners and technicians, truck instructors and trainers, and truck equipment and parts suppliers” (NATEF, 2004, p. 34). These updates are then incorporated into the new edition of the respective program certification manuals. When NATEF standard updates are published, they are clearly only a snapshot in time. At the time of this research study, the latest Automotive certification standards manual was the 2005 edition, the latest edition for the Diesel (Medium/Heavy Truck) was 2004, and the Automotive Collision manual was dated 2006. Each of these manuals has training tasks derived from the ASE task lists. “It is a NATEF policy that the task lists developed by the National Institute for Automotive Service Excellence (ASE) serve as the basis for the NATEF task list” (NATEF, 2005, p. 9). These ASE task lists, which are the basis for the ASE test questions, are, as already identified in Chapter 1, inherently two model years behind current technology. According to ASE President Ronald Weiner, “ASE’s tests are designed to reflect a national fleet of about two years behind the most current model year” (ASE, 2003).

NATEF further validates the value of the task list and its process, stating “An essential element of any curriculum or training program is a valid task list.

Automobile technician instructors need a well-developed task list that serves as a solid base for course of study outlines and facilitates communication and articulation of their training programs with other institutions in the region" (NATEF, 2005, p. 9). Clearly the importance of valid tasks, a process to identify them, and the dissemination of said tasks, is a very important role which NATEF fulfills. However, what needs to be brought out with task development is the look-back feature of ASE's, and thus NATEF's, task design, which appears to be at the root of the inherent technological lag identified in this study.

With the two-year look back design of the ASE tasks, and thus the NATEF task development and later publication already identified, we must also examine other ways this time lag builds and develops. One way the lag occurs between the development of the NATEF tasks and the publication of these tasks is with the development to publication time line of new standards. It takes time for NATEF to gather input from the revision committee review and get the new standards published. As an example, in the case of the latest Diesel standards it was 10 months between the development of new recommendations and publication of these new standards and tasks (the National meeting was held in January 2004 and dissemination of the new standard book occurred in November 2004) (NATEF correspondence, November 12, 2004; NATEF, 2004). Another element of this time lag is that NATEF allows a given program up to 18 months from the date of their initial application for certification or recertification. "Programs will have a maximum of 18 months to complete the certification process from the date of their

Application for Certification or Application for Recertification is received by the NATEF office" (NATEF, 2005, p. 3). The following is an example of this time lag in action for a NATEF certification time line:

- 2000 is the model year on which ASE tasks are derived for the 2002 publication of NATEF task and standards.
- Early in 2002, NATEF standards are developed for the 2002 certification manual based on the 2000 model year ASE tasks. These new standards are then valid for three years—until 2005 in this case.
- Early in 2005, a program applies for NATEF certification and is grandfathered under the 2002 standards, since the new 2005 standards are not out at the time of their application.
- Mid to late 2005, the new NATEF certification standards came out.
- Late in 2005, the program is evaluated for certification.
- Some time in 2006, the program is certified by ASE/NATEF for five years under the 2002 standards.
- 2008/2009 – Program will be due for its mid-program review.
- 2011 – Program will be due for recertification.

Looking specifically at the research in this study, College B applied for certification in 2005, had up to an additional 18 months to certify under the previous 2002 standards—standards developed on 2000 technology. Thus, by the time College B had certified, they were already utilizing standards from 2000,

which formed their core curriculum—standards which were over 60 months, or five years, out of date with the technology on the road at the time of College B's certification.

College B is but one example of how certification time lines can cause a potential technological lag in a program curriculum. Looking at the fact that NATEF standard updates are published in three year cycles, if any given school is seeking certification in the second year of a standards publication, that school could possibly be as much as four years and 10 months, or 58 months, out of date from when the initial ASE tasks were developed. These ASE tasks then form the foundation of the NATEF standards, which in turn, as identified in the case studies, form the foundation of a school's curriculum at the time the school sought certification, and are already up to four years and 10 months out of date with technology on the road the day the school is certified.

Looking further into this issue, NATEF certification is valid for five years and most of the individuals interviewed expressed difficulty in justifying the purchase of newer technologies if these were not in the NATEF certification standards at the time of their certification or recertification. It is then reasonable to assume that a program certified under an older set of standards might not be able to facilitate the purchase or inclusion of newer technologies into their program until it is required for their next recertification date. This could then extend the 58 month time lag an additional 60 months, for a total lag time of 118 months, or 9 years and 10 months between the date a program's certification standards were designed

(model year technology) and the certification date for said program expires (as well as the technology on the road at the certification expiration date).

Even given this apparent time lag issue, the colleges studied for this research were already expecting that the next standards release due in late 2005 would, or should, address their concerns about technology missing from the standards (from their perspective). Specifically, those interviewed at the colleges had surmised that in the next set of standards, NATEF would begin to incorporate more of the advanced technology like the Hybrids. By comparing the 2002 through 2005 standards and tasks, the researcher was able to verify some of their assertions about future changes. However, the 2005 standards only include six low priority P-3 tasks related to Hybrids (NATEF, 2002; NATEF, 2005), which in light of the increasing popularity of Hybrids seems to be a minimal number. While having these new tasks identified is a positive, it must be realized that the NATEF required tasks break out as follows. A program must teach 95% of the P-1 tasks, 80% of the P-2 tasks and only 50% of the P-3 tasks. Out of those percentages, in the case of the latest automotive standard, there are a total of 92 P-3 tasks (NATEF, 2005). Remembering that only 50% of the P-3 tasks need to be covered for certification, it is easy to see how, with the Hybrid tasks rating only a P-3 designation, many schools opt to not teach these six tasks (especially if budget is an issue), and thus do not justify purchasing related training aids.

One might think that this is not an issue because another common theme in this study was that the programs had identified ways to incorporate curriculum that

exceeded the NATEF standards. While covering more than the NATEF standards called for in a given curriculum has already been demonstrated as commonplace, the negative impact of not having something identified in the standards for justification to purchase has also been identified. Each college reported that they do use the regular NATEF updates as a tool for revising their curriculum. However, typically these more costly changes are only justified upon a program's certification or recertification, as was the case with the improvement needed to meet the certification standards for College A and College B, even though the standards under which they were seeking certification had been out for a several years prior to their certification visit. Both of these colleges had curriculum foundations already derived from the NATEF standards before they sought certification. At College C it was identified by CF2 that the NATEF standards were helpful when it came to the budgeting process (and thus justification) in meeting certification requirements. At College B, BF2 identified how the NATEF standards enabled their purchase of newer tire technology for their certification; BF1 identified that they very much wanted to add Hybrid training to the curriculum but are held back due to budget constraints. Given that items called out in the standards typically are justifiable for purchase, and those not in the standards are harder to justify, it is reasonable to assume that a college like College B might never be able to get ahead of the technological curve because they must wait until the actual certification date (2011) to make any equipment related purchases for the newest standards, thereby operating a program under guidelines from a bygone era.

The above is only an example of the possible technological time lags that could impact standards development. With respect to the technology on the road at the time a program seeks certification, these time lags might not seem important, but it must be remembered how rapidly today's on the road technology is changing.

With NATEF standards being set in the specific time frame in which they are developed, and realizing the time lag that can occur in the life cycle of a program's certification efforts due to the dramatic technological advances in the industry, the issue of standard and task development time lag needs to be addressed. Using examples raised in this research study, the most pressing need for a given "technology" to be addressed by NATEF seems to be the introduction of Hybrids into the standards and tasks. No doubt the need for this is being felt by all three programs due to the rapid increase of Hybrids on the road over the past few years. Hybrids, which only started to "hit the streets" and the mainstream market in 2002, are now a hot item on showroom floors. Recent articles about the growth and expansion of Hybrids in the marketplace support the desire for the inclusion of this technology into the NATEF tasks. According to J.D. Powers and Associates, in the first half of the 2007 model year, Hybrid car sales accounted "for more than 2 percent of all new vehicle sales" (WGAL, 2007, retrieved from the internet). This is not the only advanced technology taking to the roads. Honda and GM will both introduce a pilot run of hydrogen based alternative fueled internal combustion engine cars in a few selected U.S. markets in late 2007 (CNNMoney, 2007a). GM is also gearing up to have production of their fuel cell vehicle on the market by

2010. When GM made this type of production shift for their Hybrid models, they had the Hybrids on the market in just four short years (CNN, 2007).

If these technologies take off as well as the early Hybrids did, in a very few years the hydrogen or fuel cell propelled vehicle could represent another 2% of the marketplace. The market for these minimal emissions vehicles is so popular that even Porsche has a prototype SUV in development and hopes to bring it to market in two or three years (CNNMoney, 2007b). The increasing prevalence of technologies that only very recently were still on the drawing board or in their infancy, like fuel cell technology, supports the need expressed by all three colleges in this study—to incorporate at a faster rate the recent and impending technological advances into the NATEF standards and tasks.

Recommendations

In looking at the themes that emerged from this study, there are several areas that can be considered for improvement with respect to the questions posed. Both the colleges (and their respective programs) as well as NATEF could consider the following recommendations to potentially improve effectiveness. I will start with specific recommendations for the program(s), its administration, faculty and staff at the colleges studied, then make recommendations specifically for NATEF. After each set of recommendations I provide the justification for them derived from the research in this study. Reflecting back to Chapter 1, Halfin and Nelson (1982) stated that one of the greatest challenges vocational education faced was keeping

curriculum development current with the technology of the day. This clearly is still an issue at the time of this study. It is incumbent upon each college to ensure that its programs and curriculum are current. My recommendations for programs based upon the findings of this study are:

- Each program should continue to be proactive and seek the incorporation of newer technology ahead of the NATEF standards.
- Each program should use their NATEF mid-point review cycle to incorporate new NATEF standards, as they are released, into their program, thus easing the budgetary issues of being able to afford needed items before a recertification.
- As new NATEF standards are released, each program should review the changes with their advisory board, seeking recommendation on what new parts of the standards to include currently, rather than waiting until the next certification cycle.
- Programs seeking certification during the time period between NATEF standards updates should elect to certify under the newer set of standards, rather than opting to certify under the older set.

These recommendations have been made because during the research interviews, a clear theme emerged that the colleges desired NATEF to be more proactive with incorporating newer technologies into the standards. This desire for faster adoption can be a two way street. As the interview data showed, each program identified how they had a number of ways to aid in keeping their

curriculum current. While NATEF was a key player in that role, it is not the only one. Outside of the NATEF process, to update and revise their curriculum, programs relied on their advisory boards for input. It must be remembered that NATEF certification is voluntary and the programs studied here can take the opportunity to exceed the NATEF standards and address some of the concerns voiced about the curriculum being current with the technology on the road. Each program in this study was doing this to some extent. The DTAE system that provides curricular support for College A (and all their sister institutions in Georgia) is a good example of how administrators, faculty and programs can take this approach. Even though their curriculum is based on the NATEF standards, they had already created five specific courses that clearly were designed to exceed the NATEF standards in areas of newer technologies. These are courses that any of the more than 30 state programs DTAE supports could elect to offer.

Taking a very proactive approach such as this, and seeking to be ahead of the national standards could lead a given program to even higher levels of excellence in comparison to other peer institutions and programs. However, the struggle in this approach to the issues identified is dependent on monetary issues. Each program in the study expressed concern and need related to the inclusion, or lack, of something in the standards. The faculty, staff and administrators could seek to exceed the NATEF standards as budget permits, but without specific items or technologies, inclusion into the only national standard for the respective program becomes an uphill fiscal challenge.

One possible way for each program to address this fiscal issue would be to take the mid-program review cycle as an opportunity for the inclusion of newer NATEF standards within their program. With the NATEF standard revision process on a three-year cycle, it is very possible that a given school could be certified under one set of standards and by the time of their mid-program review a newer set of standards will have been published. While the program is not responsible to adopt the newer standards until they are up for recertification, they should proactively seek to incorporate as much of the newer standards as they can afford. This could be accomplished by reviewing the new standards with their respective advisory committees and seeking input on what, if anything, to incorporate into their current program.

Programs could also use the mid-point program review and or any changes in the NATEF standards to begin budget planning to slowly acquire the items needed to meet the next set of standards. Rather than waiting until the actual program recertification process to update and meet new standards, taking a few years to slowly ramp up to the next level of standards and technology could aid in being able to afford needed items before a recertification.

Another approach would be for those colleges seeking certification at the time of a NATEF certification update (College B in this study) to voluntarily seek certification under the newest standards, wait slightly longer (a matter of a few months), to seek certification under the latest set of NATEF guidelines. Whatever the outcome of any implementation recommended above, it must have the full

backing of a college's administration and faculty to help address the fiscal implications.

Aside from recommendations specific to programs at these three colleges, recommendations geared specifically towards the NATEF certification process and not the programs seeking NATEF certification also need to be considered. With NATEF certification seen as the benchmark of quality, focusing efforts to raise the bar here could foster more effective change for the colleges studied and possibly beyond. My recommendations for NATEF based upon the findings of this study are:

- NATEF should develop a new optional certification area for emergent technologies, or develop an advanced certification endorsement option.
- NATEF should require schools to use their mid-point program review process to begin incorporating the latest standards.
- NATEF should use current model year technology for the development of the NATEF tasks, and stop using the ASE tasks as their foundation, since the ASE tasks, as designed, are two years out of date.
- NATEF should adjust the timing of their certification standards revision and development as well as the subsequent dissemination of this information, to aid in minimizing the technology lag issue.
- NATEF should allow schools only one year, not 18 months as a "grace" period between application for certification and completion of the

certification process, again to aid in minimizing the technology lag issue.

- NATEF should better control the timing of program application and evaluation for certification to minimize the possible overlap with the certification standards revision cycle.
- NATEF should increase their communication with certified programs to disseminate standards updates as soon as NATEF adopts them.

As already identified, the colleges in this study are basing their curricular foundations on the NATEF standards, and they are typically able to justify necessary purchases to keep up to date with the standards only at the time of certification or recertification; therefore, the timing of standards and task development is an important issue. In Chapter 1 it was identified by Parks (1996) that external standards, which are developed by industry and business, should be used as the basis for developing and updating technical curriculum. The issue of keeping the curriculum current, as well as current external standards (which can form the basis for the curriculum) can be difficult. Technology changes so rapidly that during the typical life cycle of a curriculum in a professional technical program, the program and its curriculum could be surpassed by technology. Part of the overall concern regarding the NATEF timeline (time lag) is that under the current processes (using College B as the example) a program can easily find itself in the situation where its program is certified under already outdated standards and might only meet the new standards at its next certification due date, leaving a

program as much as 9 years or more out of date with respect to the technology on the road at the time.

This leads to the question: “Are there ways or practices NATEF could draw from to address these concerns?” In reviewing the initial research, there are obviously a number of possible options to be considered. Crunkilton and Finch (1999) stated:

> Contemporary vocational curriculum must be responsive to a constantly changing world of work. New developments in various fields should be incorporated into the curriculum so that graduates can compete for jobs and, once they have jobs, achieve their greatest potential. (p. 17)

Clearly this concern was, and still appears to be, an issue due to the time lag between the development of vocational programs and when the curriculum is updated and approved. “Too much time has lapsed during this curricular life cycle and topics become obsolete or new technology has surpassed the program” (Halfin & Nelson, 1982, p. 1).

In the past, NATEF addressed this type of concern by developing an optional area for certification as a new technology was becoming prevalent in the field. An example of this was the 1996 implementation of the optional CNG standard for the Medium/Heavy Truck certification. The process for this development began in 1992 and culminated in 1996 with the release of the new optional certification area offered by NATEF. This past process of adding an optional area for certification early on was in line with Samuelson’s (1987) Fast-Follow Response Mode, where the advent of new technologies or standards are

brought in ahead of the curve of the technology becoming mainstream. Given the time lag issue, which equates to curricular currency and was identified by each of the cases in this study, NATEF should consider continuing to develop an optional certification standard for emergent technologies like Hybrid vehicles.

If we look outside of NATEF, other accreditation/certification entities also must grapple with the issue of curricular currency of the technology available or about to become available. The Accreditation Board for Engineering and Technology (ABET) addresses this concern in their Criteria for Accrediting Engineering Technology Programs manual for the 2006-2007 accreditation cycle. Under their first general criterion, ABET states they expect programs they certify to have program educational objectives that "are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve during the first few years following graduation" (ABET, 2005b, p. 5). This forward-looking goal ABET expects from a program's objectives and outcomes is further supported by their program outcome requirement that graduates from a ABET accredited program can "apply current knowledge and adapt to emerging applications of mathematics, science, engineering and, technology" (ABET, 2005a, p. 32). Clearly, ABET is focusing on keeping a program up to date with current and emerging technology and applications.

The question is how could NATEF follow suit, given that NATEF has an inherently look-back design, or as Samuelson (1987) called it, the Delayed Response Mode. A possible answer is that NATEF should use the existing mid-

point program review as an opportunity to take a more forward-looking approach akin to the ABET approach. The mid-program review, which occurs at the 2 ½ year point in a program certification, would provide an opportunity to infuse more current tasks into a program. NATEF should consider requiring programs to update their tasks to the most current set of NATEF standards at the time of their mid-point review. NATEF could also offer two separate levels of certification. ABET offers Engineering accreditation "at either the basic or advanced level" (ABET, 2005b, p. 4). The choice of which to apply for is left up to the school. NATEF should offer their Master certification and a Master with an Advanced endorsement for those programs voluntarily seeking the higher level.

Another way NATEF might address this issue is the foundation on which the NATEF tasks are developed. Currently, NATEF operates in the Delayed Response Mode Samuelson (1987) identified. Since their tasks are based on the ASE tasks, which are by design two model years behind what is current, this an area where NATEF can take a more proactive approach, similar to Samuelson's (1987) Early Adopter approach. In an Early Adopters approach, NATEF should building their tasks on the actual model year available at the time of a standards update, not on the already outdated ASE tasks. This would easily cut two years off the curricular and technology currency time line/lag issue.

Another solution is to take a more proactive approach in the development of their foundational tasks, and seeking to incorporate newer technology ahead of the curve. Looking again outside of the NATEF standards to another accreditation

agency, The American Veterinary Medical Association (AVMA), their Essential and Recommended Skills list calls for the need for “standards that reflect contemporary veterinary medicine” (American Veterinary Medical Association, 2006, Appendix I, p. 1). The AVMA goes further to encourage instructors “to expand the list (of tasks) with additional skills representing current trends in veterinary medicine” (ibid). NATEF should adopt a policy more like the AVMA and stop using the ASE two-year look-back for tasks, instead developing standards based on the technology on the road at the date of a standards manual triennial review.

A review of the NATEF program certification time line is also recommended. This review would include examining the timing of the various stages within the NATEF certification process for any given program, from the initial application to the actual notification of certification status, including the time line for onsite visits and any needed follow up. This review is suggested because of the identified issue of newer NATEF standards being published and available for use during the currently allowed 18 months between the beginning of a NATEF certification process and when the entire process must be completed (as was the case identified for College B). After reviewing their certification time line NATEF should consider taking an approach in which when a program seeks certification or recertification at or near the time a standards update is about to occur, NATEF could either require the program to use the new standards at the time of their actual certification onsite visit, or could allow the program to use the older set of

standards, and then require that by the mid-point review the program must document how they are now incorporating the newer set of standards. This suggestion could replace the current practice where a program can currently grandfather in under the older standards in this 18 month time frame. NATEF could also consider reducing their 18 month time line to at most 12 months.

NATEF should also consider revising the timing of when actual program certification onsite visits occur and thus be able to control the timing of standards updates with respect to program certification efforts. Here, NATEF could take the lead from ASE. ASE only offers certification exams at set dates and times each year, in November or May. If NATEF adopted the same schedule and allowed the certification/evaluation process to occur only in the fall or spring, they might be able to minimize the number of programs falling between certification update cycles. This would require NATEF to set a specific time line for the release of new standards at each three-year NATEF standards update. This proposed process of the certification cycles occurring on a set schedule (in this case November and May) is similar to how colleges schedule and cycle through their own regional accreditation processes. Regional accreditation agencies like the Middle States Commission on Higher Education or the Northwest Commission on Colleges and Universities typically conduct site visits only twice a year, in the fall and spring.

Future Research Implications

To research the perceived impact the industry standards of NATEF have on a given program with respect to current and emerging technology, it might be beneficial to conduct a study on ASE end-of-program test results, to compare schools that have stepped ahead of the NATEF standards by including advanced or advancing technologies into their curriculum against schools that have not exceeded the NATEF standards. Another research suggestion would be to gauge employer satisfaction and employment success between these same groups. A future study opportunity could be along the same theme as above but with AVMA or ABET programs.

In identifying ways NATEF might consider revising their program certification development and time line, both the AVMA and ABET processes were given as examples of other certification/accreditation process that took a more proactive approach to including new and emerging technologies. It might be beneficial to study the positive or negative impact on student success in AVMA or ABET programs that have clearly moved beyond the requirements and see if there is a direct identifiable benefit to the students upon program completion. Due to the limitations of this multi-case study, it would also be beneficial to study more NATEF certified programs to see if the themes identified in this research are truly representative of the over 700 NATEF certified programs in the country. Since the programs identified for study were already a subset (a subset that had self-selected themselves to apply for the AIPC awards) of all the existing certified programs, it

would also be valuable to replicate this study with programs that have never applied for or participated in the AIPC awards process.

Summary

The findings of this research study on the perceived effect, impact or role the industry standards of NATEF have on the currency of a given program, or a program's curriculum with respect to current and emerging technology, show that NATEF and its standards are partially perceived of as meeting this need. Generally, the programs studied voiced positive support for the strong foundation NATEF provides for their respective curricula. In each case, their curriculum was based around the NATEF standards. Each program identified that they had to bring their curriculum and facility into alignment at their initial certification, and that they seek an ongoing basis to use the NATEF standards as one of the major benchmarks for updating their programs. Outside of NATEF, a program's advisory board was the second most important source of input and influence on a program's curriculum. In some cases, only through the advisory board was a program able to add material that exceeded NATEF standards.

An area of concern each program expressed was in relationship to the timing of the incorporation of newer and emerging technologies. In some cases, this lack of incorporating newer and emerging technologies did not stop the programs from seeking to add to their curriculum above the NATEF standards; however, this lack of meeting the perceived need for the newer and emerging

technologies translated into difficulty for programs justifying purchases related to those advancing technology not yet incorporated into the NATEF standards. Investigation into the underlying cause of the perceived deficiency uncovered that a time lag in the NATEF standards development, implementation, and certification cycle was the issue. Revising how standards are developed and the time line for certification cycles could benefit the programs in this study, as well as other programs, in staying current with their respective curriculum and the technology currently on the road.

It must be said that the positives of the NATEF standards clearly outweigh any issues raised in this research study. Solid evidence in this study, and many others, has documented the positive impact to automotive related training program standards and benchmarks since the introduction of the NATEF certification program. It is the hope of this researcher that no matter what the future brings, NATEF will be a key element in continuing to raise the bar in automotive related training.

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