The Phenomenology of the Bachelor of Science in HVAC Engineering Technology from Ferris State University

Michael Feutz
Western Michigan University

Follow this and additional works at: https://scholarworks.wmich.edu/dissertations
Part of the Community College Leadership Commons, Curriculum and Instruction Commons, and the Higher Education Commons

Recommended Citation
Feutz, Michael, "The Phenomenology of the Bachelor of Science in HVAC Engineering Technology from Ferris State University" (2010). Dissertations. 556.
https://scholarworks.wmich.edu/dissertations/556

This Dissertation-Open Access is brought to you for free and open access by the Graduate College at ScholarWorks at WMU. It has been accepted for inclusion in Dissertations by an authorized administrator of ScholarWorks at WMU. For more information, please contact maira.bundza@wmich.edu.
THE PHENOMENOLOGY OF THE BACHELOR OF SCIENCE
IN HVAC ENGINEERING TECHNOLOGY
FROM FERRIS STATE UNIVERSITY

by

Michael Feutz

A Dissertation
Submitted to the
Faculty of The Graduate College
in partial fulfillment of the
requirements for the
Degree of Doctor of Philosophy
Department of Educational Leadership, Research, and Technology

Western Michigan University
Kalamazoo, Michigan
December 2010
Career and Technical Education (CTE) has evolved from industry-specific training to a more broad-based education that incorporates core academic learning objectives and prepares the student for work (Rothwell & Gerity, 2008; Uloa, 2006; Reese, 2002; Rojewski, 2002; Stone, 2002; Schmidli, 2001). Little is known about how well individual programs align with the industry for which graduates are prepared, (Zinser, 2003) or what CTE has meant to its graduates.

This research focused on graduates of the Bachelor of Science in Heating, Ventilation and Air Conditioning Engineering Technology (HVAC-ET) at Ferris State University in Big Rapids, Michigan. A phenomenological design was used to view the HVAC-ET program from the perspective of both campus and distance learning (online) graduates. Ten campus graduates and eight online graduates were interviewed to determine (a) what the HVAC-ET program meant to them on a personal level; (b) how they perceived they were prepared for their careers; (c) the essential core-academic, general education, and non-academic elements of a relevant HVAC-ET program; (d) and what changes they perceived would improve the HVAC-ET program from the perspectives of pedagogy and relevance.

Most significantly, the study found that all graduates: (a) exhibited a strong
positive attitude toward HVAC-ET; (b) harbored feelings of pride, gratitude and self fulfillment as a result of their experience; (c) were ambivalent toward general education; (d) identified the curriculum, the faculty, and the social environment as essential elements of a relevant HVAC-ET program; (e) felt well-prepared for their jobs; and (f) found the program to be aligned with the HVAC industry. Additionally, campus graduates cited the facility, internships, and industry-sponsored student organizations, while online graduates found the quality and organization of the online lecture series and prompt feedback to be as essential elements of their experience.

Though the study found HVAC-ET to be meaningful to the graduates and relevant with the industry, campus graduates recommended the addition of a contracting business course and program accreditation that would enable graduates to become professional engineers. Online graduates advocated for improved communication via faster feedback and continuous quality improvement of course materials.
ACKNOWLEDGMENTS

To my brother Ron who lost his battle with cancer while I toiled on this dissertation: his humor, zest for life, and love for family has touched us all. I love you, brother.

The completion of this dissertation and a Ph.D. would not have been possible without the help and support of several people who contributed to my efforts and motivation. I would like to thank my advisor and committee chairperson, Dr. Richard Zinser, for his guidance and support throughout the years. His calming demeanor and quiet encouragement significantly reduced my stress and bolstered my confidence. To committee member Dr. Patricia Reeves, your encyclopedic knowledge of qualitative research served as a guiding light and inspired this research. And to committee member Dr. Katherine Manley, who lives by her personal philosophy that taking the time to treat each student as an individual makes all the difference, I am honored to be one of your starfish. Thank you for your inspiration and for taking the time for personal attention. It has made all the difference.

I would also like to thank the participants of this study for taking the time to candidly share their personal experiences. Without them, this dissertation would not have been possible. To fellow students Daryl, Suzette, Jennifer, Denise, and Jason, whose friendship and support helped to keep me going. Dr. Louann Bierlein Palmer, I am grateful for your enthusiasm and staunch support. To Mitch LeClaire, one of the truly great educators of our time, who inspired me to pursue a career in higher education, and to Mike Lafferty and Mike Korcal, for their support and encouragement, thank you for believing in me. Thank you to Dr. William Sederburg and the Honorable Scott Hill-
Acknowledgements—continued

Kennedy, both former presidents of Ferris State University and model educational leaders, for their support and confidence in me.

To my parents for the values of hard work, honor, and commitment. Thank you for the sacrifices you have made for me. To my daughter Julie, sons Greg, Steve and Dave, daughters-in-law Christine and Michelle, and son-in-law Josh; you are my greatest sources of pride. You have taken me places I didn’t know existed and enriched my life beyond imagination. Your accomplishments amaze me and your can-do attitude taught me that anything truly is possible. It was you who gave me the confidence to tackle this doctorate. Thank you for your love and support. I am honored to be your dad.

Finally, to the love of my life, my wife Joanne. Thank you for the selfless sacrifices as I pursued both career and education over these past 18 years. I could not have done this without you. Your love, encouragement and support carried me through. Thank you for sharing life’s journey with me. I love you.

Michael Feutz
TABLE OF CONTENTS

ACKNOWLEDGMENTS ........................................................................................................ ii
LIST OF TABLES .................................................................................................................... ix
LIST OF FIGURES .................................................................................................................. x

CHAPTER

1. INTRODUCTION ............................................................................................................... 1
   Background .................................................................................................................. 1
   Conceptual Framework .............................................................................................. 8
   Assessment of HVACR Engineering Technology using APR ................................ 12
   Problem Statement ..................................................................................................... 15
   Purpose of Study .......................................................................................................... 17
   Research Questions ...................................................................................................... 18
   Rationale for the Study ................................................................................................. 20
   College degrees should prepare students for work .................................................... 20
   HVAC competency tests .............................................................................................. 24
   Workforce readiness tests .......................................................................................... 25
   SAT/ACT Large scale tests .......................................................................................... 26
   Help students select program of study ....................................................................... 29
   Limitations and Delimitations ...................................................................................... 30
   Conclusion ................................................................................................................... 32

2. A REVIEW OF THE RELATED LITERATURE .................................................................. 33
# Table of Contents—continued

## CHAPTER

| Introduction | 33 |
| What is Career and Technical Education? | 35 |
| History of Career and Technical Education (Vocational Education) | 44 |
| General Education Outcomes | 54 |
| LEAP | 54 |
| Basic knowledge and applied skill requirements | 55 |
| Partnership for 21st Century Skills (P21) | 56 |
| Secretary’s Commission on Achieving Necessary Skills (SCANS) | 56 |
| History of HVACR | 57 |
| Assessment | 66 |
| Assessment of curricula: A comparison | 68 |
| HVAC technician certification | 77 |
| Assessment of CTE using performance tests | 86 |
| Assessment of engineering programs | 89 |
| Assessment of HVACR engineering technology using APR | 92 |
| A Review of the CTE Assessment Literature | 95 |
| Alignment with Industry | 106 |
| Summary | 109 |

3. **METHODOLOGY** | 111

<p>| Introduction | 111 |</p>
<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phenomenology: A Qualitative Design</td>
<td>112</td>
</tr>
<tr>
<td>Selection of Subjects</td>
<td>114</td>
</tr>
<tr>
<td>Data Collection</td>
<td>116</td>
</tr>
<tr>
<td>Confidentiality of Subjects</td>
<td>120</td>
</tr>
<tr>
<td>Validation of Data</td>
<td>121</td>
</tr>
<tr>
<td>Data Analysis Processes and Procedures</td>
<td>122</td>
</tr>
<tr>
<td>The Researcher</td>
<td>126</td>
</tr>
<tr>
<td>Summary</td>
<td>127</td>
</tr>
<tr>
<td>4. RESULTS</td>
<td>129</td>
</tr>
<tr>
<td>Introduction</td>
<td>129</td>
</tr>
<tr>
<td>Data Reduction and Bracketing</td>
<td>130</td>
</tr>
<tr>
<td>The Subjects</td>
<td>133</td>
</tr>
<tr>
<td>The Campus-Degreed Graduates</td>
<td>136</td>
</tr>
<tr>
<td>Theme One: Strong positive attitude toward HVAC-ET</td>
<td>136</td>
</tr>
<tr>
<td>Theme Two: Ambivalence toward general education</td>
<td>147</td>
</tr>
<tr>
<td>Theme Three: Personal meanings - pride, gratitude, self-fulfillment</td>
<td>152</td>
</tr>
<tr>
<td>Theme Four: Quality and supportive Ferris educational assets</td>
<td>154</td>
</tr>
<tr>
<td>Theme Five: Well-prepared graduates</td>
<td>164</td>
</tr>
<tr>
<td>Theme Six: HVAC-ET is not perfect</td>
<td>180</td>
</tr>
<tr>
<td>The Online-Degreed Graduates</td>
<td>185</td>
</tr>
</tbody>
</table>
Table of Contents—continued

CHAPTER

Theme One: Strong positive attitude toward HVAC-ET .................185
Theme Two: Ambivalence toward general education......................196
Theme Three: Personal meanings - pride, gratitude, self-fulfillment ....200
Theme Four: Quality and supportive Ferris educational assets.........205
Theme Five: Well-prepared graduates ........................................217
Theme Six: HVAC-ET is not perfect ...........................................223
Summary .................................................................................229

5. DISCUSSION, RECOMMENDATIONS FOR FUTURE RESEARCH,

CONCLUSIONS ........................................................................232

Overall Summary .....................................................................232

Invariant structure of the HVAC-ET program ............................232

Purpose of Study .................................................................234

Research Questions .............................................................235

Research question one .........................................................235

Research question two ........................................................237

Research question three .......................................................240

Research question four ........................................................248

Practical Applications .........................................................254

Opportunities for Future Research ..........................................258

Conclusions ...........................................................................261
REFERENCES .............................................................................................................264

APPENDICES

A. HSIRB Approval Letter ......................................................................................283
B. Consent to Participate in Study .........................................................................285
C. Interview Protocol ..............................................................................................290
D. Email Correspondence/Telephone Script to Potential Participants ............292
E. HVAC Course Descriptions ..............................................................................299
LIST OF TABLES

1. Participant Demographics ................................................................. 118
2. Crosslink: Industry Sectors and Core Academic Courses .................. 242
3. HVAC-ET Student Record in ASHRAE Design Competition ............. 251
LIST OF FIGURES

2. Subject Demographics ......................................................................135
3. Alignment of HVAC-ET with Students and Industry..........................234
CHAPTER 1
INTRODUCTION

Background

In this study, the Bachelor’s of Science in Heating, Ventilation and Air Conditioning Engineering Technology (HVAC-ET) at Ferris State University in Big Rapids, Michigan program was viewed from the perspective of both campus and distance learning (online) graduates using qualitative methodology to learn about their experience, what it meant to them, and how it prepared them for their careers. Through their experiences, HVAC-ET emerged as a relevant Career and Technical Education (CTE) program that is squarely aligned with the industry for which it prepares its graduates. From the perspective of the graduates, the essential core-academic and non-academic elements of a relevant HVAC-ET program were identified along with opportunities for curriculum improvement.

In this chapter, CTE and the program at the focal point of the study will be discussed for the purpose of framing and justifying the research. This discussion will illuminate the diversity of CTE curricula, the unique features of the curriculum in the study, and some of the background and challenges that face educators when evaluating a CTE program.

Career and Technical Education, formerly known by many names including “vocational education,” is generally thought of as that which prepares a student for a specific vocation and typically one that includes hands-on competencies (Bragg & Russell, 1993). Though workforce development or education for jobs has always been
and continues to be an integral part of CTE (Rothwell & Gerity, 2008; Reese, 2002; Rojewski, 2002; Stone, 2002), the evolution of educational theory has recognized the importance of integrating general education outcomes across all curricula including CTE (Humphreys, 2009; Meeder, 2008). Federal regulations, including the most recent Carl D. Perkins Career and Technical Education Improvement Act of 2006 (Perkins IV), have also required it since the 1990 Amendments to the Carl D. Perkins Vocational Education Act of 1984 (Stone, Kowske, & Alfeld, 2004; Milne, 1998). Today, CTE programs vary from pure training (apprenticeships) to associate and baccalaureate degrees which include a full complement of core academic courses. Whether CTE is viewed simply and narrowly as workforce development or more broadly to encompass both job preparation and general education outcomes, logic dictates that it aligns with the industry for which it produces graduates.

CTE includes a wide range of curricula that prepares students for multiple sectors of industry. The range is of sufficient breadth that it is difficult to compile a definitive listing of all educational programs or industry sectors that are considered to be a part of “career and technical education.” Much work has been done by many groups to develop such a list. As may be suspected, several lists resulted, with the defined CTE sectors varying from state-to-state by name and number. According to the Digest of Educational Statistics 2008, there are eleven (Snyder, Dillow, & Hoffman, 2009). Levesque, Laird, Hensley, Choy, Cataldi, and Hudson (2008) list 21 CTE curricula for secondary education and 12 for postsecondary education, though the relationships among several of the secondary curricula were close enough to justify reducing the number to 10 for some analyses. Beginning in 1990, California's Career-Technical Assessment Program (C-
TAP) identified five vocational educational areas. In the same year, Ohio developed *Occupational Competency Analysis Profiles* (OCAPs) for around 60 occupational areas, only to abandon that system in 1998 in favor of *Integrated Technical and Academic Competencies* (ITACs) with only six career clusters (Rahn, O’Driscoll & Hudecki, 1999). Wonacott (2002) provides examples of other states. In Alaska, there are six “Career Pathways.” Indiana has eight “Schools.” Massachusetts, Vermont and Kentucky all use the term “Career Clusters” to describe sectors of industry, but vary by the number used with seven, 15, and 14 respectively.

The variety of names and numbers used to describe sectors of CTE curricula begin to illustrate the diversity and complexity of the system and foreshadow the enormity of assessment across the breadth and depth of all that is career and technical education. In an effort to establish boundaries around CTE despite the multiplicity in name and number of CTE sectors, the 16 career clusters model was used to frame this study. Originally begun in 1996 as a cooperative effort between the U.S. Department of Education Office of Vocational and Adult Education (OVAE), the National School-to-Work Office (NSTWO), and the National Skill Standards Board (NSSB) as part of the Building Linkages initiative (Uloa, 2006; U.S. Department of Education, Office of Vocational and Adult Education, 2005; Schmidli, 2001), the 16 Career Clusters were eventually adopted by the OVAE in 1999 (Ruffing, 2006). The clusters include: (a) Agriculture, Food, and Natural Resources; (b) Architecture and Construction; (c) Arts, A/V Technology and Communications; (d) Business Management and Administration; (e) Education and Training; (f) Finance; (g) Government and Public Administration; (h) Health Science; (i) Hospitality and Tourism; (j) Human Services; (k) Information
Technology; (l) Law, Public Safety, Corrections and Security; (m) Manufacturing; (n) Marketing; (o) Science, Technology, Engineering and Mathematics; (p) Transportation, Distribution and Logistics (States’ Career Clusters Initiative, 2010).

These clusters are meant to reflect all 21st century careers and are designed to help students plan their education in pursuit of those careers. Each cluster is further delineated into career pathways, and each pathway contains numerous job titles. For example, the Architecture and Construction Cluster includes careers involving designing, planning, managing, building, and maintaining the built environment. Within those careers, three career pathways are identified: design/pre-construction, construction, and maintenance operations. Finally, within each pathway are 107 sample occupational specialties such as mechanical engineer and heating, ventilation, air conditioning and refrigeration (HVACR) mechanic (Losh, 2002). Each cluster contains a similar delineation of occupational specialties, summing to a very large number overall.

Ferris State University in Big Rapids, Michigan offers a number of CTE programs including an associate degree in Heating, Ventilation, Air Conditioning and Refrigeration Technology (HVACR-T) and the program at the center of this study, a baccalaureate degree in Heating, Ventilation and Air Conditioning Engineering Technology (HVAC-ET). Though numerous associate degree programs in HVACR can be found in every major city throughout the United States, there is only one other baccalaureate program in HVAC in the U.S.: the Bachelor’s Degree in Heating, Ventilation and Air Conditioning Design Technology at Pennsylvania College of Technology.

Though both serve the same industry, there are fundamental and significant differences between associate degree programs in HVACR and the baccalaureate degree
program in HVAC at Ferris State. These differences exist in part due to the wide diversity within the HVACR industry. The acronym itself contains an elementary industry delineation: heating, ventilation and air conditioning (HVAC) is generally identified with human comfort, while refrigeration (R) is identified with products and processes. A second fundamental delineation is made between “unitary” and “system” installations, along with a corresponding demarcation: “unitary” installations are limited to residential and light commercial installations, while “system” installations are used for large commercial, institutional and industrial applications.

For the purpose of focusing this study on the HVAC-ET program, these differences are important to note, particularly with the level of student preparation in mind. Unitary equipment, designed and built by manufacturers, arrives on the job site with all the necessary components for heating, ventilation, and cooling self-contained. Installation involves setting a single piece of equipment (e.g., a furnace or roof top unit) in place and making connections for fuel supply, exhaust venting, electrical supply, and air/water distribution systems. “System” installations involve numerous pieces of equipment (e.g., boilers, chillers, air handling units, fans, pumps) that are selected to accomplish a specific function within a larger system.

HVACR associate degree programs typically prepare students for careers in the unitary sector of the industry. Graduates most often find jobs as installers and service technicians. Design courses at this level are generally limited to relatively simple residential and light commercial systems. Students gain expertise through hands-on learning exercises while in school, and most graduates work with their hands upon graduation.
In contrast, the baccalaureate degree (HVAC-ET) program was designed to serve the larger commercial and industrial/institutional sectors of the industry. Students no longer work with hand tools and labs are no longer filled with HVACR equipment. Instead, labs are equipped with computers that students use as their tool to analyze, design and control mechanical systems. Student learning shifts from component-level to system-level thinking, and the educational focus shifts from small systems for homes and small businesses to large systems for buildings such as hospitals, schools, factories and office buildings.

HVACR faculty and industry stakeholders, including contractors and engineers with knowledge and expertise in HVAC system design, combined forces in 1984 and designed the baccalaureate degree in HVAC engineering technology. Founded on the belief that the best engineers combine the strengths of hands-on experience with the principles of sound engineering theory and application, the program integrates the associate degree as the first two years of the four-year program.

The junior and senior years of study do not comprise an engineering program and do not include foundational engineering courses such as thermodynamics, heat transfer and fluid mechanics. Instead, elements of those courses are incorporated into the curriculum as they apply to mechanical systems. The program also differs from a typical engineering program by the lack of traditional engineering courses such as statics, dynamics and materials. Instead, it focuses on the principles of sound mechanical system design: psychrometrics (properties of air), secondary system selection and design (ducting and piping), energy load calculations and standards, selection of primary equipment (boilers, chillers, air handling units, etc.), control, and commissioning.
In short, the HVAC-ET program combines the hands-on experiences and system knowledge that students gain during the first two years in the associate degree program with two more years of the engineering principles and applications borrowed as needed from the mechanical engineering discipline to properly design large mechanical systems for buildings. With the pervasive attention given to energy conservation during the time the program was designed in the 1980s, the curriculum was developed with energy efficiency at the core of all courses and included two courses that focused on energy audit and analysis. The resulting program was designed to incorporate the strengths of HVACR technician and mechanical engineering curricula into one hybrid and unique baccalaureate degree, with the goal to prepare students for careers as pragmatic engineers.

Others features of HVAC-ET set it apart from most other CTE programs; as a baccalaureate-level program, it differs from the norm. CTE has traditionally been limited to secondary and postsecondary associate degree programs. Only recently, with the Carl D. Perkins Career and Technical Education Improvement Act of 2006, has federal legislation recognized baccalaureate degrees as CTE programs. As a second example, the two-plus-two laddering structure presents an inherent feature: students can complete an associate degree in HVACR at any accredited institution around the world and then transfer to Ferris to finish their baccalaureate degree. With only two baccalaureate degrees in HVAC offered in the U.S. and with an online version available through Ferris, the HVAC-ET program serves national and even international markets. This is not the norm for CTE. Rather, programs typically focus on serving the local economy, a fact that is self-evident in the name of the many institutions that offer them: “Community”
Colleges (Reid, Jacobs, Ivanier, & Most, 2007; Waterhouse, Virgona, & Brown, 2006; Zinser & Lawrenz, 2004).

**Conceptual Framework**

Evaluation of CTE on a nationally standardized basis is currently impossible. The very definition of career and technical education is shrouded in ambiguity. There are far too many types of schools that offer CTE programs, there are far too many CTE fields of study to categorize and catalog, and there are too many levels of CTE programming offered in many of the fields. Certainly, an education system exists under which CTE programs are administered and offered. Broad categories for CTE fields of study called career clusters or pathways bring some sense of order to the system. But the sheer number of programs simply prohibits a standardized assessment system. However, a standardized process could and should be established.

This educational “system,” though categorized as elementary, secondary and post-secondary, is indeed a very large, complex and multilayered system with a staggering number of school districts (13,862), public elementary schools (74,974), private elementary schools (32,137), public secondary schools (29,420) and private secondary schools (12,184). There are 4,352 post-secondary institutions of which 653 are public four-year, 1,032 public two-year, 1,532 private not-for-profit four-year, 92 private not-for-profit two-year, 490 private for-profit four-year, and 553 private for-profit two-year (Snyder, Dillow, & Hoffman, 2009, p. 124 & p. 391). Within the vast educational system in the Unites States, career and technical education exists to prepare students for careers in any number of industries. CTE programs have been grouped according to industry
and/or career sectors to categorize the multitude of options and to make it easier for students to choose a career field.

Just as the term "career technical education" has multiple definitions and names, multiple lists are used to delineate fields of study within CTE. The more common system adopted the concept that any career will fit into one of 16 "Career Clusters." Within each of the 16 broadly defined fields of study are numerous separate and unique sub-fields of study. HVACR, the focus of this research, resides within two defined fields of study in each of the lists described above, depending on which level of education is considered. At the HVACR certificate or associates degree level, HVACR careers fall under all three sub-categories of design/pre-construction, construction and maintenance/operations within the Architecture and Construction cluster, and under the sub-category of technology within the Science, Technology, Engineering and Mathematics (STEM) cluster. Regardless of the list chosen to categorize jobs and careers, each sub-category contains numerous career and technical education paths. For example, "construction" includes HVACR, construction, construction management, electrician, pipe fitter, plumber, sheet metal worker, and so on.

The baccalaureate degree in HVACR engineering technology "fits" in the Science, Technology, Engineering and Mathematics (STEM) cluster, again as a sub-category under engineering. Regardless of the list used, within the engineering sub-category are engineering disciplines, which includes mechanical, chemical, aerospace, civil and others. The career clusters information lists 54 engineering disciplines. HVACR engineering technology, as a sub-category of mechanical engineering, is not even listed.
As such, despite the efforts to categorize all possible jobs and careers within listings, groupings, pathways or clusters, HVAC engineering technology, the focal point of this study, is not identified. Compared to CTE, evaluation of a college-prep or “academic” curriculum, though difficult in many ways, is relatively simple. All college-prep curricula is standardized in that, no matter what part of the country a high school may exist, the curriculum is focused on university entrance requirements, which are standardized through measurements of high school grade point average and standardized ACT or SAT test scores. In stark contrast, countless curricula can and do exist for CTE programs, and despite efforts to group career pathways within the CTE universe, standardized assessment is a poor fit. Despite national efforts to cluster CTE fields, assessment of CTE programs requires individual attention similar to this study.

When viewed using a macro lens, HVAC-ET is but a speck within the vast career and technical educational system, which itself exists within a much larger national educational system. Figure 1 provides a graphic depiction of HVAC-ET within the postsecondary educational system. Seen as a small speck within the HVACR segment that exists as a portion of three sectors or “clusters” of CTE, the diminutive scope of HVAC-ET becomes readily apparent. Influenced by the histories of the HVACR industry and the career and technical education system, as well as legislation, the integration of general education, and changing technologies, HVAC-ET can be seen as a very small portion of a very large educational system. Easily lost in the crowd by all but its own stakeholders, HVAC-ET, like any CTE program, must provide for its own assessment: it is simply too small a portion of the system to warrant anything more.
Figure 1. Conceptual Framework: Assessment of HVAC-ET
Assessment of HVACR Engineering Technology using APR

With the HVAC-ET program framed as a small and unique niche within the much larger spectrum of CTE, it is now necessary to frame the program further in the context of accountability and assessment as background information for this study. The quality of the HVAC-ET program cannot be assessed using a national test, since none exist, yet assessment does take place. Each program at Ferris State University undergoes an Academic Program Review (APR) every five years. HVACR programs, including HVAC-ET, were last involved during 2006 when students (n=92), graduates (follow-up surveys, n=52; and exit surveys, n=25), faculty (n=7), employers (n=20), and advisory committee members (n=12), responded to Likert-style survey questions and provided short, one-sentence comments in response to a number of open-ended questions. The unpublished study provided quantitative data that indicated a high level of quality in the program.

Four-year graduates were asked to rate their perception of 35 questions on a five-point scale, with 5 = Strongly Agree and 1 = Strongly Disagree. Most questions centered on technical content, with two questions per content area: “XXXX is an important part of your job,” and “you were well prepared in the area of XXXX.” The technical content areas included:

- Design
- CAD
- Load calculation
- Equipment selection
- Control theory
In addition to questions on technical content, some questions were asked of general education and some general perception questions were asked related to:

- Math
- Written communication
- Verbal communication
- Mix of technical/social and cultural course
- Overall preparation for the job
- Demand for graduates
- Productivity on job right out of school

The average perception for all 35 questions was 4.06 out of 5 (Agree), with 3.22 as the lowest ("You were well prepared to deal with job specifications") and 4.89 ("Verbal communication skills are an important part of your job") as the highest.

When asked for general comments, graduate responses varied greatly and often contradicted one another, with several pointing out what they felt were areas of strength (e.g., design, controls) or weaknesses (e.g., design and equipment selection). Some felt that more hands-on experience would be beneficial while others called for less laboratory work and more lecture time. Several commented on their perception of the quality of the
program and their ability to be productive on the job very soon after graduation. Several comments contained testimonials, such as “I am very proud to be a graduate,” “This is an excellent program,” and “I always recommend FSU-HVAC to anyone looking for employees.”

Employer surveys included 28 similar questions ranked on a five-point Likert scale with 5=Excellent, 4=Good, 3=Acceptable, 2=Below Expectations and 1=Poor. The breadth of questions expanded beyond technical and general education outcomes to include outcomes such as critical thinking, leadership, ethics, planning, and working with a group as a team player. Employers responded at a 3.67 average, with “Ability to troubleshoot complex or multiple HVACR systems” as the lowest at 3.13, and “Chooses ethical courses of action” as the highest with a 4.21. Overall, all responses were “Acceptable” or better, with most above a 3.5, meaning the responses averaged closer to “Good” than to “Acceptable.” Of the 28 responses, only four were 4.0 or better.

Responses to open-ended questions were typically one sentence in length or shorter and were varied to such an extent that no themes emerged. One comment reinforced the need for both written and verbal communication skills; others identified personal needs for specialized areas, e.g., “ability to pass NEBB (National Environmental Balancing Bureau) certification,” “centrifugal, absorption, screws (compressors), high pressure steam and large boilers,” and “increased knowledge on setting up a VFD (variable frequency drive).” Several announced the need for more graduates, and a number of testimonials similar to those of the graduates were offered, e.g., “You have a great program, keep up the good work,” “Review is for our most recent hire with whom we are well pleased!”
The data provided by the Academic Program Review was generally positive and provided a basic quantitative measure of stakeholders’ perceptions of quality. Responses to open-ended questions provided a bit more information, but sufficient data were not available for analysis. Further, in using a simple survey instrument, no opportunity for follow-up was provided, which precluded probing and in-depth questioning.

In summary, CTE encompasses a diverse array of educational curricula, each designed to serve a rather narrow sector of industry. Within one of those sectors the HVACR industry can be found. Diverse in and of itself and containing its own multiple sectors, the HVACR industry amounts to a mere sliver in the universe of CTE. Narrower yet is the segment served by the HVAC-ET program at Ferris State. Nearly unique, this hybrid, baccalaureate-level CTE program with an international market undergoes cyclic quantitative assessment, but has escaped evaluative scrutiny of a qualitative nature until now.

Problem Statement

It is the Bachelor of Science in HVACR Engineering Technology (HVAC-ET) at Ferris State University that is the focus of this study. This unique program does not fit neatly into any one career cluster or serve a traditional industry niche. The market for which it prepares students is not local or even regional; it is national and occasionally, international in scale, yet the program itself is relatively small. Graduates accept jobs at companies that vary widely in size and scope. Some have less than 10 employees and serve a local market. Others have thousands of employees with branches throughout the world. Though no benchmark has been developed against which quality can be measured, quantitative assessment in the form of Academic Program Review (APR), last conducted
in 2006, indicated a high level of quality as perceived by key stakeholders, including students, graduates, employers, faculty, and advisory committee members. In order to gain a better understanding of how quality in the program is achieved and what opportunities exist for curriculum improvement, a more in-depth analysis of a qualitative design was necessary.

This research began where the APR left off and provided rich data from which in-depth analysis was conducted. As a current faculty member and former chair of the HVACR department, the researcher and fellow faculty are interested in these data as an essential component of continuous quality improvement. These data will also be useful to prospective students as they deliberate choice of university and program of study, and to prospective employers who are and will be interested to know how students are prepared for work. Administrators, mindful of the expense of CTE during times of ever-shrinking resources, are interested in these data to find if funding for the program shows fiscal responsibility. Other researchers interested in a qualitative design of a CTE program may find this study useful as a foundational guide for their work.

Most studies of CTE are quantitative in nature (Kagaari, 2007; Brown & Conbere, 2005; Coryn, Gullickson, & Hanssen, 2004; Bozick & Macallum, 2002; Rahn, O’Driscoll, & Hudecki, 1999; Bragg & Russell, 1993; Barlow, 1976) and focus on statistics such as enrollment, retention, graduation rate and employment rate. Efforts to collect data related to how graduates apply their learning on the job and how they impact their place of employment are often neglected due the constraints of time and money (Zinser, 2003). Given the role of CTE to prepare students for success in the world of work, data related to graduate performance on the job are of more significance than
statistical counts of student numbers or even student performance in school. In reality, higher education currently knows little about the effectiveness of college education as measured by knowledge of student learning (Millett, Stickler, Payne & Dwyer, 2007). To increase accountability, more CTE programs may need to conduct qualitative follow-up studies of their graduates and the companies that employ them.

**Purpose of Study**

The purpose of this study was to investigate the phenomenon of industry-employed graduates of the Bachelor of Science in Heating, Ventilation and Air Conditioning Engineering Technology (HVAC-ET) at Ferris State University in Big Rapids, Michigan. In particular, the researcher was interested in learning what the educational experience meant to the graduates and how they perceived they were prepared for work. And from their perspectives, what the essential elements of the program are and what changes they would make to improve it.

Existing quantitative data indicated a high level of program quality in terms of how well graduates and their employers perceived the graduates were prepared for work in specific technical areas. These data provide a measure of how well the HVAC-ET program prepares its students for employment but do not provide definitive results that lead to improvement. A goal of the research was to learn how the HVAC-ET aligns with the industry for which it prepares its graduates, as judged from the point of view of its graduates. A secondary goal of the study is to establish a process by which other CTE programs may be assessed.
Research Questions

This study used a phenomenological design with the goal to gauge the alignment of the HVAC-ET program with its industry, as measured by the perceptions of graduates. Characterized by an exploratory nature, qualitative research seeks a more in-depth, detailed and close-up view of a topic, collecting data with questions that typically begin with “how” or “what” (Creswell, 1998) and expressing data using words rather than numbers. A phenomenology studies a specific experience shared by a relatively small number of people, purposefully chosen as a nonrepresentative sample (Bogdan & Biklen, 2003), using a systematic yet flexible in-depth interview structure based on open-ended questions (Marshall & Rossman, 2006; Burke & Christensen, 2004; Bogdan & Biklen, 2003; Patton, 2002; Creswell, 1998). A phenomenology was chosen for this study because of the opportunities to interact with subjects on a human-to-human basis, to explore further if necessary using follow-up questions, and to arrive at conclusions post hoc rather than a priori (Creswell, 1998; Lancy, 1993). Kahn and Cannell (1957, p. 149), as quoted in Marshall and Rossman (2006, p. 101), describe the in-depth interview as a “conversation with a purpose” employed to discover the perspective of the phenomenon from the point of view of the subject (Marshall & Rossman, 2006). Such a strategy allowed the researcher to explore the subjects’ perception of the HVAC-ET program to a great depth.

In a qualitative design it is common to reduce an entire study to one overarching question (Creswell, 1998). Such a question lies at the heart of this inquiry: How do graduates perceive their experiences and education in the HVAC-ET program at Ferris State University meet their personal and professional needs? The questions that follow
stem from this overarching question and were designed to discover the meaning of the experience and the strengths and weaknesses in job preparedness of these graduates, relative to the HVAC industry.

From the perspective of the graduates of the HVAC-ET program at Ferris State University:

1. What does the HVAC-ET program mean to its graduates on a personal level?
2. How do graduates perceive they were prepared for their careers?
3. What are the essential
   a. core-academic;
   b. general education; and
   c. non-academic elements of a relevant HVAC-ET program?
4. What changes, if any, could improve the HVAC-ET program from the perspectives of
   a. pedagogy, and
   b. relevance?

The answers to these questions reflect the perceptions of the graduates who participated in the study. These data provided a detailed portrayal of the strengths and weaknesses of the HVAC-ET, as viewed from the perspective of graduates. Perhaps more importantly, the researcher learned what the degree means to graduates. These data provided a measure of program quality and will be used as a basis for program improvement.
Rationale for the Study

There is a “dearth of empirical data on student learning in higher education” (Millett, Payne, Swyer, Stickler, & Alexiou, 2008, p. ii). It was important to learn that HVAC-ET, juxtaposed between a technician-level associate degree and a baccalaureate-level engineering degree, did indeed fill a need in the market. This study also provided a level of accountability and provided data for curriculum improvement in some key areas, as well as confirmed the need for a new course added to the program in the fall of 2009. Federal legislation (Perkins IV) requires assessment of CTE programs, and key stakeholders need to know that this program is relevant. Professors want to know that their teaching has meaning, administrators want to know that funding is justified, employers want to know where to find qualified employees, and prospective students want to know how their program of study will prepare them for the world of work. This dissertation or excerpts of it will be shared with these stakeholders.

College degrees should prepare students for work

Students recognize that a college degree is a basic requirement for success in today’s job marketplace (Peter D. Hart Research Associates, 2004). In broad terms, students attend college with the expectation that their education will prepare them for a career (Belcheir, 2002), and employers recruit college graduates with the expectation that they will be prepared for the world of work (Hoey & Gardner, 1999; Clagett & Alexander, 1995). Students who enroll in CTE programs have the same expectations, but often with a more narrowly focused outcome: a career in a specific field. From that perspective, CTE educators must know whether a curriculum aligns with the career for which it prepares students. But how is that alignment to be determined? Many
assessments are available to measure student learning in terms of what students know and can do in school. While knowledge of student learning is important, the researcher posits that knowledge of graduate success on the job can provide a better measure of the effectiveness of any CTE program: what the graduate can do on the job is a measure of applied knowledge and provides an indication of how well learning in school translated to the job.

Assessment of employer satisfaction with graduate performance is also a powerful measure of a CTE program’s success or shortcomings and should to be a central characteristic of an effective CTE program (Munyofu & Kohr, 2009). In order to measure what the graduate can do on the job, the research must be focused on the workplace rather than on the school. However, little research is available which has focused on assessing CTE programs from the perspective of the employer (Zinser, 2003). While this study did focus on the workplace, it stopped short of interviewing employers. This is an area recommended for future research.

The literature does present some evidence of employer and alumni satisfaction surveys (Belcheir, 2002; Hoey & Gardner, 1999; Clagett & Alexander, 1995; Lee, 1993). As quantitative designs, these studies all sought to measure program effectiveness as either in-depth follow-ups to earlier studies (Belcheir, 2002), longitudinal studies (Washington State Workforce Training and Education Coordinating Board, Olympia, 2001; Lee, 1993), or as follow-ups to contract workforce training (Clagett & Alexander, 1995). These literatures serve as foundations for this study, though the dated material indicates a decline in this kind of assessment. Lately, most information on employer satisfaction with graduates is obtained by advisory boards (Belcheir, 2002), through
formal visits between faculty and employers during student internship assessment, or 
happenstance visits between employers and faculty or administrators. Results are not 
published beyond the confines of the institution (Zinser, 2003), leaving a void in the 
literature where these data would be found. This study will begin to fill that void.

CTE has always existed to prepare workers for gainful occupations in industry 
(Rothwell & Gerity, 2008; Cohen, & Besharov, 2002; Sheppard, 1931). The government 
has had an interest in CTE as a source of workforce development beginning with the 
Morrill Act of 1862 (Stone, 2002; Mobley, 1964) and continuing up to the most recent 
federal legislation, the Carl D. Perkins Career and Technical Education Improvement Act 
of 2006, or Perkins IV (Stone, Kowske, & Alfeld, 2004; Milne, 1998). Contained in 
Perkins IV are requirements for accountability to include “Student attainment of 
challenging career and technical skill proficiencies” (§ 113 (b) (2) (B) (i)): “Student 
participation in, and completion of, career and technical education programs that lead to 
employment in non-traditional fields” (§ 113 (b) (2) (B) (v)): “the extent to which career 
and technical education programs prepare students, including special populations, for 
subsequent employment in high skill, high wage occupations” (§ 114 (d) (2) (B) (iii) 
(II)); and “employer involvement in, and satisfaction with, career and technical education 
programs and career and technical education students’ preparation for employment” (§ 
114 (d) (2) (B) (iv)).

These requirements are not targeted directly at baccalaureate-level CTE programs, 
but they do provide clear evidence of the government’s interest in the success of CTE. 
Culminating with a baccalaureate degree, HVAC-ET is a rare program that slips in the 
cracks between the CTE and academic curricula. Though industry stakeholders and
federal legislation clearly have an interest in the quality of workforce development, there are no instruments available to measure the success of HVAC-ET. This study served as that instrument and as an example for baccalaureate-level and other CTE programs to assess curriculum-industry alignment using qualitative methodology.

Career and Technical Educational programs for specific occupational specialties are typically developed with input from stakeholders within the industry for which the curriculum is designed, such as alumni and employers (Grier, 2005; Bozick & Macallum, 2002). Once deployed, the task of measuring alignment of the plethora of CTE programs with their respective industries is daunting when viewed as a whole. From a practical perspective it is sensible that each CTE program be measured by its key industry stakeholders, such as alumni and employers (Furst-Bowe & Bauer, 2007; Zinser, 2003; Imel, 2001; Bragg & Hamm, 1996). For example, advisory committees are often used as an important component for measuring the quality of a CTE program. Committee membership typically consists of industry practitioners, including alumni and employers presently working in the industry served by the CTE program. Through their daily industry exposure, these members have first-hand knowledge of current trends. During committee meetings, members advise faculty and administrators about those trends. These data may identify areas in need of innovations and improvements to better serve the alumni and employers (Welch and Reineke, 2002).

The researcher has participated in more than 20 advisory committee meetings over a 12-year span. Though many good discussions have taken place, the researcher felt that much was yet to be learned. The 30+ large-group size of the meetings have not allowed for in-depth, exploratory conversations with members, and the meeting structure
has not facilitated long, personal conversations with any one member. The researcher felt that the advisory committee provides quality data of reasonably sufficient breadth, but that these data are “on the surface” and lack in depth. This study allowed further exploration into the perceptions of those who are working in the industry. It is from the “evaluation by industry stakeholder” perspective that this study was conducted.

**HVAC competency tests**

There are other measures by which HVAC curricula can be assessed. Many HVACR technician certification programs, intended as indicators of job readiness, measure technician performance via written tests but do not measure hands-on competencies (Levesque, Laird, Hensley, Choy, Cataldi, & Hudson, L, 2008). Some instruments, such as the National Occupational Competency Testing Institute (NOCTI), do include both a cognitive (written) component and a psychomotor (performance) component (Munyofu & Kohr, 2009). At the secondary and associate degree postsecondary levels, several HVACR technician certification tests have been developed for measuring the technical competency of students and/or graduates as a means to predict job readiness and performance. A number of HVACR curriculum accreditation programs are also available for measuring the quality of the educational content of secondary and postsecondary programs. These instruments, developed by industry entities such as the Refrigeration Service Engineers Society (RSES), the Air-Conditioning, Heating, and Refrigeration Institute (AHRI), HVAC Excellence, and the United Association Union of Plumbers, Fitters, Welders and HVAC Service Techs (UA), all provide national assessments against which students and programs can be measured. Hundreds of HVACR secondary and postsecondary (associate degree level) program
exists and are attended by thousands of students annually. These numbers are large enough to justify and sustain multiple competency tests despite the competition among them in the marketplace.

Though these exams are administered to both students and workers, they do not measure job performance or competency, they measure job knowledge. Certainly, knowledge is an essential ingredient, but knowledge alone is not enough. It must be accompanied by the skill to apply the knowledge in an effective and efficient manner (Edwards, 2004). Knowledge is only the prerequisite for job competency. Despite the shortcomings of these industry competency exams in measuring actual job performance, a benchmark is provided against which students and programs can be measured. At the least, these data allow a comparison of program scores against the universe of similar programs. But these tests are designed for technician-level competencies. Without an existing instrument to measure the HVAC-ET program, a study such as this one became necessary.

**Workforce readiness tests**

The skills needed by graduates to be successful include not only technical (industry-specific) skills, but also employability skills (Association for Career and Technical Education, 2010). Several assessments are available for purchase that measure general education and workforce readiness outcomes, such as the Collegiate Assessment of Academic Proficiency (CAAP) and the Standardized Assessment of Information Literacy Skills (SAILS), while some tests measure subject-area knowledge and skills, with the Area Concentration Achievement Tests (ACAT) and the Major Field Tests (MFTs) serving as examples (Millett, Stickler, Payne & Dwyer, 2007). Though these
tests do indeed exist, none are commonly used to measure the effectiveness of a college education (Dwyer, Millett, & Payne, 2006) and none exist that measure HVAC-ET specifically.

Certification and many college examinations can be passed by "book smart" persons who may be unemployable because of deficits in other areas. These measures present quantitative results that are meant to be predictive of job performance. Industry certifications might show that employees who obtain a certain certification are more successful on the job, but they do not explain why and they do not explain why those who failed the exam failed it. More importantly, they do not provide insight into potential corrective action. In short, they do not provide the rich, in-depth analysis inherent in qualitative inquiry.

**SAT/ACT Large scale tests**

On a much larger scale, millions of students hoping to attend college are assessed each year using college readiness tests such as the ACT or SAT. At the college level, student learning and personal development is measured each year at over 1400 post secondary institutions using national instruments such as the National Survey of Student Engagement (NSSE) and the CCSSE (Community College Survey of Student Engagement, 2009). These large annual numbers justify the funding and development of nationally deployed tests. But while the HVACR industry competency exams target a population in the thousands and the market for college readiness exams numbers in the millions, less than 50 students graduate from the HVAC-ET program at Ferris each year. With such a small number, any national instrument for the assessment of the graduates would be economically unfeasible to develop and the results would be irrelevant due to
the lack of a comparison group. Understandably, no such standardized or national assessments exist for a baccalaureate degree in HVACR. Thus, the only method by which a valid assessment may be achieved is a self-study of some form.

Instruments such as ACT, SAT and NSSE measure students performance while they are in school, but a disconnect exists between common academic assessments and actual job performance. Massey (2003), as cited in Furst-Bowe & Bauer (2007, p. 11), points out that, “Most colleges and universities have few data about how well they are serving current and future stakeholders.” Of course, the real assessment of job performance is employability, and that measure is administered judiciously by the employer through a pass/fail system with much greater consequences than any competency or college examination. Employees who are valuable are retained; those who are not are terminated. Without a formal process to collect employment performance, educators do not know the long-term success of their graduates.

In the final analysis, assessment of graduates on the job is the best measure of their job performance. Any tests taken pre-employment may predict job performance, but the only measure of job performance must be made where job performance takes place: on the job. A process is needed by which to gather these data. Quantitative studies describe the characteristics of a subject (e.g., a CTE program) as numerical values of observable parameters (Glass & Hopkins, 1996). These data can provide information for making data-driven decisions based on facts, but lack the capacity to organize the data for viewing a CTE program holistically (Furst-Bowe & Bauer, 2007). Most of the literature contains evaluations of CTE programs through quantitative measures of indices such as
enrollment, retention and graduation rates: good data, but lacking in job performance indices.

Following the quantitative academic program review, qualitative designs can be used for further in-depth analysis leading to a more thorough understanding of the subject under study (Bragg & Hamm, 1996), and many evaluation projects combine quantitative and qualitative data collection methodologies (Knox, 1998). This study followed the quantitative analysis of the HVAC-ET program, conducted in 1996 as a cyclic Academic Program Review (APR).

A qualitative design studies subjects in their natural environment to gather the most accurate data (Creswell, 1998). In this study, a focus was on workplace performance as an indicator of program quality and success. As such, these data were best gathered in the workplace. By nature, qualitative inquiry is exploratory and seeks to present a detailed close up view of a topic using questions that commonly begin with “how” and “what” (Creswell, 1998). A qualitative assessment can bridge the gap between measures of school performance and job performance (Bragg & Hamm, 1996). Such inquiry would allow educators to gain rich information about how successful their graduates actually are, and what deficits, if any, they possess. Most importantly, in a qualitative study, measures of outcomes are of less concern than the process by which the outcome was achieved (Bogdan & Biklen, 2003). By means of a qualitative design, this researcher gained a more holistic view of the entire program’s performance, from the perspective that matters most: the graduates (Furst-Bowe & Bauer, 2007).

This study is important because it determined that a niche CTE program is relevant in an economy and educational culture that increasingly encourages the
incorporation of core academic learning objectives throughout the curriculum and advocates for a more broadly-focused course of study. Strengths and weaknesses of the program revealed by the study serve as foundational information for quality improvement. Results of the study indicate that this educational model should be adopted more widely, as HVAC-ET was shown to exactly align with its target industry sectors. More importantly, graduates achieved high levels of success within those targeted sectors. Such workforce development is precisely the goal of CTE. This study set the framework for further research by others who are interested in the alignment of other CTE programs and industry through the use of a more relevant focus on actual job performance rather than job preparedness.

**Help students select program of study**

With the thinking that the skills and abilities needed to succeed in college and career are nearly identical (Harris & Wakelyn, 2007), it follows that college curricula, particularly CTE curricula, should align with industry (Obama, 2009; Foster, Belandy, Bateman, & Dyson, 2007). The measurement of that alignment is another matter. Most often, education is measured using other criterion.

Students recognize that a college degree is a basic requirement for success in today’s job marketplace (Peter D. Hart Research Associates, 2004). Yet the data available to students for selecting a college rarely indicate student preparedness for work. Instead, common metrics used for providing information about colleges and universities involve measures of student performance and quantity. Expressed as inputs or outputs, these data are intended to indicate quantity or quality. The number of applicants and the number of graduates indicate input and output facts of a quantitative nature, while applicant average
high school GPA and graduate average GPA indicate input and output data as a measure of quality. Other data intended to indicate both quantity and quality include measures of endowment and library collection size, as well as amounts of grant dollars (Dwyer, Millett, & Payne, 2006). All of these data are used to judge postsecondary institutions, yet none of them measure how well the graduate is prepared for the workforce.

Thus framed, this research focused on the evaluation of the graduates of the Bachelor of Science in HVACR Engineering Technology at Ferris State University. This course of study prepares students for a career that blurs the line between the Architecture & Construction and the Science, Technology, Engineering & Mathematics career clusters as identified by OVAE. Further, it contains elements of the Business Management & Administration and Information Technology clusters. Offered by an institution that is a relatively young university with a long history of CTE offerings, this program is very unique as one of only two known to exist in the United States. It prepares students neither as engineers nor as technicians, but rather a blend of the two. The results indicated strong evidence of that the curriculum excels at preparing graduates for successful careers. These data will be shared with prospective students to help them decide their program of study.

Limitations and Delimitations

This study provided information on the phenomenon of graduates of the Bachelor of Science in HVAC Engineering Technology (HVAC-ET) at Ferris State University and their performance in workplace. This is a very unique program, with only one other similar program known to exist in the United States. The subjects of the study were graduates of both the campus and online versions of HVAC-ET. As the research is
limited to these subjects, their experiences and perceptions may or may not be similar to those of other graduates.

The size of the sample was relatively small, as is common in qualitative inquiry (Locke, Spirduso, & Silverman, 2007; Bogdan & Biklen, 2003; Creswell, 1998). The sample was also purposeful and involved only graduates from the past three years. The reason for this limitation was to interview those who were relatively new to the workforce. As time passes, it may be more difficult for graduates and employers to determine which knowledge and skills were learned in school and which were acquired through experience on the job. The graduate subjects were known to the researcher through his role as department chair during the time they were students on campus, though none of the subjects were former students of the researcher.

Several of the subjects were located out of state, which allowed the sampling to be national in scope. Phenomenological interviews are normally conducted in a face to face setting so that both verbal and nonverbal communication can be used. With subjects located from north to south and coast-to-coast, all of the interviews were conducted via recorded phone calls to save time and expense due to the geographical separation involved.

Though it was possible for the sampling to cut across only a narrow cross-section of the HVAC industry, the sampling represented a broad cross-section of the companies who hire graduates. The companies varied by size, scope of work, geographic location and geographic market.
Conclusion

In summary, this study determined the relevancy of HVAC-ET, measured by its perceived alignment with the industry for which it prepares students as viewed from the perspective of its graduates. The study indicates that there is still room for narrowly-focused CTE programs in a culture that encourages education with a wider focus to prepare graduates for employment in an economy that features dynamic and diverse careers.

The study was needed because the program is unique from a number of perspectives and no national or normative assessment tools exist as benchmarks. The study may serve as a model for other CTE assessments of alignment.
CHAPTER 2
A REVIEW OF THE RELATED LITERATURE

Introduction

The purpose of this study was to investigate the phenomenon of industry-employed graduates of the Bachelor of Science in Heating, Ventilation and Air Conditioning Engineering Technology (HVAC-ET) at Ferris State University in Big Rapids, Michigan. In particular, the researcher was interested in learning what the educational experience meant to the graduates and how they perceived they were prepared for work. And from their perspectives, what the essential elements of the program are and what changes they would make to improve it.

Students earning this degree must first earn an associate degree in HVACR. The associate degree can be earned at Ferris or at any other institution worldwide. Regardless, all students must transfer into the four-year program in order to complete their junior and senior years. The program has been offered on the campus since 1984. In 2003, an online version was launched to serve those who are bound by place or time. Currently, all core and most general education courses are offered online, with students from across the United States and as far away as Saudi Arabia.

The four-year program is unique in several ways. As a curriculum that prepares students specifically for employment in the HVACR industry, it is a CTE program, but as a baccalaureate degree program, rather than a secondary or postsecondary two-year program, it does not fit the standard CTE mold. As one of only two such programs known to exist in the United States, no benchmarks exist against which graduate quality and success can be measured. With graduates employed throughout the United States and
overseas, it serves a far larger market than the typical CTE program. Offering dozens of careers tracks with employers ranging from small family-owned shops to large multinational corporations, the employment opportunities represent an extremely diverse cross-section of the job market.

President Barack Obama recognized the importance of CTE in his *American Graduation Initiative* speech given at Macomb Community College on July 14, 2009, citing the prosperity that resulted in America when the government bet the future on education. The key for the program is to fund programs that “connect students looking for jobs with businesses that are looking to hire” (Obama, 2009, p. 6). The President acknowledged that while the most successful educational programs are those that partner with business, it is critical to measure such programs to determine what is working and what is not.

This chapter will preview the study from several perspectives to frame the research that follows. The first perspective is needed to define CTE due to conflicting perceptions of what CTE is and the evolutionary nature of CTE in society. The definition is provided to frame CTE for this study and position the HVAC-ET program firmly within the margins of CTE. A sketch of the history of CTE will document its origins and evolution throughout time. Contained within this discussion is a chronology of the legislation within the United States that has shaped both CTE and the assessment of CTE. Because of the current emphasis on the integration of core academic learning objectives throughout all curricula, a discussion of some of the recent work in liberal education is offered. The next perspective profiles the history of the HVACR industry to depict its evolution and multi-faceted complexity, and includes a brief discussion of recent and
radical changes in the way buildings are designed and must perform. This frame justifies
the need for this study to measure the alignment of the curriculum with the rapidly-
changing industry. A discussion of evaluation across the broad spectrum of education
will provide a comparison of a range of assessment practices designed to measure diverse
areas such as apprenticeship, college readiness, postsecondary achievement, technician
competency (using written and performance tests), engineering, and academic programs.
This perspective centers on assessment in CTE to provide an accounting of methods used
to measure the efficacy of CTE programs. Next, the scope of assessment in the vastly
diverse field of CTE will be compared to relatively narrow scope of nationally normed
assessment instruments used for core academic curricula. Finally, a review of the
literature will identify a lack of qualitative studies linking CTE programs to the world of
work.

What is Career and Technical Education?

Vocational education can be defined as encompassing some 28,000 institutions
providing three types of occupational preparation, in nine general types of
program areas, at four educational levels, to meet the needs of at least seven
special needs groups…evaluated on a variety of criteria, with a confusing mix of

This study used the perception of graduates to evaluate a career and technical
education program that culminates in a baccalaureate degree and determined that it aligns
with the industry for which it prepares its students. There is a problem. Many educators
would not know this as a career and technical education program. Until the most recent
iteration of federal vocational education legislation (the Carl D. Perkins Career and
Technical Education Improvement Act of 2006, or Perkins IV), versions of previous legislation defined vocational-technical education in broad terms as “preparation for employment in positions requiring less than the baccalaureate degree” (Hayward & Benson, 1993). Perkins IV broadened the definition to include baccalaureate degrees and changed the name from vocational-technical education to career and technical education. And while the current legislation includes the baccalaureate degree as a terminal point, the very same legislation defines career and technical education with the associate degree as the highest terminal point. With a relatively new name and conflicted terminal points, what then, is this thing called career and technical education?

Vocational education, now known as career and technical education, has long been seen as education for jobs and necessary for workforce development (Stone, 2002). On a local, state and national scale, CTE is a foundational aspect for economic development (Rothwell & Gerity, 2008) and socioeconomic development (Waterhouse, Virgona & Brown, 2006), and is even an important ingredient of national defense (Stone, 2002; Mobley, 1964). With such an important role in so many sectors of national success, it follows that CTE regulation is conducted at a national level. As a part of a national strategy, it is helpful to understand how the federal government views its purpose in legislating CTE through language from the most recent CTE Act, Perkins IV (Senate Bill 250, 2006):

“SEC. 2. PURPOSE.

“The purpose of this Act is to develop more fully the academic and career and technical skills of secondary education students and postsecondary education students who elect to enroll in career and technical education programs, by—
“(1) building on the efforts of States and localities to develop challenging academic and technical standards and to assist students in meeting such standards, including preparation for high skill, high wage, or high demand occupations in current or emerging professions;

“(2) promoting the development of services and activities that integrate rigorous and challenging academic and career and technical instruction, and that link secondary education and postsecondary education for participating career and technical education students;

“(3) increasing State and local flexibility in providing services and activities designed to develop, implement, and improve career and technical education, including tech prep education;

“(4) conducting and disseminating national research and disseminating information on best practices that improve career and technical education programs, services, and activities;

“(5) providing technical assistance that—

“(A) promotes leadership, initial preparation, and professional development at the State and local levels; and

“(B) improves the quality of career and technical education teachers, faculty, administrators, and counselors;

“(6) supporting partnerships among secondary schools, postsecondary institutions, baccalaureate degree granting institutions, area career and technical education schools, local workforce investment boards, business and industry, and intermediaries; and
“(7) providing individuals with opportunities throughout their lifetimes to
develop, in conjunction with other education and training programs, the
knowledge and skills needed to keep the United States competitive.

With the purpose of national CTE legislation stated to develop academic and
career and technical skills of students, the description of CTE remains to be defined. In
the Digest of Educational Statistics 2008 (Snyder, Dillow, & Hoffman, 2009), the U.S.
Department of Education, National Center for Education Statistics (NCES) defined
career/technical education in secondary education to include, “general labor market
preparation, consumer and homemaking education, and occupational education in
agriculture, business, marketing, health, occupational home economics, trade and
industry, and technical courses” (p 216). That description is somewhat broad, and NCES
provides additional definitions to delineate various forms of education at the high school
level. “Academic” programs prepare students for further education at the
college/university level while “vocational” programs prepare students for employment in
semiskilled, skilled or technical occupations and “general” programs are a combination of
the two. In general, NCES defines vocational education as preparation for “paid or
unpaid employment…requiring other than a baccalaureate or advanced degree” (Snyder,
Dillow, & Hoffman, 2009, p. 681). NCES further delineates vocational education into
two tiers, with trade and industrial education preparing semiskilled or skilled workers,
and with technical education preparing students for a career at the technician level, some
place between the skilled craftsman and the professional.

Students in the CTE track are considered to be those who take “more than 3
Carnegie units in an occupational education field, but less than 12 Carnegie units in
academic courses.” By the same measurement, students on the academic track complete at least 12 academic Carnegie units, “but less than 3 Carnegie units in any occupational education field.” Academic courses include English, Math, Science, Art, History/Social Studies and Foreign languages. (Snyder, Dillow, & Hoffman, 2009, p 216).

To the general public and likely even many educators, the definition offered by Wikipedia describes what many believe CTE to be. While Wikipedia is not considered to be a valid source of information in dissertation work, it is offered here to make a point. In the public eye, CTE is seen as something less than academic (Cohen & Besharov, 2002). With sources such as Wikipedia pervading public research, definitions and descriptions contained therein perpetuate that view.

**Vocational education** or *Vocational Education and Training* (VET), also called *Career and Technical Education* (CTE), prepares learners for jobs that are based in manual or practical activities, traditionally non-**academic** and totally related to a specific trade, **occupation** or **vocation**, hence the term, in which the learner participates. It is sometimes referred to as **technical education**, as the learner directly develops expertise in a particular group of techniques or **technology**.


Funding and regulations related to career and technical education originate at the Federal government. In 2007, of $57.8 billion in total appropriated for major programs by the U.S. Department of Education, $1.8 billion (3%) was appropriated for CTE and adult education (Snyder, Dillow, & Hoffman, 2009, p. 549). Though the percentage is small, the Federal government is considered the official agency for defining career and technical...
education. Within Perkins IV, career and technical education is defined as follows (Senate Bill 250, 2006):

The term “career and technical education” means organized educational activities that--

(A) offer a sequence of courses that--

(i) provides individuals with coherent and rigorous content aligned with challenging academic standards and relevant technical knowledge and skills needed to prepare for further education and careers in current or emerging professions;

(ii) provides technical skill proficiency, an industry-recognized credential, a certificate, or an associate degree; and

(iii) may include prerequisite courses (other than a remedial course) that meet the requirements of this subparagraph; and

(B) include competency-based applied learning that contributes to the academic knowledge, higher-order reasoning and problem-solving skills, work attitudes, general employability skills, technical skills, and occupation-specific skills, and knowledge of all aspects of an industry, including entrepreneurship, of an individual.

The phrases “rigorous content” and “challenging academic standards” indicate that the government intends and expects CTE to be academically challenging while continuing to provide “relevant technical knowledge”; yet this view contrasts sharply with the public’s view of CTE as “non-academic and totally related to a specific trade” as articulated by Wikipedia.
Where Perkins IV is clear on the curricular parameters of career and technical education, it is inconsistent in defining the terminal point. The definition above clearly articulates the highest credential to be achieved in CTE as an associate degree (“provides technical skill proficiency, an industry-recognized credential, a certificate, or an associate degree”). The sub-baccalaureate level is corroborated by the U.S. Department of Education, which defined vocational education as that which prepares individuals for employment, or for additional schooling requiring “other than a baccalaureate or advanced degree” (Snyder, Dillow, & Hoffman, 2009, p. 681).

Yet the stated purpose of the Perkins Act supports partnerships with baccalaureate degree granting institutions, and in laying out guidelines for State plans, describes CTE content that “leads to an industry-recognized credential or certificate at the postsecondary level, or an associate or baccalaureate degree” (Perkins IV: § 122 (c) (1) (A) (iv)). Until Perkins IV, CTE required less than a baccalaureate degree. With the Act, baccalaureate programs came to be seen as an extension of other CTE programs, though Federal funding does not extend to the four-year portions of the education (Meeder, 2008). This broadened definition represents a significant shift in philosophy for both CTE and the Perkins Act.

Many CTE programs as described in the Perkins Act are funded by the Federal government at some level, while many apprenticeship programs, which also fall under the CTE umbrella, are funded by trade unions, the military or employers. Regardless of the funding source, CTE is traditionally taught at the secondary and post-secondary level. Comprehensive high schools, secondary vocational or technical schools that serve a number of high schools within and sometimes beyond a single school district’s
boundaries, and some full-time vocational high schools comprise the scope of the secondary educational offerings. At the post secondary level, vocational certificates and associate degrees are provided by comprehensive community colleges and technical community colleges (Levesque, Laird, Hensley, Choy, Cataldi, & Hudson, L, 2008). A few universities (including the one in this study) also offer CTE programming that culminates in an associate degree or even a baccalaureate degree. Beyond the types of schools listed above, CTE programs are also offered by organized labor and employers, including the military.

While the literature, and up until Perkins IV, the legislation, focused on secondary and post-secondary career and technical education, statistics compiled by the U.S. Department of Education, National Center for Education Statistics (NCES) (2006) reveal that a significant percentage of both public and private four-year institutions award what NCES terms “career education” credentials. The three categories reported include public four-year, private not-for-profit four-year, and private for-profit four-year, with career education credential rates of 96.4%, 82.3% and 92.9% respectively in 2006. Clearly, the vast majority of four-year institutions offer career oriented education at the baccalaureate level. Further, the most recent NCES data (2004) reveals that the majority of students (59% of public four-year students and 60.2% of private not-for-profit four-year students) were enrolled in career education programs.

The ambiguity of CTE definition within the culture, within government documents, and even within Perkins itself, as well as the conflicting understanding of what kind of education CTE encompasses, dictates the need to frame CTE for the purpose of this study. The definition offered below is nearly verbatim from Perkins IV,
but is clarified and articulated to combine language from various sections of Perkins IV so that the full intent and scope of CTE programming is understood and framed for this study. Italics have been added to emphasize the combination of “challenging academic standards” with “relevant technical knowledge” and the inclusion of a “baccalaureate degree.”

CTE is organized educational activities that offer a sequence of courses that provide individuals with coherent and rigorous content aligned with challenging academic standards and relevant technical knowledge and skills needed to prepare for further education and careers in current or emerging professions. It shall provide technical skill proficiency, an industry–recognized credential, a certificate, an associate degree, or a baccalaureate degree. It may include prerequisite courses (other than a remedial course) that meet the requirements of this paragraph and include competency-based applied learning that contributes to the academic knowledge, higher-order reasoning and problem-solving skills, work attitudes, general employability skills, technical skills, and occupation-specific skills, and knowledge of all aspects of an industry, including entrepreneurship, of an individual.

For the purpose of this study, CTE is thought of as any secondary and post-secondary education culminating in a credential up to and including a baccalaureate degree that prepares a student for a career, regardless of skill level to be attained. Within that definition, the HVAC-ET program at the focal point of this study fits squarely in the CTE category.
History of Career and Technical Education (Vocational Education)

A sense of history can foster an appreciation for the origins of the field, contribute to an understanding of how and why program purposes and missions have changed over ensuing decades in reaction to political and economic concerns, define the current status of the field, and encourage the consideration of possible directions for the future (Rojewski, 2002, p. 3).

In order to establish the program at the focal point of this study as a career and technical education program, it is important to explore the evolution of this type of education throughout history to see how culture, philosophy and legislation have molded it into what it is today. Career Technical Education (CTE) is a relatively new term used to describe vocational education, coined in an attempt to diffuse the attitude that vocational education is a haven for the underprivileged and of lower quality than academic programs (Cohen & Besharov, 2002; Hayward & Benson, 1993). Many people, including some educators, still think of any education and training that prepares students for useful labor as “vocational” education. This is a logical title, as what one does for work is thought of as their vocation. Historically, vocational education has been used to teach through, about, and for work (Stone, 2002). The strong focus on the preparation for careers and direct alignment of education and training with a “vocation” will be discussed in order to frame this study and establish the need to study the alignment of current CTE programs with a specific industry. Because CTE was known as vocational education throughout much of the literature, the two terms will be used interchangeably throughout this document.

Arguably the oldest form of education, CTE is indeed as old as time, or at least as
old as the time humans have existed on earth, and has roots in one form or another dating back beyond recorded history. As far back as the early Stone Age, parents taught children how to hunt and gather in order to survive. Records of organized apprenticeship systems first appeared in approximately 1760 BC. The Babylonian Code of Hammurabi contained provisions for artisans to pass their skills on to youths whom they adopted as “sons.” Records exist for apprenticeship from the 5th century BC in Greece through the Roman Empire to the beginning of the Middle Ages in the 5th century AD. Apprenticeship was first formalized with the craft guilds of the Middle Ages through an indentured servant system that provided for the education of young people by which a master craftsman took a young apprentice into his home and taught him the skills needed to carry the craft into the next generation. Apprenticeship was first legislated and standardized in England in 1563 with the Elizabethan Statute of Artificers (The National Training Fund for the Sheet Metal and Air Conditioning Industry, n.d.).

Apprenticeship was carried into the Modern Age through the Renaissance as a common method of learning most occupations and was adopted in Colonial America in the late 16th century as one of the fundamental educational institutes. Apprenticeship flourished for approximately a century and a half in America until the need for the skilled worker began to be replaced by machines in the factory system during the industrial revolution in the late 18th century (Barlow, 1976). Yet, the need for skilled labor was never completely replaced. As the apprenticeship system began to die, the National Association of Manufacturers complained that the very factory system that was destroying apprenticeship was also destroying their source of skilled labor (Hayward & Benson, 1993).
In 1862, the federal government became established as a major player in vocational education development as the First Morrill Act authorized public land grants (30,000 acres to each State for each senator and representative) to establish land grant colleges to train agriculturalists and mechanics (Stone, 2002; Mobley, 1964). Where the First Morrill Act provided land, The Second Morrill Act of 1890 provided additional funding ($15,000 per State or Territory) to support the two programs (agriculture and the mechanic arts) and indicated that federal funding (and legislation) was here to stay. The Second Morrill Act also provided anti-discrimination language that prevented funding for colleges that distinguished between race or color for the admission of students (Congress of the U.S., 1999).

In the early 1900s, several factors contributed to the establishment of a national policy on vocational education. There were the complaints from the National Association of Manufacturers about the factory system destroying the apprenticeship program as a source of skilled labor. A study commissioned in 1913 by Congress, the Commission on National Aid to Vocational Education, found that only 1% of workers engaged in agriculture and manufacturing were technically trained to do the work they were doing (Schulz, 1931). Though only about 8% of the population at that time worked in areas of liberal arts and professional employment, the educational system from grammar school through the university placed virtually exclusive emphasis on the liberal arts. The remaining 92% of the population had no educational system to serve their needs and the nation had no system to train the workforce it needed to produce the food, clothing, shelter, infrastructure and defense (Schulz, 1931). With its emphasis on broadening students’ intellectual and emotional horizons rather than their skills for employment, the
educational system was designed to educate for consumption rather than production (Wonacott, 2003).

This system was a poor fit not only for the workforce, but for the growing number of children with a demand for a secondary education. Only slightly more than one million out of more than seven million young people between the ages of 14 and 18 years enrolled in high school in 1910, and only a small percentage of those engaged in technical studies (Schulz, 1931). Meanwhile, the flow of highly skilled immigrants from Europe, especially Germany, was cut off due to World War I. Economists at the time warned about the shortage of skilled labor caused by the poor educational system, the growing need for a technically trained workforce, and the reduction of skilled workers due to the war (Hayward & Benson, 1993; Schulz, 1931).

In response to these factors and the findings of the Commission on National Aid to Vocational Education, the Smith-Hughes Vocational Education Act of 1917 officially kicked off vocational education and established the Federal Board for Vocational Education (Wonacott, 2003; Stone, 2002; Schulz, 1931). Designed to stimulate development of a more technologically literate workforce during World War I, Congress saw vocational education through Smith-Hughes as, among other things, a means by which to build a strong work force as an integral element of a national defense strategy (Stone, 2002).

Funding originally provided for vocational education in agriculture, home economics and trade and industry (e.g., building trades, printing, machine-shop, textile, auto mechanics, woodworking), and later for commercial education (e.g., clerks, cashiers, bookkeepers, salesmen,) and vocational rehabilitation (training for those with
disabilities). From the onset, the legislation segregated vocational education from higher education. Instruction was to be made available to those over the age of fourteen and was to be less than college grade (Wonacott, 2003; Schulz, 1931).

Smith-Hughes, as the first vocational education act, both helped and hindered the cause of vocational education. While it established vocational education as a distinct and separate educational system, in doing so it drove a wedge between vocational education and the rest of the high school curriculum (Wonacott, 2003; Rojewski, 2002; Hayward & Benson, 1993). Though the curriculum was to be a balance between preparation for work skills and instruction in the liberal arts, education evolved into two branches: one branch was for students planning to attend college and the other was for those preparing for the workforce upon graduating from high school (Hayward & Benson, 1993). This separation between mainstream education and what is now CTE still exists as reinforced by legislation following Smith-Hughes.

In the United States, even though education governance is constitutionally the responsibility of the individual States, policy-making in most States is delegated to local school districts. Yet the strongest influence over the establishment of vocational education was the federal government through the Smith-Hughes Act, several elements of which served to segregate vocational education from general education. Smith-Hughes established a separate State board for vocational education as a vehicle by which adherence to requirements and procedures of the Federal Board of Vocational Education would be met. In some States, the establishment of the State Board of Vocational Education and the State Board of Education as two separate educational governance structures promoted vocational education as separate and distinct from general or
“academic” education (Hayward & Benson, 1993). Smith-Hughes provided funds to be used to pay vocational education teachers and not academic teachers. The intent was to ensure that funding would be used only for vocational education, but the result was to further separate vocational education.

Through subsequent legislation, vocational education became a means by which military veterans could be trained for the workforce following their service to the country. Though the legislation discussed in this paragraph has little impact on vocational education as a whole, it is included to illustrate the role vocational education has played in trying to help specific segments of the population. The 1918 Vocational Rehabilitation (Smith-Sears) Act provided training grants for World War I veterans themselves and was soon followed by the Smith-Bankhead Act of 1920, which provided funding to states to establish vocational rehabilitation programs for veterans. During World War II, similar legislation in the Vocational Rehabilitation Act of 1943 provided assistance to disabled veterans.

As the next major act to impact vocational education to follow the Smith-Hughes Act, the Vocational Education Act of 1963, with amendments in 1968 and 1976, served to further segregate vocational education from main-stream education. With portions of Federal funds called “set-asides” designated for vocational educational needs of the poor and disadvantaged or students with disabilities, vocational education was called upon to not only provide workforce development, but to do so with those who otherwise were difficult to educate. As an example, the Vocational Education Amendments of 1968 called for policies and procedures that assured for due consideration to be given to the vocational education needs of all population groups. The good intention to serve all
people spawned the unfortunate consequence in which vocational education began to be thought of by some as a refuge or dumping ground for underprivileged minorities (Wonacott, 2003; Cohen & Besharov, 2002; Hayward & Benson, 1993). This act continued the sub-baccalaureate nature of vocational education in providing training for all types of occupations except those considered professional and requiring the baccalaureate (Mobley, 1964).

In 1984, the Vocational Education Act was renamed the Carl D. Perkins Vocational Education Act in honor of the former chairman of the House Education and Labor Committee (Skinner & Apling, 2005). It continued funding of vocational education and unfortunately furthered the notion that vocational education was a second tier option. Its objectives were to improve vocational programs and provide better services and access to those with special needs, with 57% of funding set aside for disadvantaged groups and the remaining 43% for program improvement. The result was significant enrollment increases of students with special needs (Wonacott, 2003). In 1990, Perkins II, known as the Carl D. Perkins Vocational and Applied Technology Education Act, amended the 1984 act, most significantly with the tech-prep program, which was designed to coordinate secondary and postsecondary education into a more logical sequence. The set-asides for special populations were removed, although the focus remained on providing access to high-quality education for special populations. Perkins II also required states to develop and implement performance standards and measures such as job placement, but not job performance. In 1998, Perkins III amended Perkins II and renamed the act the Carl D. Perkins Vocational and Technology Education Act, replacing “vocational education” with “vocational and technical education” (Skinner & Apling,
Perkins III, perhaps in part to reduce the perception that vocational and technical education was second tier, required that vocational and technical education students be taught the same challenging academic proficiencies as all other students (Rahn, O’Driscoll & Hudecki, 1999).

With the passage of the Carl D. Perkins Career and Technical Education Improvement Act Of 2006 the federal government replaced the term “vocational and technical education” with “career and technical education” to keep pace with professionals in the field and to officially name CTE in Federal law. The focus also changed from CTE for work or college to CTE for work and college. With the same Act, the federal government clarified its intention and removed limiting language in the definition of career and technical education to eliminate a perception that career and technical education ends with the completion of a two-year postsecondary degree or certificate. Under this Act, the government saw CTE as a critical component that combines academic curricula with relevant job skills in the development of a 21st century workforce needed to keep America competitive in the global economy.

Vocational education carried the United States through two world wars and provided career and technical training through public education while the remnants of apprenticeship, maintained mainly through organized labor, continued to provide training in controlled sectors such as the building trades. Throughout its history, the name “vocational” has sparked debate as a term that stigmatized the education provided as being less desirable than academic preparation (Cohen & Besharov, 2002). The roots of the debate can be seen early in CTE history with the emergence of the American Vocational Association (AVA) in a 1926 merger of the National Society for Vocational
Education and the Vocational Education Association of the Middle West. Since then, several names have been used that mean essentially the same thing, including vocational education (voc-ed), vocational-technical education (voc-tech), work-based learning, occupational-technical, vocational education and training (VET in Australia) industrial arts, and occupational education (oc-ed). In 1970, President Nixon proposed the name “career education” while in 1989 the House of Representatives liked the name “applied technology education.” A Google search conducted on April 12, 2009 turned up several schools that use the term “Professional-Technical Education” to present a more pleasing façade, yet their programming contains largely the same curricula as any other vocational education school. At its 1998 Convention, the American Vocational Association changed its name to the Association for Career and Technical Education (ACTE), and vocational education has been known as career and technical education ever since (Barlow, 1976).

Through the years, educators have engaged in a debate to determine if CTE should be targeted to a narrow portion of business and industry or if it should include outcomes of a more academic curriculum. In spite of the debate, or perhaps because of it, the emphasis in CTE has evolved from “training” to “education” (Gaunt & Bierlein Palmer, 2005). In this context, Chickering (2009) provides a relevant distinction between training and education:

The purpose of training is to take a collection of diverse persons and make them more alike. It aims to give them a common set of skills, a base of shared information and knowledge, shared values, and identification with some particular cause or purpose.
I contrast it sharply with “education,” whose Latin root is “educare (sic), which means “to lead or to draw forth.” For me, education starts with the learner. It takes a collection of diverse persons and helps each of them become more what they want to be, to realize their own personal potentials and talents, to achieve their own purposes and aspirations (p. 12).

In short, training attempts to make all students the same while education endeavors to help them be different. When viewed through this lens, assessment in CTE encompasses a more complex criterion. Rather than measuring simply the industry-specific knowledge and skills, assessment must encompass all that a graduate should know and be able to do within whatever sector of the industry he or she is employed.

Several factors have influenced this evolution from CTE as training to CTE as education. As the abundance of jobs available to high school graduates has been reduced, CTE as a portion of overall high school curriculum has declined, from 21.8% in 1982 to 16.2% in 2000. The resulting shift in the role of career preparation from the high school to the postsecondary institution, particularly the community college, brought with it a higher academic standard (Silverberg, Warner, Fong, & Goodwin, 2004). The focus on overall academic improvement at the secondary level fueled by the No Child Left Behind Act (NCLB) of 2001 resulted in significant academic progress by CTE students, as indicated by higher 12th-grade reading and math skills and a reduction in the gap between CTE and non-CTE students to less than 1.0 Carnegie credit (Silverberg, Warner, Fong, & Goodwin, 2004). Other federal legislation (Perkins IV) reinforces NCLB through greater emphasis in integrating academic courses into CTE programs and further encourages an approach to CTE that is more “education” than “training” through a
curriculum called “all aspects of industry” that provides a more comprehensive understanding of the target industry rather than simply job-specific skills.

**General Education Outcomes**

**LEAP**

Concurrent with this changing emphasis in CTE from training to education and from secondary to postsecondary levels, several entities endeavored to define what students really need to know. Most recently, the National Leadership Council for Liberal Education and America’s Promise (LEAP) recognized that learning beyond high school is necessary for students and the United States to be successful in the dynamic international economic environment. It is no longer realistic to expect that students will graduate and find a life-long career within their field of study: Americans already change jobs 10 times within 20 years of entering the job market (Association of American Colleges and Universities, 2008). Further, “Student success in college cannot be documented—as it usually is—only in terms of enrollment, persistence, and degree attainment.” (Association of American Colleges and Universities, 2008, p. 4). This statement aligns with the researcher's goal to measure the four-year HVAC engineering technology program not by what its students know and can do in school, but by what they know and can do in the workplace.

A list of educational outcomes, developed by the Association of American Colleges and Universities (AAC&U) through a multiyear study involving colleges, universities, the business community and accreditation requirements for engineering, business, nursing and teacher education, provides a framework of liberal education that all college students need, regardless of their field of study. This list, which encompasses a
common foundation for success in any field, thereby bridging the academic and the vocational, is known as *The Essential Learning Outcomes*.

**Basic knowledge and applied skill requirements**

This set of outcomes aligns with the findings of a 2006 job-readiness study entitled *Are They Really Ready to Work?* conducted in collaboration by the Conference Board, the Partnership for 21st Century Skills, Corporate Voices for Working Families, and the Society for Human Resource Management. Over 400 Fortune 500 companies were surveyed and a dozen human resource and senior executives were interviewed to determine the corporate perspective of graduate workforce readiness. The study defined workforce readiness by asking:

1. Whether or not the skill levels that new entrants are currently bringing to their jobs are deemed “excellent,” “adequate,” or “deficient,”

2. What basic knowledge and applied skills they consider “very important,” “important,” or “not important.” Basic knowledge refers to the academic subjects and skills acquired in school. Applied skills refer to those that enable new entrants to use what they learned in school to perform in the workplace.

3. How the importance of these skills may change over the next five years,

4. What emerging content areas are considered “most critical” over the next five years, and

5. What are the nature and costs of remedial training or initiatives, if basic skills are lacking (Casner-Lotto, 2006, p. 2)?

Subjects determined that the most important skills needed by graduates include professionalism/work ethic, oral and written communications, teamwork/collaboration
and critical thinking/problem solving. Further, what the study defines as “applied skills” were determined to be of greater value to employers than so called “basic knowledge/skills” (Casner-Lotto, 2006).

**Partnership for 21st Century Skills (P21)**

In 2002, twelve years after the SCANS workplace know-how list of competencies and skills was published, the Partnership for 21st Century Skills (P21) was founded “to serve as a catalyst to position 21st century readiness at the center of US K12 education by building collaborative partnerships among education, business, community and government leaders” (The Partnership for 21st Century Skills, 2009). Based on a framework of student outcomes and support systems, P21 includes a list of skills designed to be integrated into the teaching of core academic subjects identified by NCLB. P21 adds to these core subjects content determined to be critical to workplace and community success.

**Secretary’s Commission on Achieving Necessary Skills (SCANS)**

Prior to this work, in 1991 the Department of Labor’s Secretary’s Commission on Achieving Necessary Skills (SCANS) culminated 12 months of work involving interviews with business owners, public employers, managers, union officials and workers with a publication entitled *A SCANS Report For America 2000*. In part, the Commission was directed to define the skills needed for employment and identified “five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance” (Brock, 1991, p. iii) as “a set of common competencies and skills shared by all workers” (Brock, 1991, p. 6). A comparison of these skills and competencies, called “workplace know-how” finds striking similarities to *The Essential
Learning Outcomes developed by the AAC&U (2008) and the skill sets that graduates need to succeed as determined by the Conference Board, the Partnership for 21st Century Skills, Corporate Voices for Working Families, and the Society for Human Resource Management (Casner-Lotto, 2006).

The sets of outcomes as developed by AAC&U; the Partnership for 21st Century Skills; SCANS; and the collaboration of the Conference Board, the Partnership for 21st Century Skills, Corporate Voices for Working Families, & the Society for Human Resource Management all differ in some ways but essentially all say the same thing: students need more than technical or even academic skills. These efforts align with the philosophical shift in thinking of CTE as education and training. Research challenges the conventional view that liberal education is, by definition, “nonvocational” and declares that view to be obsolete by disputing the idea that "liberal education is achieved only through studies in arts and sciences disciplines” (Association of American Colleges and Universities, 2008, p. 4; Chickering, 2009). With CTE now considered more academic than ever and the notion of liberal education challenged as nonvocational, the concept of measuring graduates holistically by what they know and can do on the job is a timely concept, but it presents a more challenging task of assessment that encompasses not only the job-specific competencies of a distinctive industry, but also the broader skills and knowledge included in a liberal education (McLester, 2007).

History of HVACR

Despite the philosophical shift over time in thinking of CTE as simply “training” for a specific industry to the broader view of CTE “education,” by nature and definition, CTE must still provide “relevant technical knowledge” (Perkins IV). To frame the need
for assessment of the attained technical knowledge of graduates of the four-year engineering technology program, a brief history of the HVACR industry is provided. This history demonstrates the diverse and dynamic nature of HVACR and illuminates the need for constant feedback from industry stakeholders to ensure the curricula remains aligned with industry. The history to follow frames this research in terms of documented changes over time and helps to establish a need for the study.

Heating, ventilation, air conditioning and refrigeration are all technologies that are taken for granted in society, much like the ubiquitous cell phones and MP-3 players that proliferate the year 2010 when this is being written. Chocolate shakes, drinks “on the rocks,” indoor skating rinks, refrigerated food preservation, and environmentally controlled homes and buildings are among many of the luxuries provided by HVACR systems that never warrant a second thought. Yet virtually all of this technology has emerged in the past three generations, and educational programs have found it necessary to change with the technology. The urgency for schools to maintain a reading of the “pulse of the industry” has increased as the rate of change has increased in the digital age.

The actual birth or starting point of the modern HVACR industry is difficult to establish. The industry itself has roots dating back to the dawn of man, when fire was first discovered and used for cooking and for warmth. Historical records include accounts of Leonardo Da Vinci experimenting with mechanical “climate control” using a water-driven fan, circa 1500 (Gladstone, 1998). Long before Da Vinci, early man first discovered the need for ventilation as a requirement when the burning of indoor fires required a hole or “vent” to let smoke out and another to let fresh air in. Thus, the quest for thermal comfort (heat) led to a need for ventilation. Dust control became a second
need for ventilation when the ancient Egyptians noted that stone carvers suffered higher incidents of respiratory issues than those working outside. Later, during the Middle Ages, a third need for ventilation was discovered when people began to realize that disease could be transmitted through “bad air” in crowded rooms (Janssen, 1999). Cooling has a much murkier history. Though the Holy Bible contains accounts of Roman emperor Varius Avitus using snow or ice for cooling, early accounts of the commercial ice industry in the U.S. began with a shipment of ice to Martinique soon after the turn of the 18th century to relieve the yellow fever epidemic. Prior to the late 19th century, air conditioning consisted of blowing air over melting ice, using one means or another to move the air (Nagengast, 1999). At this time, before the first electric fan was marketed in 1882, steam was the power of choice to turn the relatively few fans and pumps used for heating and cooling.

During the last half of the 17th century, any mechanical cooling used the absorption method, in which a source of heat (steam) drives the cooling (thermodynamic) cycle. (This is similar to the modern refrigerator found in recreational vehicles, which use propane as the source of heat.) Heating was provided by fireplaces, cast iron stoves, or boilers. The historic competition between Thomas Edison and his advocacy of direct current (DC), and George Westinghouse Jr., who was a proponent of alternating current (AC), along with the subsequent testing of various voltages and frequencies, took another half a century before the present electrical AC current, generated at 60 cycles per second, was established as the standard in the U.S. during the 1930s. The new power source took over, and by 1925, 62% of the motive force required for machinery was the electric
motor. The HVACR industry had the source of power it needed for rapid advancement (Flaniken, 1999).

From that point until now, changing technologies has been the constant. As the industry proliferated, the need for qualified technicians grew, and with the innovations came the need for sources of training and education. The next several paragraphs chronicle some of the changes in the industry since the 1900s and discuss current industry trends to emphasize the need for constant alignment of HVACR curricula with the industry. Such alignment is typically accomplished through the use of industry advisory committees. The unique nature of the four-year program at Ferris calls for a more in-depth analysis, as this brief history will illustrate.

The development of electricity and the electrical distribution system drove revolutionary change in the HVACR industry. The electric-driven compressor led to rapid innovation in the vapor-compression refrigeration cycle, which has all but replaced the earlier mentioned absorption cycle. Willis Carrier, founder of the modern-day Carrier Corporation and generally credited as the father of air conditioning, found a way in 1902 to control humidity in a Brooklyn, NY printing plant by using an air conditioning system, even though the term “air conditioning” was not even coined until four years later (Arnold, 1999). This installation is generally considered to be the birth of the modern air conditioning industry.

Soon, refrigeration began to catch on. In 1921, only 5,000 household refrigerators were manufactured in the US. By 1935, the number had grown to six million. This sector of the industry has seen changes not only in the equipment, but in the refrigerants used. Most early refrigerants (e.g., ammonia, sulfur dioxide) were either toxic, flammable,
corrosive, or a combination thereof. In 1930, chlorofluorocarbon (CFC) refrigerants were
developed as a safe and efficient replacement, and the public came to mistakenly know
all refrigerants as “Freon®” after Dupont registered the name for its fluorocarbon
products (Anonymous, n.d.). Though ammonia systems were still very common in large
municipal type plants, CFCs and HCFCs (hydrochlorofluorocarbons) dominated the
market and were well established by the time the refrigeration program was founded at
Ferris in 1945 (Nagengast, 1999).

Students at the time needed to be familiar with chemical and physical properties
of the various refrigerants. In addition, students needed to learn about the various
refrigeration systems and the different types of compressors and other system
components, as well as the correct operating temperatures and pressures of each type of
system. When the Ferris HVACR program was founded, the first window air conditioner
and automotive air conditioner (in the trunk of a Cadillac) had been introduced, and the
industry saw a dramatic growth and demand for technicians (Anonymous, n.d.). In 1935,
934 air conditioning systems were installed in Chicago alone, with 48 residential systems
reported in Washington D.C. By 1938, federal government buildings in Washington D.C.
featured the largest air conditioning system in the world (Arnold, 1999). In 1947, 43,000
window air conditioners were sold. Five years later, the number grew to 360,000. By
1950, 80% of farm homes and 90% of urban homes had refrigerators, and by 1959, one
million cars were air conditioned (Pauken, 2009). As the industry grew, so grew the need
for technicians and for training of those technicians.

The so-called “energy crisis” in the 1970s began to focus attention on energy
efficient HVACR systems and led to the development of a whole new sub-industry, as
well as the accompanying need for new educational objectives. The impact of CFCs on stratospheric ozone lead to the discovery of the “ozone hole” over Antarctica in 1985 and resulted in a 1987 international agreement (the Montreal Protocol) to phase out CFC use. The subsequent Clean Air Act Amendments of 1990 led to a complete phase out of CFCs by 1996. Sections 608 and 609 of the Act required all technicians that might release CFCs and HCFCs into the atmosphere to be certified under the Environmental Protection Agency (EPA) by November 14, 1994 (Feutz, 2000).

The CFC phase out led to a new era of “replacement” refrigerants. This was a major and fundamental change in the industry. Technicians in the field and educators in the classroom all needed to relearn their industry as the old familiar refrigerants were replaced with new, more ozone-friendly refrigerants. For the first time, students and existing technicians were required to learn about the environmental impact of their industry, including the ozone depletion potential (ODP) and global warming potential (GWP) of various refrigerants. At the time, the concern over the global warming potential of refrigerants was related to the potential of the refrigerant gas itself to contribute to the greenhouse gas effect. Subsequently, awareness grew of the secondary greenhouse effect, caused by carbon dioxide emitted by the burning of fossil fuels to generate the electricity needed to power the systems that used refrigerants. Currently, the ozone hole is all but forgotten, and the attention has been turned to sustainable design with a holistic focus on the environment and climate change (Feutz, 2000). In 2010 as this is being written, the industry is undergoing another major shift in the type of refrigerants used. All refrigerants containing chlorine (CFCs and HCFCs) are being phased out. It is the chlorine atom that, upon reaching the stratosphere, is released as the chemical compound is broken apart by
ultraviolet radiation and catalytically destroys ozone. Production of HCFC 22, the most common refrigerant used for residential air conditioning systems, has been phased out for all but equipment manufactured before January 1, 2010, and by 2020, all production and imported HCFC 22 will cease. Replacements include hydrofluorocarbon (HFC) and perfluorocarbon (PFC) refrigerants. These replacements exhibit different physical and thermodynamic properties, necessitate different equipment, and require education and training materials and programs to change with the technology.

Prior to the energy crisis of the 1970s, large HVAC systems were essentially controlled by varying the temperature, while allowing fans and pumps to run at constant speeds. With energy a cheap commodity and the lack of environmental awareness or concern, there was no perceived need to provide for greater efficiency provided by variable-flow systems. The energy crisis and new environmental awareness created a heightened consciousness of energy efficient design and operation during the 1980s. Concurrent with these new concerns, variable frequency drive (VFD) technology became a more economical and reliable means to control electric motor speed. This emerging technology enabled a fundamental shift away from constant speed to variable speed in large HVAC system design. Due to the exponential advancements in computer technology that took place during the same period, a second fundamental shift occurred in large HVAC system control. The electric and pneumatic control mainstay began to be replaced by computers and direct digital control (DDC).

The VFD and DDC technologies enabled a paradigm shift for engineers and technicians in the HVAC industry. VFD allowed (or perhaps required) engineers to design systems with variable flow. Many variable air volume (VAV) systems operate at
an average of 70% of full speed. With the power requirement varying as the cube of the ratio of speed reduction (i.e., 70% speed requires 34.3% of the power needed at 100% speed), a substantial energy savings can be realized (Owen, 2008). Direct digital control has enabled control engineers to monitor many more control points in the building and use computer software to adjust system parameters with much more accuracy than older electric and pneumatic systems.

Both of these technologies were in their infancy when the four-year HVAC engineering technology degree was launched at Ferris. Where control systems were just beginning to use computer technology, virtually all new installations across all sectors of the industry use some sort of digital control today. And where control systems used to be the domain of a few major players in the industry (e.g., Honeywell, Johnson Controls), advances in hardware and software have enabled numerous companies to develop economical and powerful high-quality graphical user interface systems that have shifted knowledge requirements from line-code to point and click programming. Finally, where the proprietary nature of early systems prevented connection to components from any other manufacturer, new interoperability protocols now allow cross-connection of most all devices.

Currently, buildings consume more than 60% of electricity used in the United States and HVACR systems account for 40% to 60% of all energy consumed by buildings (Janis & Tao, 2009; Bellenger, 2008, U. S. Green Building Council, 2006). Today, the focus on energy efficient and sustainable design is galvanized by the United States Green Building Council (USGBC) and its associated Leadership in Energy and Efficient Design (LEED) rating system, as well as an initiative called Architecture 2030.
Challenge. Supported by the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), the American Institute of Architects (AIA), and the USGBC, the goal of the Architecture 2030 Challenge is identical to the Energy Independence and Security Act of 2007 (EISA), which requires all federal buildings to reduce their use of fossil fuel based energy to zero by 2030. Using a rating system for buildings called the Commercial Buildings Energy Consumption Survey (CBECS), this so called Net Zero Energy Buildings (NZEB) initiative calls for buildings to use no more energy than is provided by on-site renewable energy. Measured by the total amount of annual energy used per square foot using the Energy Usage Index (EUI), the CBECS provides a comparison of buildings similar to the familiar miles per gallons used to compare energy usage in automobiles (Wentz & Harrison, 2010; Bellenger, 2008).

Further, as this is written, another paradigm shift is taking place within the industries of the built environment. The very way in which buildings are designed and constructed is undergoing a revolutionary change using a process known as Building Information Modeling (BIM), in which a three-dimensional model of the building is built virtually before the building is built physically. BIM allows for a radical new way of designing buildings called Integrated Project Delivery (IPD), in which all stakeholders, from the owner, architect and engineer to the sub-contractors, can contribute to the design of the building. By including the contractors in the design process, collaboration between designers and constructors allows for a more effective and efficient building design and construction cycle, which results in a lower cost and higher quality building (Mackenzie, 2010). With the renewed interest in the reduction of energy consumption, advances in technology such as DDC and VFD, and the revolutionary design process using BIM and
IPD, HVACR students of today must learn not only the technical aspect of their chosen industry, but must also learn how to design, commission, operate, maintain and repair systems for optimal comfort and energy efficiency in constant awareness of the impact their work has on environmental issues such as carbon footprint, using emerging technologies and techniques.

This section briefly chronicled the HVACR industry and highlighted the changes that have been a constant throughout its history. While the change has been dramatic in the past 100 years, the advance of computers over the past 25 years has ushered in a much more rapid rate of change. The HVACR industry is not much different than others in terms of change. Innovations challenge educators to not only stay informed, but to keep up with changes in their classrooms and laboratories. Though the HVAC-ET faculty remain connected to the industry through involvement with various industry associations, personal contacts and biannual advisory committee meetings, it was important to learn how well students were prepared for this constant and rapidly changing industry. This historical perspective has been offered to help establish the need for this research; the study of a unique field of study in a diverse and dynamic industry.

Assessment

“Across all the discussion of access, affordability, and even accountability, there has been a near-total public and policy silence about what contemporary college graduates need to know and be able to do.” (Association of American Colleges and Universities, 2008, p. 4).

Thus far, this document has provided a discussion to establish the four-year program in HVAC engineering technology as CTE and frame it within the context of the
histories of both CTE and the HVACR industry, and within the vast national education system. This was necessary to illustrate how CTE itself has evolved over time from training for a particular job to the current broader context as integrated with an academic curriculum in preparation for an entire career. The HVACR history provided a brief glimpse into the diverse and dynamic state of the industry to illustrate the need for academic programs to keep abreast of changing technologies. To keep a curriculum current with the industry is one thing; to measure how well its students have been prepared is quite another.

It is common for colleges and universities to conduct self studies for just this purpose. At Ferris State University, each academic program undergoes a formal Academic Program Review (APR) every five years. The HVACR department (including both the two-year technology and the four-year engineering technology programs) was last involved during 2006, when students, graduates, faculty, employers and advisory committee members responded to Likert-style survey questions and provided short, one-sentence comments in response to a number of open-ended questions. The study provided quantitative data that indicated a high level of quality in the program, but stopped short of providing follow-up inquiry to learn what could be done to improve quality.

As an institution that shares an emphasis on career-oriented curricula with Ferris State University, in 2001 the University of Wisconsin-Stout (UW-Stout) became the first postsecondary institution to receive the Malcolm Baldrige National Quality Award for successfully implementing the Baldrige criteria as a framework for innovation and change. UW-Stout conducts an alumni outcomes survey at one and five year increments following graduation. Level of satisfaction with graduate knowledge, skills and abilities
are determined using formal employer surveys. Student abilities in general education are measured using the ACT Collegiate Assessment of Academic Proficiency (CAAP). These data serve as the basis for quality improvement (Furst-Bowe & Bauer, 2007). The researcher considers the UW-Stout example using the Baldrige criteria as a benchmark assessment model for institutions. However, this study focused on a single program rather than an entire university and sought to gather a richer data than is available via the Academic Program Review at Ferris.

**Assessment of curricula: A comparison**

Career and Technical Education is a complex system at both the secondary and postsecondary levels when compared to academic courses. Though much work has been done to assess academic progress, especially at the secondary level, the literature is nearly blank when discussing assessment of CTE programs as they relate to the sectors of industry which they serve. There is much written about how a program will serve a particular need in industry, but little written about how a program does serve that need (Brown & Conbere, 2005; Furst-Bowe & Bauer, 2007; Knox, 1998; Imel, 2001). There is data recording how many students are enrolled, retained, graduated, and placed, but there is little reporting on how those students performed once they were placed. The literature does not answer questions about graduate performance compared to those with no training, how well they fared after the first year or after five years, or whether they stuck with the industry or left to seek other employment.

Assessment of academic programs can be thought of as existing along a continuum, varying from an apprenticeship curriculum to general education. The apprenticeship serves a finite group of students within a very specific sector of business
and industry and is focused on training rather than education. General education serves all students across all sectors of business and industry and is focused on education rather than training. At the apprenticeship extreme, assessment is relatively easy to accomplish, while assessment of general education is well established using a number of nationally-normed instruments. Assessment of a CTE program is somewhat more difficult. The discussion that follows will illustrate the challenges that face the assessment of the four-year HVACR engineering technology program.

Assessment of apprenticeship programs. Apprenticeship programs remain closely aligned with their respective industries due to two reasons. First, in many cases apprenticeship instructors teach only part-time and hold a full-time position in the industry. They experience the industry on a daily basis and take part in changes in technologies and techniques as they emerge. In other cases, the instructor teaches full-time, but has years of experience in the industry and was likely hired due to expertise and reputation as a leader or a highly knowledgeable and/or skilled individual. This close link between industry and instruction provides an inherent assessment as instructors experience and observe the industry firsthand. Many apprenticeship programs, especially in larger cities, utilize both full-time and part-time instructors. The diverse array of skills and knowledge provided by numerous instructors from various sectors of the industry strengthens both the educational quality and the scope of inherent assessment.

The second reason for close industry alignment is due to guidance through a committee of individuals who are also involved in the industry. As an example, in the unionized sector of the building trades, a joint apprenticeship training committee (JATC) consisting of members from both sides of the bargaining table (union members and
contractors) meets on a regular basis with the instructor or training coordinator. These regular meetings include discussions related to student progress and issues but also set the direction of the curriculum. As new technologies become available and old ones drift away, course content is adjusted and updated. Curriculum is often based on a national model but is modified for the local environment and economy. From the perspective of keeping education aligned with industry, the apprentice system is inherently a very good model of assessment and accountability in the area of CTE.

While apprenticeship programs can excel in assessment due to the inherent tight connection with their industry, it must be pointed out that they have much less constraints than CTE programs in secondary and postsecondary settings. Apprenticeship programs must be registered at the national level with the Office of Apprenticeship, under the Department of Labor’s Employment and Training Administration, or at the state level through a recognized State Apprenticeship Agency. To be eligible, an apprenticeship program must have a written set of standards that address the employment of the apprentice, training to include a suggested minimum 144 hours per year of instruction, and assessment in a form that must be measured using either a time-based approach (on-the-job learning of at least the industry standard of 2,000 hours), a competency-based approach (which also requires an on-the-job component), or a combination of the two (Apprenticeship Programs, Labor Standards for Registration, Amendment of Regulations, 2008). When compared to the multi-level federal, state and local school district regulations affecting CTE programs within the general education system, apprenticeship program requirements are relatively minimal. Due to their self-funded nature and relatively minimal regulations, apprenticeship programs tend to be essentially but not
completely self-governed. Their singular focus based on close and specific industry alignment provides an inherently self-evaluative culture, and in being a part of the industry for which they train, apprenticeship programs inherently have a higher level of commitment to long-term success.

**Assessment of CTE programs.** In contrast, where apprenticeship programs enjoy a singular focus, CTE within the educational secondary and postsecondary systems consist of a wide variety of programs that serve an equally large number of industries. Where apprenticeship programs are controlled by narrowly-focused committees, CTE programs are governed by multi-level administrations and by regulations with sufficiently wide focus to encompass the entire spectrum of CTE. This wide focus runs the risk of losing sight of individual programs. Apprenticeship committee members are industry insiders with a personal stake in the success of their individual program while CTE leaders may or may not have been part of an individual industry, and as a member of public education, may have no personal stake in any one individual program. Where apprenticeship programs live and die with their respective industries, CTE as a sector of education continues to exist regardless of the fate of any one industry. These differences between two sectors of CTE, apprenticeship and CTE in public education, highlight the difficulty of assessing CTE programs in the public educational system as they relate to their respective industries. Viewed as a whole, the task of evaluating each area of CTE is challenging and daunting. From this perspective, it is sensible to consider that each program assumes the responsibility for its own assessment.

There are many methods by which to evaluate a CTE program and many criteria by which to judge effectiveness. Grades, enrollment, retention, completion rates,
graduates salaries, cost, and adherence to standardized curricula or federal guidelines are examples of data collected for assessment purposes, yet none measure what the graduate knows and can do on the job. In essence, no common assessments indicate whether the graduate is employable. In his work, Kagaari (2007) strikes the point head on: it is not enough to simply teach students how to do a job, it is necessary to teach them how to learn while on the job:

Employability is not the same as employment, just as education is not the same as training (Cox and King, 2006): to be employed is to be at risk; to be employable is to be securing (Hawkins, 1999). In this context, employability means that a person possesses the capability to acquire the skills to do the required work, not necessarily that they can do the work immediately and without further training (p. 454).

Throughout history, much importance has been placed on preparing students for the work force for reasons ranging from economic development to national defense (Rothwell & Gerity, 2008; Waterhouse, Virgona & Brown, 2006; Stone, 2002; Mobley, 1964). Current emphasis in integrating general education (academic) outcomes throughout CTE curricula is heralded as necessary for workers to be successful in a diverse and dynamic workplace (Association of American Colleges and Universities, 2008; Chickering, 2009). Yet the literature is nearly devoid of any research to measure how well CTE graduates actually perform. Discussions are offered in the following sections to highlight the sharp contrast that exists between the numerous instruments used to assess persons while they are students and the lack of instruments that link student performance to work performance.
Assessment of college readiness. Compared to CTE, evaluation of an “academic” or college-prep curriculum or student is relatively straightforward. College-prep curricula are commonly assessed by measuring student success in high school using a grade point average (GPA) based on a four-point/five-grade system and the standard Carnegie unit. While the GPA can be a weak indicator of success due to a wide range in teacher grading criteria and in school quality and effectiveness, high school success can be more accurately estimated by measuring readiness for college using various standardized tests of academic skills.

The SAT Reasoning Test (formerly known as the Scholastic Aptitude Test and Scholastic Assessment Test) is a standardized college admission test developed by the College Board, a not-for-profit education organization. The SAT, required or preferred by most selective universities, consists of two parts. The SAT I Reasoning Test measures verbal and mathematical reasoning skills using tests in critical reading, mathematics and writing. Each test is scored from 200 to 800 points for an overall possible total of 2400 points. The SAT II Subject Tests measure knowledge or skill in the specific subject areas of History (U.S. and World), Literature, Sciences (Biology, Chemistry and Physics), Mathematics Level 2, and several languages (Retrieved from http://sat.collegeboard.com/why-sat/how-is-sat-scored).

As an alternative standardized college admission test, the ACT (formerly the American College Testing Program or American College Test) tests in the four skill areas of English, Math, Reading and Science Reasoning. An optional Writing Test measures skill in planning and writing a short essay. Founded in 1959, the ACT was designed to help students decide which colleges to attend and which programs to study, and to furnish
colleges with student admission and success-prediction data. The ACT scores consist of a total of 36 points on each portion of the test. Test results report the total points in each area and an overall composite score with a maximum of 36 (ACT Inc., 2009).

As a part of the American Council on Education (ACE), the General Educational Development Testing Service (GEDTS) develops and delivers the General Educational Development Test (GED). Also known as the General Equivalency Diploma or General Education Diploma, the GED consists of standardized tests in Mathematics, Language Arts, Reading, Writing (including essay), Science, and Social Studies. The tests were first developed in 1942 to help World War II veterans finish high school (American Council on Education, 2010). Though widely known as the high school equivalency credential, the GED can be used as a college admission test in some cases. Scores are reported as both a standard score ranging from 200 to 800 and a percentile rank ranging from 1 to 99. A successful score consists of scoring better than approximately 60% of high school graduates nationwide, with each state setting their own criteria. At the time of this writing, the State of Michigan reported a minimum score consisting of 410 on each test and a total of 2250 points overall (American Council on Education, 2010).

More than two million students take the SAT each year, 1.5 million students took the ACT in 2009, and more than 728,000 students took the GED in 2007. While some students take both the SAT and the ACT, these numbers of test takers combine to produce a very large annual population from which standardized test data is collected to measure academic performance. In contrast, no national assessment of any CTE program of study exists at the secondary level.
Assessment of postsecondary achievement. Where the previously discussed assessments (ACT, SAT and GED) measure college readiness, other nationally deployed instruments measure postsecondary student outcomes. Over the past decade, the National Survey of Student Engagement (NSSE) and the Community College Survey of Student Engagement (CCSSE) have served to promote the concept of student engagement as the single best predictor of student learning and personal development (Kuh, 2003). NSSE and CCSSE collect data annually from hundreds of post-secondary institutions nationwide to measure student engagement contributing to their intellectual and personal development. Designed in 1998 as an alternative to the institutional accreditation processes that focuses mainly on resources and process measures, the overarching purpose of NSSE is to provide a measure of quality assurance that is focused on instructional practices and student experiences, activities and outcomes. Through its survey of good practices in undergraduate education entitled The College Student Report, NSSE helps colleges identify areas for improvement in teaching and learning (Kuh, 2009).

At the heart of NSSE is the principle that student engagement is the best indicator of student success in college. That is, the more students study and practice a subject, the more they know it, and the more they interact and get feedback from each other and faculty, the better they understand (Kuh, 2003). Good practices that lead to more student engagement include student-faculty contact, cooperation and reciprocity among students, active learning techniques, prompt feedback from faculty, emphasis on time on task, high expectations, and respect for diverse talents and ways of learning (Chickering & Gamson, 1987).
Building on the work of Chickering, Gamson, and others, NSSE is based on a core of five clusters or benchmarks of effective educational practice used to measure student engagement, which include level of academic challenge, active and collaborative learning, student-faculty interaction, enriching educational experiences, and supportive campus environment (Kuh, 2002). First field tested in 1999, NSSE is now essentially a web-based survey that in 2008 was administered to students in 772 schools. Through the surveys, the first NSSE goal is to improve teaching and learning at individual institutions through publication of data collected from that particular school and benchmarked against the universe of data collected from all schools that participate in NSSE. A second goal of NSSE is to learn more about effective education practices used at colleges and universities and disseminate that information for overall quality improvement efforts nationwide. A third goal is to encourage the public to accept and use the NSSE reports as a means by which to learn about and compare the quality of education at various institutions (Kuh, 2009).

When combined, the 772 schools included in the 2008 NSSE and the 663 community colleges participating in the 2009 CCSSE total more than 1400 institutions involved in the past two years alone. Though the number is growing, with a total 6,536 postsecondary Title IV institutions in the United States, less than 22% of all postsecondary institutions are measured with these instruments (Snyder, Dillow, & Hoffman, 2009; Community College Survey of Student Engagement, 2009). Even though less than a quarter of schools are measured with these tools, there is still a large number being measured with the same instrument. And with the benchmarking feature of the annual report, participating schools can see how they compare to similar institutions.
nationwide. The NSSE represents a standard form of assessment that can be used by all schools. Yet this still falls short of measuring how effective the students were once they arrived at the workplace. And the NSSE measures broad outcomes that are not specific to any one job or industry. As such, the question of curriculum alignment with industry remains not only unanswered, but unasked.

Originally supported by a grant from The Pew Charitable Trust, the NSSE is well-funded and large in scope. Economies of scale allow for extensive development, evaluation and refinement of the instrument itself, and also enable a large support infrastructure to be established. No such economy of scale is available to any one sector of industry served by a specialized CTE curriculum, leaving assessment of industry preparedness up to each individual industry and resulting in little to no graduate assessment at all. Some CTE areas, such as automotive, with the Automotive Service Excellence (ASE) program, have a well-established set of standards and assessments. In the case of HVACR, there is no one standard or assessment for technician level certification: there are several, and there is no standard or assessment for HVAC-ET at all.

**HVAC technician certification**

Surveys such as the NSSE and the CCSSE do not measure specific outcomes. Rather, they measure empirically derived good practices to determine levels of behaviors by students and institutions that accompany desired outcomes. Such instruments take a macro view of institutions by sampling students from across the curricula to discover if the elements are in place that lead to student learning. From that perspective, they are measuring the soil and the climate to determine if the elements for good crop production
are in place. They are measuring foundational elements that are essential for good
teaching and learning with the premise that good teaching and learning will follow. They
fall short of actually measuring outcomes. That is not their intent. The perspective of this
study takes the opposite approach. This study seeks to measure the outcomes. Using the
crop analogy, this study does not seek to find if the elements for a good crop are in place.
Rather, it seeks to discover if the crop actually grew, how it grew, how it tastes and who
likes it, and what could be done to make improvements.

Within the HVACR industry, several foundational assessments have been
developed to measure national skill standards. That is, instruments termed certifications
or competency exams are available that measure whether the student has obtained the
knowledge determined to be necessary throughout the industry nationwide. The skill
standards and the instruments were developed by a variety of industry entities for various
purposes, but all share one common goal: to raise the level of quality in the industry. In
stark contrast to the automotive industry with a single national certification program
(Automotive Service Excellence, or ASE), the numerous certification programs within the
HVACR industry compete in the marketplace. This point is made to illustrate the
fragmented nature of the industry and the difficulty presented when attempting to
measure student success. As competitors in the marketplace, each certification program
claims to be the best, leaving the consumer (the technician) to try and determine which is
best for their situation. Though each certification is similar in nature, their quantity
dilutes their value and impedes efforts to create a single national standard.

In all cases, the exams consist of a written test. There is no performance
component. As such, they measure knowledge but do not measure skill. These
instruments measure the knowledge for the field of study found at the secondary and two-year postsecondary levels, but no such national assessment is available for the engineering technology program at Ferris State University. A brief description of each HVACR assessment is provided to illustrate the efforts one industry has taken to raise quality. Though fragmented and without a singular focus, these programs none-the-less reflect considerable effort with quality improvement as the goal. As a measurement of technician knowledge deemed important on the job, they provide an outcome benchmark for schools to use in measuring the quality of their students and curricula.

*RSES CM and CMS.* Founded in 1933, the Refrigeration Service Engineers Society (RSES) is self billed as “the world’s leading education, training and certification preparation organization for HVACR professionals” with between 15,000 and 20,000 members (depending on which press release is referenced) throughout the U.S. and Canada. The object of the Society, per the RSES bylaws, “shall be to further the education of its members in the operation, installation, maintenance, application, and servicing of all types of heating, ventilating, air conditioning, and refrigeration (HVACR) equipment” (Refrigeration Service Engineers Society, Inc., 2009). In 1935, RSES launched what is believed to be the first HVACR industry certification: the Certificate Member (CM) and the Certificate Member Specialist (CMS) exam series. The CM test consists of 18 categories related to service and installation of refrigeration and air conditioning equipment and tests related theory, installation, service and troubleshooting. The CMS series includes eight tests, each with 100 questions and an 80% cut score, covering the industry segments of commercial air conditioning, commercial refrigeration, controls, domestic service, dynamic compression, heating, heat pump, and HVACR.
electrical. RSES offers training for their exams through a network of chapters throughout their membership area and also offers training for the North American Technician Excellence (NATE) exams (retrieved from http://www.rses.org/).

**AHRI ICE, NATE, and PAHRA.** Though the “E” in RSES stands for “engineer,” RSES is really an organization of and for the technicians of the HVACR industry. The Air-Conditioning, Heating, and Refrigeration Institute (AHRI) is a trade association that represents the manufacturing sector of the industry. AHRI as an organization has roots as far back as 1888. Existing for most of its life as the Air Conditioning and Refrigeration Institute (ARI), the primary focus has historically been on certification of cooling equipment. A recent merger (January 1, 2008) with a parallel trade association, the Gas Appliance Manufacturers Association (GAMA) joined two associations that partnered on earlier projects into the current AHRI.

With a focus on manufacturers and equipment certification, complaints from manufacturers about non-defective parts returned under warranty generated a vested interest in the quality of technicians who install, troubleshoot, and most importantly, condemn faulty equipment. A first attempt to standardize curriculum across the country began in 1967 with the *Suggested Secondary School Course Guide* and ultimately resulted in the current *Industry Curriculum Guide*. This publication is meant to be a guide for schools to use in preparing their students to take the *Industry Competency Exam (ICE)*, an exam designed to test the scope of knowledge needed by entry level technicians.

With most instructors in the industry coming from industry, ARI increased their efforts to help schools by offering an annual instructors workshop. Beginning in 1996,
this effort expanded into an association of instructors, called the *Council of Air Conditioning and Refrigeration Educators (CARE)*, designed to promote collaboration among teachers. A final development was the Partnership for Air Conditioning, Heating and Refrigeration Accreditation (PAHRA), designed to assess and accredit academic programs that adhered to ARI standards for education, including student performance on the ICE certification exam.

In 1997, ARI formed the North American Technician Excellence, Inc. (NATE) to develop a certification test for technicians at a level above the entry level test provided by ICE. The NATE program has subsequently been endorsed by many industry associations, including RSES, the Air Conditioning Contractors of America (ACCA), the Sheet Metal and Air Conditioning National Association (SMACNA), the Sheet Metal Workers International Association (SMWIA), and the United Association (UA). Confusion in the marketplace over which industry certification to use can be seen in the self-descriptive statements of RSES ("the world’s leading education, training and certification preparation organization for HVACR professionals") and NATE ("the leading non-profit certification program for technicians in the heating, ventilation, air-conditioning, and refrigeration (HVAC/R) industry and the only test supported by the entire industry") (retrieved from http://www.ahrinet.org/).

*HVAC Excellence.* Adding to the confusion is a third technician certification exam entitled HVAC Excellence, self-proclaimed as the largest provider of certification in the HVACR industry. Created in 1994, HVAC Excellence strives to improve technician competency through quality education. In addition to the technician certification, HVAC Excellence offers program accreditation and educator credentialing, similar to the AHRI
CARE and PAHRA programs. As a member of the ESCO Institute, HVAC Excellence is but one of many educational, certification and publication products offered to serve the HVACR industry. The curriculum developed by HVAC Excellence was adopted by the Michigan Center for Career and Technical Education (MCCTE) as the standard curriculum for HVACR education in the state. While similar to the certification and accreditation products offered by AHRI, the HVAC Excellence programs are not affiliated with a particular trade association and do not require specific textbooks or certification exams to establish competency (retrieved from http://www.hvacexcellence.org/Default.aspx).

**UA STAR.** In 2001, the United Association Union of Plumbers, Fitters, Welders and HVAC Service Technicians (UA) recognized that their national apprenticeship training system catered mostly to building trades plumbers, fitters and welders. These trades depend heavily on new construction and to a lesser extent, remodels of existing buildings. Historically, the abundance of work in the construction sector commanded most of the UA’s attention, and thus the heavy emphasis on training for the building trades. Meanwhile, the market for service, maintenance and repair of the systems installed by the building trades was largely ignored in many markets of the country. Though a UA curriculum for HVAC Service technicians existed, it was not widely adopted and only a few cities offered quality service training programs.

In an effort to promote the service sector and help develop further markets, the UA wished to adopt or develop a certification exam for its members. Upon discovering that existing tests catered essentially to the residential and light commercial equipment
sectors of the market, or required membership in a separate association, the UA
determined that a more comprehensive exam was needed to encompass the
residential/light commercial sectors in addition to the large commercial and industrial
service sectors. Their work resulted in the UA STAR exam. This certification is similar to
the others, but different in that it is intended for the union members of the UA. It differs
further through a program that grants 32 hours of college credit to those who successful
pass the exam, through Washtenaw Community College, in Ann Arbor, Michigan.
Members can complete an associate degree by completing the general education
requirements, and can then transfer to Ferris State University to complete a bachelor’s
degree through the online program that is the subject of this study (retrieved from
http://www.uastar.info/).

Test development. When viewed using a macro lens, HVACR education and
certification is but a speck within the vast career and technical educational system, which
itself exists within a much larger national educational system. The certification programs
discussed above each exist to measure that “speck” of industry, and each strive to do so
in a credible and valid manner. Each of the industry exams were developed using panels
of industry experts, commonly known as subject matter experts (SMEs). Though the level
of validity is unknown for all tests, development of the UA STAR exam will be used as
an illustrative example, mainly because the researcher was involved in the process
through the Technology Transfer Center at Ferris State University. A modified version of
an occupational and task analysis process known as DACUM (Developing A
Curriculum) was facilitated by Dr. Katherine Manley, in the College of Education and
Human Services at Ferris State University.
Originally created in the 1960s (Hartley, 1999) to aid faculty in developing curricula for business and industry, DACUM is a process that includes focus groups of expert or veteran workers who are chosen because of their job knowledge. DACUM requires an outside facilitator, but can significantly reduce the amount of time required to complete the analysis. An original focus group is asked to describe their job through a series of structured questions. Thoughts and ideas are recorded and displayed on storyboards or computer monitors to help the focus group generate further thought and comments. As the session progresses, deeper levels of detail are discovered and documented, starting with an overall job title, followed by a job definition, duties (major job areas), tasks (what is done within each duty), and sub tasks (how each task it is to be done). Panelists rank order duties from most to least important and/or according level of skill (i.e., beginner, intermediate, expert). Finally, panelists identify knowledge, skills, traits and levels of training needed for each task. Findings may or may not be vetted using subsequent panels of workers and managers (Dacum.org., n.d.).

As the name implies, a curriculum is then built based upon the results of the DACUM process. Often, a certification exam is created as an assessment tool. The exam may take the form of a written test, performance test, or a combination of the two. To establish validity and cut scores, the test is piloted with workers of various levels of experience and results are compared to expectations to determine if the test is actually measuring as designed. Needed adjustments are made and the test is piloted again to verify the changes actually fixed the problem.

Manley used the TURBO-DACUM, a computer-enhanced process she developed to quickly and accurately facilitate the skills assessment. The UA STAR DACUM
included fifteen technicians from five different local unions across the United States and Canada. The pilot exam was administered to 48 technicians from eight different local unions, with each local union contributing two beginning technicians, two average technicians, and two lead technicians. Though a curriculum already existed, the 12 categories and 68 tasks identified during the DACUM were used to validate the current content and develop a cross walk between learning outcomes and curricular materials (Feutz, 2003).

In summary, several HVACR industry competency or certification exams exist, each meant to measure against a list of national skill standards. For secondary or two-year postsecondary HVACR programs of study, an argument could be made for use of any of the exams, other than those that require exclusive association membership. While further research would be needed to determine the validity of many of these instruments, each was developed with the intent to set the bar sufficiently high as to ensure an increased level of quality in those that pass the test.

As mentioned earlier, one glaring weakness exists in all of the industry competency exams: they are all written tests and contain no performance component. As such, they measure knowledge rather than skill. Persons with “book smarts” may be able to pass the certification exams but may lack the skill to apply their knowledge. To actually test a student’s ability to perform a job skill, a performance test is required. The welder certification program is detailed in the next section to provide an example, based upon the experience of the researcher as a Certified Welding Inspector (CWI).
Assessment of CTE using performance tests

The American Welding Society (AWS) has a well-established system of welder certification tests that require each person to complete a performance qualification of each welding procedure according to a welding procedure specification. The performance must be conducted in a facility that has been accredited as a test facility according to AWS standards. Successful performance of the specific welding procedure is verified by an inspector previously certified by AWS as a certified welding inspector (CWI). Each test is performed according to exacting standards as promulgated in the welder performance specification and regulated under a qualification standard. The welder performance specification contains exacting details of the welding procedure to be performed such as type, size, shape, thickness and position of the metal to be welded; coating material on the metal, if any; welding process to be used (e.g., gas metal arc welding, shielded metal arc welding, gas tungsten arc welding); fit-up (position of the metal pieces prior to welding); composition of filler metal (if any); type and diameter of electrode and flux (if any), shielding gas (if any); welding current type (alternating current, direct current electrode negative or direct current electrode positive); and acceptable voltage and amperage levels. The welder performance specification also contains specific instructions for testing method and acceptable results. The testing method may be a non-destructive method such as radiographic examination or a mechanical type of test that requires the weldment to be destroyed and visually inspected for defects. Testing methods are held to exacting specifications and must follow strict guidelines according to codes and standards. A common test for structural steel welding calls for the weld to be completed, visually inspected, ground flush with the surface of
the base material and polished to expose any defects, visually inspected, cut into two strips of a specified width at specified dimensions along and perpendicular to the weld, bent to a specified radius with the face (top of weld) at the outside of the bend on one sample and the root (bottom of weld) at the outside of the bend on the other sample, and finally visually inspected again. Some tests call for the sample to be machined to a specified shape and pulled apart to measure tensile strength. Other tests require hardness testing of the weld and the area between the weld and the base metal, called the heat affected zone, where the temperature transition between melting and not melting occurred, to test for excessive hardness that can result in brittleness and a future failure of the weldment.

Defects are specified to exacting acceptable tolerances for items such as level of fusion, level of penetration, acceptable height of reinforcement (how high the weld extends above the surface of the metal), number and size of pores both at the surface and within the weldment, maximum amount of undercut (base metal melted away without being replaced with filler metal), and maximum cracking. For tensile pulls and hardness tests, tensile strength and hardness tolerances are given.

The welder certification performance tests provide high confidence that a person who has passed the test will be able to perform the same type of weld on the job. The test is not perfect. It is administered in controlled conditions with the technician standing on the floor. On the job site, the technician may be on high steel in extreme climatic conditions. The weld may have to be completed at a distance that requires a long reach, and conditions may require an uncomfortable position. However, the performance tests
verify that the person was able to produce a weld of acceptable quality, which provides a level a validity that is lacking in the HVACR industry competency exams.

Strides have been taken to develop a test for accurately predicting employer satisfaction. The National Occupational Competency Testing Institute (NOCTI) is a provider of norm-referenced occupational competency assessments. Used as a means to measure job-readiness, the NOCTI tests consist of both a cognitive (written) component and a psychomotor (performance) component. In the state of Pennsylvania, Munyofu and Kohr (2009) found that, although there was a significant correlation between student achievement on the written and performance portions on NOCTI tests, $X^2 (9, N = 118) = 76.246, p < .001$, only student attainment on the written portion was positively correlated to employers’ customer satisfaction ratings, $X^2 (9, N =118) = 20.696, p = .014$, while student attainment on the performance portion was not, $X^2 (9, N = 118) = 15.228, p = .085$. Though the NOCTI Job-Ready assessments are well-established and credible, issues with setting cut scores and a composite score resulted in questions of validity (Munyofu & Kohr, 2009).

Whether job-readiness tests such as NOCTI are credible and valid is aside from the point of this study. Occupational competency assessments attempt to predict the success of a graduate before they reach the workforce. Other assessments or measurements aligned with student achievement accomplish the same thing: they correlate the chance of success on the job with success in school. These tests have been described here to document the kinds of assessments that are currently available and deployed. This study gaged graduate success in the workplace by actually measuring graduates in the workplace.
Assessment of engineering programs

While assessment of HVACR graduates of secondary and postsecondary two-year programs can be accomplished using any one of a number of industry technician competency exams, assessment of the engineering sector of the industry is accomplished through ABET. Formerly called the Accreditation Board for Engineering and Technology, ABET accreditation assures that a college or university program meets quality standards set by the professionals within the profession for which its students are prepared. ABET is a well-established measure of quality with a history traced back to 1932 and with 2,900 programs currently accredited at more than 600 institutions nationwide. Focused on outcomes assessment and continuous improvement, ABET is interested in what is learned rather than what is taught. ABET accreditation is divided among four commissions depending on discipline: Applied Science Accreditation Commission (ASAC), Computing Accreditation Commission (CAC), Engineering Accreditation Commission (EAC), and Technology Accreditation Commission (TAC).

Programs periodically conduct a self-study based on ABET templates to determine if students, curriculum, faculty, administration, facilities, and institutional support meet the established criteria. A number of data are collected during the self-study, including student and faculty demographics; program criteria, objectives and outcomes; and reports on facilities, budget, support, and equipment. The findings, published in a comprehensive report, are used as a basis for ABET determination and for quality improvement efforts.

A campus visit by an ABET evaluation team follows the self-study to provide further evidence that established criteria have been met. The evaluation team provides a
follow-up report of findings, which provides the program a chance to clarify misunderstood information and correct any deficiencies. Finally, each self-study and follow-up report is reviewed by a panel of ABET commissioners who meet annually, and a vote is taken to grant or deny accreditation. The commissioners file a final finding with the program detailing strengths, weaknesses and suggestions for improvement. The accreditation is granted for up to six years, after which the process is repeated in a renewed cycle for quality assurance and improvement (retrieved from http://www.abet.org/the_basics.shtml).

ABET self-studies and findings are deemed confidential, and are meant for individual program use. A list of accredited programs on the ABET website is the only public record of the self-study efforts. A rich literature would exist if these studies were published, but the confidential nature leaves a significant void in the information relative to engineering education quality. Three self-studies were reviewed for this literature but must remain confidential in order to honor ABET regulations. Two self-studies were ABET-TAC; one was ABET-EAC. One was conducted in 2005 while the other two were conducted in 2009. Germaine to this research, each self-study contained surveys of alumni and employers. Samples of typical questions that might be asked of alumni include:

1. On a scale of 1 to 5, how pertinent were your classes to your current assignment?

2. On a scale of 1 to 5, how pertinent were your emphasis area classes to your current assignment?

3. How effective was your course work in preparing you for work?
4. Should any changes be made?

Samples of questions that might be asked of employers include:

1. On a scale of 1 (low) to 5 (high), rate the following items that apply to your employee
   a. Overall technical knowledge
   b. Overall technical skill
   c. Task organizational practices
   d. Leadership qualities
   e. Level of confidence to complete tasks
   f. Verbal communication skill level
   g. Written communication skill level

2. What are your overall impressions of the XXXXXXX academic program?

3. What are the strengths of the program?

4. What are the weaknesses of the program?

5. How could the program be improved?

Self-studies such as these provide much information about the perspectives of both alumni and employers relative to the alignment of the academic program with the workplace. Such information may preclude the necessity of a study such as this research. Though the data is essentially quantitative, the short response and open-ended questions do provide qualitative feedback that is relatively shallow due to the lack of an opportunity for follow-up questions. Though these data are relatively shallow, they are none-the-less valuable. The program at the focus of this study is not ABET-accredited for reasons listed below, and thus does not conduct the self-studies required for accreditation.
In the State of Michigan where Ferris State University is located, graduates wishing to write the professional engineers (P.E.) examinations must possess an ABET-EAC accredited bachelor’s degree in engineering (retrieved from http://www.michigan.gov/dleg/0,1607,7-154-35299_35414_35472_35657-141912-00.html). This effectively eliminates graduates of the HVAC engineering technology program. In order to gain EAC status, the program would be required to adopt a number of foundational engineering courses, which of course would necessitate dropping a number of core HVAC courses to make room. Such action would allow graduates to become professional engineers but would cost the program its unique focus and strength in the area of HVAC, thus rendering it similar to any number of other engineering programs in the region. The HVAC-ET program could presumably gain ABET-TAC accreditation, but this does not meet the state criteria for taking the P.E. exam. While TAC accreditation would provide an important reason for the program to conduct a self-study on a cyclical basis, there is no perceived direct benefit to the student, though an indirect benefit may be realized through the opportunities for quality improvement.

Assessment of HVACR engineering technology using APR

For the reason of quality improvement alone, this researcher believes that a study similar to the ABET self-study is warranted and necessary. Though the ABET self-study is not conducted by the four-year HVAC engineering technology program at Ferris State, a similar study is conducted on a repeating cycle. Each program at the university undergoes an Academic Program Review (APR) every five years. HVACR was last involved during 2006, when students (n=92), graduates (follow-up surveys, n=52; and exit surveys, n=25), faculty (n=7), employers (n=20), and advisory committee members
(n=12), responded to Likert-style survey questions and provided short, one-sentence comments in response to a number of open-ended questions. The study provided quantitative data that indicated a high level of quality in the program.

Four-year graduates were asked to rate their perception of the program through 35 questions on a five-point scale, with 5 = Strongly Agree, and 1 = Strongly Disagree. Most questions centered on technical content, with two questions per content area: “XXXX is an important part of your job,” and “you were well-prepared in the area of XXXX.” The technical content areas included:

- Design
- CAD
- Load calculation
- Equipment selection
- Control theory
- Control application
- Blue print reading
- Job specifications
- Troubleshooting
- Energy auditing
- Commissioning of HVAC systems

In addition to questions on technical content, some questions were asked of general education, and some general perception questions were asked related to:

- Math
- Written communication
- Verbal communication
- Mix of technical/social and cultural course
- Overall preparation for the job
- Demand for graduates
- Productivity on job right out of school

The average perception for all 35 questions was 4.06 out of 5 (Agree), with 3.22 as the lowest (“You were well-prepared to deal with job specifications”) and 4.89 (“Verbal communication skills are an important part of your job”) as the highest.

When asked for general comments, graduate responses varied greatly and often contradicted one another, with several pointing out what they felt were areas of strength (e.g., design, controls) or weaknesses (e.g., design and equipment selection). Some felt that more hands-on experience would be beneficial while others called for less laboratory work and more lecture time. Several commented on their perception of the quality of the program and their ability to be productive on the job very soon after graduation. Several comments contained testimonials, such as “I am very proud to be a graduate,” “This is an excellent program,” and “I always recommend FSU-HVAC to anyone looking for employees.”

Employer surveys included 28 similar questions ranked on a five-point Likert scale with 5=Excellent, 4=Good, 3=Acceptable, 2=Below Expectations and 1=Poor. The breadth of questions expanded beyond technical and general education outcomes to include outcomes such as critical thinking, leadership, ethics, planning, and working with a group as a team player. Questions were developed by the APR committee and modified as needed for HVACR. Employers responded at a 3.67 average, with “Ability to
troubleshoot complex or multiple HVACR systems” as the lowest at 3.13, and “Chooses ethical courses of action” as the highest with a 4.21. Overall, all responses were “Acceptable” or better, with most above a 3.5, meaning the responses averaged closer to “Good” than to “Acceptable.” Of the 28 responses, only four were 4.0 or better.

Responses to open-ended questions were varied with no themes emerging. One comment reinforced the need for both written and verbal communication skills; others identified personal needs for specialized areas, e.g., “ability to pass NEBB certification,” “centrifugal, absorption, screws (compressors), high pressure steam and large boilers,” “increased knowledge on setting up a VFD (variable frequency drive).” Several announced the need for more graduates, and a number of testimonials similar to those of the graduates were offered (“You have a great program, keep up the good work,” “Review is for our most recent hire with whom we are well-pleased!”).

The data provided by the Academic Program Review was generally positive and provided a basic quantitative measure of stakeholders’ perceptions of quality. Responses to open-ended questions provided a bit more information, but sufficient data were not available for analysis. Further, in using a simple survey instrument, no opportunity for follow-up was provided, which precluded probing and in-depth questioning. This research began where the Academic Program Review left off and provided rich data from which in-depth analysis was conducted for the purpose of quality improvement.

A Review of the CTE Assessment Literature

“In too many instances we have not been able to be specific in our assessment of the qualitative factors in vocational education” (Stevenson, 1977, p. 8).

A review of literature is the foundation for any scholarly activity. It can be
thought of as an ongoing conversation (Locke, Spirduso, & Silverman, 2007), which the researcher joins first by discovering what others have had to say, and then adding to the conversation with new knowledge. In seeking the threads of this conversation, this researcher discovered that little has been said about linking curricula to industry via quantitative or qualitative designs. Further, there are few journal articles about evaluation of CTE at the postsecondary level (Brown & Conbere, 2005). One example of research results bears mention, if only to illustrate the sparse literature. A promising study was found, entitled *A Study of Vocational Success of Fifty-Three High-School Graduates* (Edmiston, 1927), but the publication date provided a disappointing reason to reject the document as irrelevant to this study.

This search process involved conversations with librarians at two universities and the dissertation chair, seeking advice and assistance with the search process. Bibliographies of other dissertations and scholarly works discovered in the process were used to locate other works of relevance. Throughout the search, the Internet was used extensively, utilizing search engines at the two universities to locate scholarly works, and general search engines (i.e., Google and Google Scholar) to locate general and background information or information relating to legislation.

Within the universities library websites, the Education Resources Information Center (ERIC) database was used extensively, with searches conducted using a number of keywords derived from other scholarly articles found. ERIC is an Internet-based database of education literature with more than 1.3 million education-related materials from scholarly organizations, professional associations, research centers, policy organization, university presses, the U.S. Department of Education and other government...
agencies, and selected works submitted by individual contributors. As a comprehensive repository of scholarly works related to education, ERIC was used as a primary source of information.

Other primary sources of information included associations and councils related to CTE. The National Council for Workforce Education (NCWE) is headquartered at the university where the researcher teaches. NCWE’s mission is to promote excellence and growth in workforce education at the post secondary level. The researcher is familiar with this organization, having presented at a conference in 2002, but no information related to this study was found. Several researchers from the Center on Education and Training for Employment (CETE) at the Ohio State University were contacted. Dr. Robert Mahlman could not locate relevant literature, but recommended Dr. Morgan Lewis at The National Research Center for Career and Technical Education (NRCCTE) at the University of Louisville. Dr. Lewis provided a study he had completed in 2004 for the Accrediting Commission of Career Schools and Colleges of Technology (ACCSCT) entitled Evaluation of Standards Established by the Accrediting Commission of Career Schools and Colleges of Technology (personal communication, March 17, 2010). This particular report is very similar to ABET self-studies in the type of questions asked of students, graduates, faculty and administrators at accredited schools. Though an earlier version of the study with the same title (Lewis, 1999) is available in ERIC, like ABET self-studies, the 2004 report was not published, but was emailed to the researcher in response to a request for related literature. This fact reinforces the suspicion that studies such as this research, as well as ABET self-studies and accreditation evaluations such as those conducted by Dr. Lewis are not published external of the immediate stakeholders.
Other findings related to evaluation and assessment deal with the alignment of CTE programs with federal legislation or programs. Examples include literature on the programs such as the *Job Training Partnership Act* (JTPA) of 1983 and the 1994 *School-to-Work Opportunities Act* (STWOA). Most of the literature reports on the successes, failures and challenges of the programs, relative to implementation, enrollment, retention, and of course, funding. Few could be found that provide more than anecdotal evidence of workforce linking, other than during the design phase.

Dr. Kirsten Sundell, Communications Director for The National Research Center for Career and Technical Education (NRCCTE) was contacted seeking assistance in the search. Dr. Sundell provided much information related to assessment and accountability of CTE relative to Perkins legislation. NRCCTE is also involved in work involving crosswalks that link occupations to career clusters and pathways and other issues that seek to improve integration of academic outcomes into CTE curricula, professional development and improved methodologies for special populations, but nothing was found directly related to this study.

During the search, a promising assessment instrument called Technical Education Curriculum Assessment (TECA) turned up (Keiser, Lawrenz, & Appleton, 2004). The TECA was designed as a means to measure the quality of CTE curricular materials using three rubrics: one for workplace competencies, one for technical accuracy and one for pedagogical soundness. The authors developed a theoretical framework combining SCANS, Finch and Crunkilton’s curriculum development theory for technical and vocational education, and Wiggins’ model of assessment and curriculum development (Keiser, Lawrenz, & Appleton, 2004). Further searches using keywords “Technical
Education Curriculum Assessment" or “TECA” produced no results. Dr. Frances Lawrenz was contacted as a follow-up, but knew of no other instances where the TECA was used and recommended Dr. Jonathan Keiser for further information, but efforts to make contact were not successful.

Two additional researchers (Drs. Michael Wonacott and Christopher Zirkle) from the Center on Education and Training for Employment (CETE) at the Ohio State University were contacted, seeking similar information and assistance. Neither knew of any literature directly related to this study, but kindly offered advice for areas to search. The chair for this dissertation, Dr. Richard Zinser, was also consulted and offered a plethora of possible sources, the follow-ups of which are contained herein.

Other work using employer surveys has preceded this study, though all the literatures found contained quantitative designs. The Munyofu and Kohr (2009) study cited earlier was used to test for a correlation between student attainment on NOCTI tests and employer satisfaction with graduate on-the-job performance. As a quantitative design, this study provided a measure of program quality and alignment, but lacked the depth provided by qualitative designs. A common quantitative methodology used when surveying employers involves Likert-style ratings. Examples range from short surveys rating 19 skills on a scale of 1 – 3 (Belcheir, 2002), to comprehensive surveys rating basic skills (reading, writing, math), job-specific skills (occupation-specific skills and computer skills), and general workplace skills (teamwork, problem solving, communication, work habits, accepting supervision, and adaptability to change) (Washington State Workforce Training and Education Coordinating Board, Olympia, 2001; Lee, 1993). Instead of using graduate performance as a measure of quality, some
employer surveys are used to rate contract training program quality directly, using measures such as cost effectiveness and a more ambiguous level of satisfaction (Clagett & Alexander, 1995).

In the only literature found directly related to this study, Zinser (2003) documents a study similar to this design, though with a slightly different focus. In his study, Zinser sought to find why a plastics program at a community college was being underutilized when a strong plastics industry existed in the area. At stake was the future of the program. In this qualitative study, interviews of stakeholders at local plastics companies found dissatisfaction with the curriculum, course schedule, faculty and facilities. Student perceptions captured via focus groups found dissatisfaction with the course schedule, equipment, facilities and job placement services. In this case, the school and the industry already knew that enrollment was dropping. The qualitative design of Zinser’s study allowed the researcher to discover “why.” In the HVAC program, enrollment is strong and quality is thought to be high based on anecdotal and quantitative data. As Zinser’s study demonstrated, much more can be learned through an in-depth qualitative design.

Where Zinser (2003) conducted a study very similar in design to this one, other literature related to assessment or evaluation of CTE programs view quality from a variety of different lenses. The Advanced Technological Education (ATE) is a national program “designed to educate technicians for the high-technology disciplines that drive the Unites States’ economy” (Coryn, Gullickson, and Hanssen, 2004, p. ii), established in response to the Scientific and Advanced Technology Act of 1992, and in particular “to establish a national advanced technician training program…to expand the pool of skilled technicians” (Gullickson, Lawrenz, & Keiser, 2004, p. 137). As part of program
improvement efforts, The Evaluation Center at Western Michigan University in Kalamazoo, Michigan is charged with the responsibility of evaluating the ATE programs. An extensive literature is available through the Evaluation Center, a review of which found little measurement of alignment between school and work. A summary of publications from the Evaluation Center will illustrate this point.

For example, Zinser and Hanssen (2006) conducted an analysis of national data from the ATE focused on the transfer of two-year technical degrees to baccalaureate degrees and found that articulation programs that aid students in transferring from associate degree to baccalaureate degree programs benefit the business community by providing trained workers, but stopped short of providing data to corroborate this point. In another example, Welch and Reineke (2002) confirm the importance of getting feedback from advisory committees, but no work on linking curriculum to industry was completed. Their work does offer many findings relative to advisory committees, based on surveys and observations from site visits during committee meetings. Advisory committees provide an excellent means for gathering qualitative data, especially when guidelines found by Welch and Reineke are followed (2002, Report parts A & B, and their Advisory Committee Checklist). These data are rarely published; rather, they are used internally for quality improvement efforts (Zinser, 2003). Further, advisory committee proceedings rarely produce formal assessment information, relying instead on anecdotal information that leaves validity and reliability suspect (Ritchie, Gullickson, & Coryn, 2006).

Elements used by the Evaluation Center to judge program improvement include mainly curricular and pedagogical measures: development of integrated curriculum and
implementation process; sequential organization of courses, labs and work-based experiences; emphasis of general education and specific advanced technological field competencies; availability to diverse students over an extended time period; appropriate credentials; articulation; and increases in the number of skilled technicians for the workforce. (Gullickson, Lawrenz, & Keiser, 2004). The Evaluation Center did find evidence of all measures, though none evaluated graduates in the workplace. For example, data on the number of skilled technicians entering the workforce was reported to increase over the life of the project, but no follow-up data were found to determine the success of the graduates in the industry. Several mentions are made of advisory board relationships, both for developing and updating curricula, but the results of that work remain unpublished.

In another study more typical of that found in the literature, Gullickson, Coryn and Ritchie (2006) summarized the productivity of Advanced Technological Education (ATE) grantees regarding three major aspects of the ATE program: educational program improvement, materials development, and professional development for educators, all valuable components of a quality educational program, but again, not in reference to industry. In fact, of the three aspects, educational program improvement efforts (most relevant to this dissertation) were typically assessed at the classroom level, with no reports of extensive follow-ups with students or employers. Any evidence of quality in these programs had a weak validity foundation due to the lack of assessment of students against industry standards (Gullickson, Coryn & Ritchie, 2006).

Germuth, Gullickson, Lawrenz, and Hanssen (2006) studied value added via reduced business costs and improved business results, and the number and quality of
trained technicians available. In this study, quality was one of only four elements, and of the three ATE program advantages cited under the "quality" element, one was actually a "quantity" advantage (ATE programs produced more students). Of the literature reviewed, this study was one of the most relevant, though the results were very generic and non-empirical. The study found that ATE programs were better than non-ATE programs for a variety of reasons. Two of those reasons, strong collaboration between school and industry, and ability of the school to nimbly respond to input from industry, are interesting but yet still generic. Of the four elements included in the work of Germuth, Gullickson, Lawrenz, and Hanssen, this researcher is concerned with the quality issue for this study. That is, are the HVAC engineering technology students prepared for the workforce? The quantities of graduates or the impact they have on their employers’ cost are not foci of this research.

Alignment of the program with the needs of industry, though a primary goal of the funding agencies, becomes a secondary goal of programs as assessments are conducted to ensure alignment not with industry, but rather with the requirements of funding, other types of support and regulations. This fact can be corroborated by the findings of Ritchie, Gullickson, & Coryn (2006): 73% of ATE grantees conducted workforce needs assessment either prior to receiving their grant or since the project inception. The needs assessment was a means by which funding was received, thus reinforcing the concept that assessment is conducted to align with funding requirements. Surprisingly, a full 26% of grantees never conducted a workforce needs assessment, which challenges the notion of assessment for funding purposes. Despite the appearance that assessment is conducted as a means to receive funding, ATE grantees consider
workforce needs assessment as most useful for developmental and formative evaluation (prescriptive) activities.

In addition to conducting workforce needs assessment for the purpose of obtaining or retaining funding rather than discovering alignment with industry, Ritchie, Gullickson, & Coryn (2006) discovered another weakness: the lack of formal assessments such as the DACUM questions the validity and reliability of data collected. With formal assessments defined as systematic acquisition and documentation of data, ATE grantees were found to rely heavily on anecdotal data gathered through advisory committees and conversations, with no written report produced. This fact raises two points that reinforce the need for qualitative studies such as this dissertation: advisory committees are a valid means by which to collect data, but only if a formal process is followed; and qualitative designs can provide the means by which that formal process can be conducted. Regardless of the nature of the assessment (formal or informal), there lacks a clear understanding of the relationship between gathering workforce needs assessment data and the use of these data for program evaluative purposes (Ritchie, Gullickson, & Coryn, 2006). It seems that workforce needs assessment is a tool by which to define a target, a CTE program is built to hit the target, but efforts are rarely taken using formal methodology to determine if the target is being hit. Using this analogy, workforce needs assessment activities amount to linear thinking: the hazards of which are well-documented in The Fifth Discipline (Senge, 1990). Rather than linear thinking, feedback data from a formal assessment allows for systems thinking, a discipline with a holistic view that reveals interrelationships and more effective and efficient ways in which to structure those interrelationships (Senge, 1990).
The ATE program provides an example of linear rather than systems thinking relative to program improvement. Described as the “pinnacle of collaboration between industry and education” (Zinser & Lawrenz, 2004, p. 85), ATE programs that had been in operation for one year were surveyed to learn about program improvement, among other things. Described as an integrated effort of the entire process, program improvement is meant to span everything from needs assessment to sustainability with elements that include curriculum development of a program that leads to an appropriate completion point and provides industry with more workers. One of eight indicators of program improvement was listed as increased relevance, which is assumed to mean alignment with industry, yet no measure of this is reported other than the fact that 55% of the programs had more relevant and current materials due to the ATE. While this is a good indicator, it is clearly linear thinking: there is no feedback to indicate if the relevant and current materials prepare better graduates for the workforce. Overall, the impact of the ATE program is cited as quantitative: “the numbers of new and updated technicians being employed” (Zinser & Lawrenz, 2004, p. 96): another example of linear rather than system thinking. More graduates finding jobs is also a good indicator, an indirect measure of success, but it does not indicate how well they were prepared, nor does it provide data for program improvement.

Collaboration with industry is common in the beginning when developing a program or curricular materials. There is much less collaboration once the program and materials are developed in the collection of formal data to determine the effect on student outcomes or program alignment. In order for a program to be sustainable, it must collect and use abundant information for program improvement. Collected information that is
not used or related to program improvement may be simply information for the sake of information (Lawrenz & Keiser, 2001). This study provided the feedback data needed to analyze the HVAC-ET program and determined that it is indeed “on target.”

**Alignment with Industry**

Throughout history, CTE has been viewed as the means by which workforce development is accomplished. Success in CTE is then measured not only by the achievements of students while in school, but also through graduate achievement in the industry for which they were prepared. It follows that curricula should align with and remain responsive to an ever-changing industry while at the same time provide students with the knowledge, skills, attitudes and values necessary to enhance their employability. The goal of CTE then, is to serve the student, the industry, the community and the country. The student is served through enhanced employability, the industry through a qualified workforce, the community through preparation of citizens capable of becoming assets rather than liabilities, and the country through industries able to persevere in a globally competitive environment. The relevance and effectiveness of any such curriculum can only be determined and subsequently improved through a continuing evaluative process in which performance is determined using explicitly stated and measurable outcomes (Keiser, Lawrenz, & Appleton, 2004).

The notion that the link between CTE and industry is a crucial ingredient in the evaluative process is implicit. In many (most) cases, the link between industry and CTE programs is seen in the development rather than in the improvement of the program. In other cases, industry partners work directly with community colleges in a mutually beneficial arrangement providing training customized to industry needs while supplying
the community college with funding, equipment, facilities and faculty. The Olin Corporation in Clayton, Missouri collaborated with Lewis and Clark Community College in Godfrey, Illinois on just such a partnership, as did Delta College and Dow Chemical in Midland, Michigan in creating the Midland Center, a Delta College branch that caters directly to Dow’s needs.

In the Olin/Lewis and Clark example, the surrounding community benefitted from the alliance as well. In response to Olin’s needs for computer training, Lewis and Clark formed the PC Institute and enrollment consists of more community students than Olin students. This case measured success in terms of how many people received training, how much grant funding was obtained, and how many college credits were earned. The broad statement that Olin and the community benefitted from those that earned associate and baccalaureate degrees is based on the assumption that simple attainment of the degree was evidence of benefit but provides no proof that the degrees actually improved employability and job skills for the student or bottom line for Olin. This statement is assumed to be true, but without a study to actually measure the validity, there is no way to determine the facts (Rothwell & Gerity, 2008).

The Goodyear Maintenance Technician Co-Op Program is an example where evidence of success takes a meaningful form. As a result of a partnership between Goodyear, the Obion County Industrial Development Corporation, Dyersburg State Community College, the Tennessee Technology Center and the business community in Union City and Obion County, Tennessee the Goodyear Union City plant was able to downsize and improve production in response to global competition and remain the largest employer in northwest Tennessee while other Goodyear plants closed in response
to global competition. The Union City facility expanded its offerings beyond Goodyear to provide a competitive edge to numerous other manufacturers, including Firestone. Success in this case is not measured pedagogically, it is measured by the bottom line of the companies for which the training is provided (Rothwell & Gerity, 2008).

In another case of school/industry partnership, Lockheed Martin in King of Prussia, Pennsylvania found itself increasing in the need of a significant number of information technology (IT) professionals during a time of a decreasing pool of qualified candidates. The solution was to create a source of new and qualified IT professionals in collaboration with Bucks County Community College in Newtown, Pennsylvania. This partnership featured an IT apprenticeship leading to an associate degree, and ultimately articulating to a baccalaureate at Pennsylvania State University if the student chose. With the simply stated goal of increasing qualified candidates, success began to be realized as soon as graduates became employed with Lockheed Martin (Rothwell & Gerity, 2008).

Launched in 1997, the Lansing Area Manufacturing Partnership (LAMP) was a cooperative school-to-career (STC) effort between the United Auto Workers (UAW), General Motors Corporation (GM) and Michigan’s Ingham County Intermediate School District. Students from 25 high schools spent two and a half hours each day during their senior year attending the LAMP classroom located in the UAW-GM Training Center in Lansing, Michigan. With several manufacturing plants nearby, mentors from both GM and the UAW, along with three certified instructors, delivered the jointly-developed curriculum. Though STC programs are sometimes criticized for steering students into one-track career paths, a longitudinal study of LAMP graduates found that the program did not seem to limit participant career choice: only 13% of LAMP graduates ended up
working for GM, though they were nearly four times more likely than non-LAMP graduates to list the automotive industry as a career goal (Bozick & Macallum, 2002). The cases provided by Rothwell and Gerity (2008) illustrate the success of CTE programs when partnerships are formed between large single employers and local community colleges. The LAMP project also indicated benefits for stakeholders including GM, the UAW, students and their parents, and teachers and employees of GM (Johnson, McDonald, & Macallum, 2002).

Curriculum integration is easiest when focused on a single industry (Johnson, Charner, & White, 2003), but what about industries such as the HVACR industry? This industry consists of multiple small “mom and pop” local residential contractors, large local and regional commercial and industrial mechanical contractors, and larger national and international corporations with local, regional, national and international branches. Complexity is added by the numerous sectors of the industry in which a graduate may find employment, including the technical sectors such as design, installation, service, control; business sectors such as sales, estimating, and contracting; the professional sector of engineering; and the manufacturing sectors of production, quality control and research and development.

Summary

This chapter reviewed several factors that have shaped the HVAC-ET program at Ferris State. The histories of both CTE and HVACR provided foundational data upon which the study can be built. The efforts to describe and name CTE, and to categorize the breadth of careers served by CTE programs were documented to develop an appreciation of the complexity of all that is CTE, and to position the HVAC-ET program within the
construct of CTE. A discussion of assessment across the spectrum of education was provided to describe how the HVAC-ET program lacks an instrument for assessment. The foci of several studies discussed in the literature illustrate the shortcomings of the majority of assessment efforts, and the need to provide a more systematic process by which program relevance can be measured via the performance of graduates on the job. Further, this chapter documents a large gap in the literature in reference to formal qualitative studies of the graduates of CTE programs. From the perspective that the best measure of a CTE program alignment with the industry for which it prepares students is a measure of the graduates working in that industry, there is much work to be done.
CHAPTER 3
METHODOLOGY

Introduction

The purpose of this study was to investigate the phenomenon of industry-employed graduates of the Bachelor of Science in Heating, Ventilation and Air Conditioning Engineering Technology (HVAC-ET) at Ferris State University in Big Rapids, Michigan. In particular, the researcher was interested in learning what the educational experience meant to the graduates and how they perceived they were prepared for work. And from their perspectives, what the essential elements of the program are and what changes they would make to improve it.

Though many affirming comments were heard by the researcher during the eleven years served as chair of the HVACR department, time was not taken to probe deeper in order to collect a more thoughtful and in-depth commentary about the educational offerings, quality and alignment of the HVAC-ET program. Without these data, it has not been possible to determine how the program is or is not meeting the needs of the stakeholders. Further, a cyclic Academic Program Review (APR), last conducted in 2006, provided quantitative data that indicated a high level of quality in the program. Students, graduates, faculty, employers and advisory committee members responded to Likert-style survey questions and provided short, one-sentence comments in response to a number of open-ended questions. But these data simply indicated the extent to which a parameter was perceived by subjects to be effective or observed. Further analysis is needed to learn how graduates were or were not prepared and what can be done to improve their knowledge and skills for the workplace. This study picked up where the APR left off.
**Phenomenology: A Qualitative Design**

This study was conducted using a qualitative method. In contrast to a quantitative design in which data are gathered and expressed as numbers, a qualitative researcher collects data as words and seeks an understanding about an experience. Measures of outcomes are of less concern than the process by which the outcome was achieved. The extent to which a change or success occurred is not important: rather, the focus is on how it occurred and what occurred (Bogdan & Biklen, 2003). Qualitative inquiry by nature is exploratory and seeks to present a detailed close up view of a topic using questions that commonly begin with “how” and “what.” To gain the most accurate data, subjects are studied in their natural environment and data are reported by in a narrative rather than numerical manner (Creswell, 1998).

There are many traditions or methodologies of qualitative inquiry; each with unique features and characteristics for various types of study. Though many studies combine elements of two or more traditions (Creswell, 1998), this study most closely aligns with the characteristics of a phenomenology. A phenomenology is best employed in situations bounded by temporal and physical limits (Lancy, 1993) and studies the lived experiences of several individuals to describe the “essence” of a phenomenon through the personal meanings of that experience from subjects’ perspectives (Marshall & Rossman, 2006; Burke & Christensen, 2004; Bogdan & Biklen, 2003; Patton, 2002; Creswell, 1998). Through in-depth interviews, the phenomenologist gains access into the subjects’ minds to learn the meaning of their experience from their own point of view (Burke & Christensen, 2004). As such, the qualitative researcher uses the subjects’ point of view as a research construct. Though the subjects may not realize they are describing their
thoughts and experiences from their point of view, qualitative research by its nature forces them to think in those terms and distorts their meaning of the experience the least. (Bogdan & Biklen, 2003).

This study provides a follow-up to the 2006 Academic Program Review (APR), which provided a quantitative view of the four-year engineering technology program. This research design probed deeper and gathered rich descriptions of graduate experiences in detail for the purpose of gauging the alignment of the program with the industry, as viewed from the perspectives of the subjects (Leedy & Ormrod, 2005; Patton, 2002). “One of the most common purposes of qualitative research is served when investigators pose the basic question, ‘What’s going on here?’” (Locke, Spirduso, & Silverman, 2007, p. 96). To answer this question, a phenomenology employs in-depth interviews with a small sample of subjects to discover the meaning of a broad concept or phenomenon. The phenomenologist expects these data to be diverse, scattered and complex. (Marshall & Rossman, 2006). At the same time, though no two humans or human experiences are completely unique, the researcher expects to find some common ground among the differences in experiences. It is the commonality, the “essence” or “invariant structure” of the experiences that the researcher seeks out among the differences, or “variant structure” (Burke & Christensen, 2004).

As a quantitative design, the 2006 APR described the characteristics of the program and its graduates as a statement of the numerical value of one or more observable parameters (Glass & Hopkins, 1996). The extent to which graduates perceived they were prepared in areas of specific course material and the importance of that material to their job was measured using a five-point Likert scale. Similarly, a five-point
Likert scale was used to measure the extent to which employers believed graduate employees exhibited attributes of skill, knowledge and attitudes. While valuable, these data could not explain how course materials or graduate attributes contributed to job success, nor could they explain what was useful about the material or attribute. A qualitative design answers “how” and “what” questions that allow the researcher to explore a deeper level of understanding through inquiry (Creswell, 1998; Marshall & Rossman, 2006; Locke, Spirduso, & Silverman, 2007).

The 2006 Academic Program Review (APR) provided measures of outcomes and success, but fell short of describing how those data were achieved. APR also provided short textural responses to questions about quality and preparedness, but provided no data relative to process. Because this study sought in-depth information by asking subjects to thoughtfully respond to open-ended questions, a qualitative design was ideally suited.

**Selection of Subjects**

Qualitative designs use purposeful samples to ensure that the subjects participated in the phenomenon at the focal point of the study (Locke, Spirduso, & Silverman, 2007; Creswell, 1998). Sampling size in phenomenology includes a small, nonrepresentative number of subjects (Bogdan & Biklen, 2003). Though the actual number of subjects is not as important as capturing the experience, Creswell (1998) suggests between five and 25.

The purposeful sampling for this study included both campus and distance learning (online) graduates of the HVAC-ET program from within the past three years (2009, 2008, 2007) who have worked at least one year in the industry. All graduates who fit these two criterions were invited to participate. All other persons were excluded.
Participants were asked to reflect on their educational and work experience, and how they feel they were prepared for their jobs. Research subjects must able to relive an experience in their minds in order to explore it in-depth (Burke & Christensen, 2004). As such, it was important to recruit subjects who are not too far removed from their educational experience. At the same time, subjects must have been in the workforce for a time sufficient to allow for reflection. It is for these reasons that graduates from before 2007 and with less than 12 months of work experience are excluded from this study. Though there is no precedent of which the researcher is aware for limiting a phenomenology to subjects within three years of their experience, the sample size for this study (n=18) is approximately 16% of the graduates (n=110) from the years 2007, 2008, and 2009. Extending the study to earlier years would not have enhanced subject selection.

To recruit subjects, contact information for all 110 HVAC-ET graduates from the years 2007, 2008 and 2009 was solicited from the Ferris State University Advancement & Marketing office. The list provided included last known email addresses and phone numbers. Because the university does not possess all current contact information, faculty colleagues who typically maintain contact with several graduates were asked for help. An additional list of email addresses from the senior capstone course was obtained and added to the list.

After the graduate list was created, all potential subjects were invited to participate via an email message and asked to reply by email if they were interested in participating. One week later, a second email invitation was sent to those who had not replied (see Appendices), providing another opportunity to participate. Those who do not respond to either email invitation were not contacted further. Graduates who do not to
respond to the email request were considered either to have declined to participate or to be unreachable using the available contact information. The study was thus limited to those graduates who could be contacted.

Because the researcher was interested in the experiences of both campus (n=88) and online (n=22) graduates, a goal to utilize half of the subjects from among the campus graduates and half from the online graduates was set. Though the ratio of campus to online graduates is four to one, an equal sample from each group would have allowed for a comparison of themes between and within groups. A total of 21 graduates (19%) responded to one of the two emails. Within two weeks of the first email, a follow-up phone call was made to all who responded as willing to participate in the interviews. Of the 21 potential subjects, 18 were successfully contacted and expressed willingness to participate, including 10 campus graduates and eight online graduates. This sampling provides a diverse, nonrepresentative group. Demographic information summarized in Table 1.

Data Collection

Following in the qualitative tradition, the researcher sought to learn what the HVAC-ET experience meant to the participants, and to determine what they believed to be the strengths and weaknesses of the program, based on their perceptions of their experience and preparedness for working in the industry after earning their degree. The most common means of data collection in a qualitative design are in-depth interviews (Locke, Spirduso, & Silverman, 2007; Burke & Christensen, 2004; Creswell, 1998) with a small number of subjects, though some studies involve many more (Creswell, 1998). The instrument of inquiry for this research was the open-ended in-depth interview
protocol, conducted over the phone and recorded due to the geographic separation between the researcher and the subjects. Though some subjects reside in the same state as the researcher, all interviews were conducted using the phone to maintain a consistent methodology. Qualitative interviews were conversational and exploratory, beginning with social conversations, and based on a few general topics (Moustakas, 1994). The subjects’ responses were allowed to unfold in their own way in whatever form they wished to frame the discussion. Questions were open-ended and designed to obtain data in a way that does not lead the subject (Marshall & Rossman, 2006).

Qualitative studies do not state hypothesis a priori and then conduct the test as do quantitative studies. Rather, the research progresses inductively, with the researcher trying to make meaning out of the data. Preconceived notions or conclusions are not a part of qualitative inquiry, as they may cloud the researchers’ findings (Marshall & Rossman, 2006, Bogdan & Biklen, 2003). Rather, the researcher attempts to remain as open-minded as possible, so that the meaning emerges from the data. In this study, the researcher sought inference from particular data generated through interviews with graduates.

Interviews are a useful method of inquiry as follow-up questions can be asked to explore further and probe deeper. When possible and most often, qualitative data is collected in the environment that is the natural setting for the subjects as opposed to quantitative designs where research is conducted under controlled conditions. This allows subjects to respond and interact in the environment in which they are the most accustomed (Locke, Spirduso, & Silverman, 2007).
Table 1

*Participant Demographics*

<table>
<thead>
<tr>
<th>Pseudonym</th>
<th>Graduation Date</th>
<th>Age</th>
<th>State</th>
<th>Transfer student</th>
<th>Ferris AAS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Campus Graduates</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>John</td>
<td>2007</td>
<td>32</td>
<td>Michigan</td>
<td>y</td>
<td>n</td>
</tr>
<tr>
<td>David</td>
<td>2007</td>
<td>24</td>
<td>Missouri</td>
<td>y</td>
<td>y</td>
</tr>
<tr>
<td>Josh</td>
<td>2008</td>
<td>22</td>
<td>Michigan</td>
<td>n</td>
<td>y</td>
</tr>
<tr>
<td>Jordan</td>
<td>2008</td>
<td>25</td>
<td>Michigan</td>
<td>y</td>
<td>n</td>
</tr>
<tr>
<td>Austin</td>
<td>2008</td>
<td>22</td>
<td>Michigan</td>
<td>n</td>
<td>y</td>
</tr>
<tr>
<td>Nick</td>
<td>2008</td>
<td>24</td>
<td>Michigan</td>
<td>y</td>
<td>y</td>
</tr>
<tr>
<td>Brandon</td>
<td>2008</td>
<td>23</td>
<td>North Carolina</td>
<td>y</td>
<td>y</td>
</tr>
<tr>
<td>Tony</td>
<td>2009</td>
<td>23</td>
<td>Illinois</td>
<td>y</td>
<td>n</td>
</tr>
<tr>
<td>Brian</td>
<td>2009</td>
<td>25</td>
<td>Michigan</td>
<td>y</td>
<td>y</td>
</tr>
<tr>
<td>Jack</td>
<td>2009</td>
<td>22</td>
<td>Michigan</td>
<td>n</td>
<td>y</td>
</tr>
<tr>
<td><strong>Online Graduates</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bill</td>
<td>2007</td>
<td>51</td>
<td>Indiana</td>
<td>y</td>
<td>n</td>
</tr>
<tr>
<td>Greg</td>
<td>2007</td>
<td>31</td>
<td>Michigan</td>
<td>n</td>
<td>y</td>
</tr>
<tr>
<td>Steve</td>
<td>2007</td>
<td>47</td>
<td>Pennsylvania</td>
<td>y</td>
<td>n</td>
</tr>
<tr>
<td>Tyler</td>
<td>2007</td>
<td>36</td>
<td>South Carolina</td>
<td>y</td>
<td>y</td>
</tr>
<tr>
<td>Nathan</td>
<td>2007</td>
<td>50</td>
<td>Texas</td>
<td>y</td>
<td>n</td>
</tr>
<tr>
<td>Dave</td>
<td>2008</td>
<td>50</td>
<td>California</td>
<td>y</td>
<td>n</td>
</tr>
<tr>
<td>Tom</td>
<td>2008</td>
<td>48</td>
<td>Georgia</td>
<td>y</td>
<td>n</td>
</tr>
<tr>
<td>Connor</td>
<td>2009</td>
<td>40</td>
<td>Florida</td>
<td>y</td>
<td>n</td>
</tr>
</tbody>
</table>
In this study, subjects were asked to secure a location where they could spend up to an hour of uninterrupted time. Some were interviewed at their workplace, both during lunch and during working hours, using their own office or a private conference room. Others were interviewed in their home during the evenings and weekends, so as to not interfere with their work schedules, and to allow for uninterrupted conversation. One subject was interviewed in his car during a three-hour drive, and one was interviewed on a park bench at a university where he was serving as a project manager. In all cases, the participants provided their undivided attention. One announced that he was expecting an important phone call related to a quote for a bid, but the call did not come during the interview and no interruptions were made.

In a qualitative study, all details are important. Field notes and photographs provide clues about the environment surrounding the data collection (Bogdan & Biklen, 2003). Phone interviews prevent the researcher from observing body language and environmental surroundings. Phone interviews do provide a personal separation that may allow some subjects to speak more freely due to the lack of protocols required of interpersonal communication. The researcher asked all participants to describe their surroundings and learned that all were in private locations that allowed them to speak freely.

This study was conducted using a structured list of open-ended questions, designed to allow the subjects’ perception of HVAC-ET to unfold in whatever context they chose. The researcher recorded all conversations and used listening skills to allow the subjects to speak freely. Follow-up questions were asked as needed to explore a concept further, or to guide the conversation back to the central subject. Though a
qualitative design is carefully thought out and planned, a measure of flexibility enhances
the study. Unlike quantitative designs, rigid adherence to study procedures is not required
and adjustments along the way are considered to be a part of doing good research.
Because the research is conducted in a natural setting, conditions are not under the
control of the researcher and unforeseen circumstances can occur. Flexibility allows the
researcher to recover from plans gone awry and make course corrections along the way as
necessitated by detours or discovery of a better method (Locke, Spirduso, & Silverman,
2007). This study was conducted through a series of telephone interviews in a single
setting with each subject. Strong central themes emerged through the data analysis
process, and no follow-up phone calls were necessary.

Confidentiality of Subjects

The fact that graduates are used removes any real or perceived academic threats
from the subjects. They have no fear of retribution for comments they have made.
Further, since the research seeks non-threatening personal perceptions and observations
about graduate academic experience and workforce preparation, there is little threat that
may be perceived when engaged in open and honest dialogue. The study was not of a
nature that could be considered embarrassing or threatening to the subjects in any way
that might have prevented them from responding in frank or even blunt statements. There
is some risk associated with the study that includes the possibility of being identified, but
subjects were quite frank in their discussions and no concern about anonymity was
detected.

The researcher developed and maintained a list of code numbers and pseudonyms
for each subject. The list was kept in a locked file. Only the researcher had a copy of the
key and only the researcher knew the true identity of each subject. Each audio cassette tape was identified only with the code number to protect the identity of the subject. All audio tapes and written records were kept under lock and key in the researcher’s home, and were maintained according to requirements of HSIRB. Once the research was complete, all written, electronic and recorded records were destroyed.

**Validation of Data**

The goal of a qualitative design is to collect data in the subjects’ natural setting, yet through the act of collecting data, the researcher is inserted into in that setting. Simply in being there, the research alters the environment by some amount. The reaction of subjects to the researcher is a threat to the integrity of the research (Locke, Spirduso, & Silverman, 2007). In a qualitative design, the researcher is the instrument of both data collection and data interpretation. The data is collected, interpreted, and indeed flows through the researcher. (Marshall & Rossman, 2006, Lancy, 1993).

Several factors affect the degree to which the researcher enters and alters the subject’s environment. The researcher’s level of participation varies from tradition to tradition and on a continuum from one extreme in which the researcher engages fully with the subjects on a regular basis, to the other in which the researcher is totally disengaged from both the subjects and the activities in which they participate. In this study, the level of researcher participation was minimal; limited to the process of negotiating entry and conducting the actual interview. In some traditions, subjects may or may not even be aware they are being studied. Covert research raises ethical concerns that did not exist in this study. All subjects were treated with full disclosure of the purpose and procedures of the study and interviews proceeded only after full and proper
consent was obtained. The duration of the study can also affect the subjects’ natural environment. In this study, interviews consumed less than one hour of time, thus inflicting minimal temporal intrusions.

The researcher used “member checking” to “spot check” as a means to validate interpretations and descriptions of the experience. Member checking involved asking interview subjects to review narration as interpreted by the researcher, to ensure as much as possible that the researcher has accurately captured the essence of the experience from the perspective of the subject and with minimum bias applied (Burke & Christensen, 2004). Though member checking and other methodologies are used as a means to validate the accuracy or the “capture” of data, the ultimate interpretation falls to the researcher. Using what Moustakas (1994) describes as “intersubjective validity,” this researcher first viewed the phenomenon through the lens of personal perspective and then through the perspectives of the subjects.

Data Analysis Processes and Procedures

Qualitative inquiry is descriptive with data in the form of narrative gathered through interviews or observations (Bogdan & Biklen, 2003). A process is needed to percolate themes from interviews conducted during phenomenological study in order to arrive at the data needed for the narrative. Data analysis followed Creswell’s (1998) accounting of the modified Stevick-Colaizzi-Keen method.

- The researcher begins with a full description of his or her own experience of the phenomenon.
- The researcher then finds statements (in the interviews) about how individuals are experiencing the topic, lists out these significant statements
(horizontalization of the data) and treats each statement as having equal worth, and works to develop a list of nonrepetitive, nonoverlapping statements.

- These statements are then grouped into ‘meaning units,” the researcher lists these units, and he or she writes a description of the “textures” (textural description) of the experience—what happened—including verbatim examples.

- The researcher next reflects on his or her own description and uses imaginative variation of structural descriptions, seeking all possible meanings and divergent perspectives, varying the frames of reference about the phenomenon, and constructing a description of how the phenomenon was experienced.

- The researcher then constructs an overall description of the meaning and the essence of the experience.

- This process is followed first for the researcher’s account of the experience and then for that of each participant. After this, a “composite” description is written (p. 147-150).

This method is similar to the seven-phase analytic procedure offered by Marshall and Rossman (2006, p. 156): “(a) organizing the data; (b) immersion in the data; (c) generating categories and themes; (d) coding the data; (e) offering interpretations through analytic memos; (f) searching for alternative understandings; (g) and writing the report or other format for presenting the study”

To organize the data, audio recordings of each telephone interview were
transcribed by the researcher using Microsoft Word software and a transcription machine. Software was then used to cut and paste each transcription into a unique tab in an Excel spreadsheet. This process enabled each line to occupy a single cell. Once all individual transcripts were copied to Excel, a column was used to code each transcript according to that subject’s code number. An adjacent column was used to number the lines of text. Next, all transcripts were copied and compiled in a new and separate tab so that coding could begin.

Coding of the data was accomplished using Excel through a process known as “phenomenological reduction” (Creswell, 1998). During the reading of transcripts for each subject, as significant statements were identified, identifying headings were added to the top row and the statements were tagged with the number “1” in the cell below the identifying heading and to the right of the statement. During readings of subsequent transcripts, new headings were created as needed and similar statements were simply tagged under existing headings. In all, 58 distinct headings were created to code the data. The headings were then clustered with other headings of similar meaning into the five main themes that emerged in the study.

This process “demands a heightened awareness of the data, a focused attention to those data, and an openness to the subtle, tacit undercurrents of social life” (Marshall & Rossman, 2006, p. 158). The researcher came to know each transcription intimately. Conducting and then transcribing the interviews provided two immersions into the story of each participant. The subsequent reading and rereading of the transcripts through the reduction and data analysis process enabled the researcher to identify a participant simply by reading a portion of his transcript. “Reading, rereading, and reading through the data
once more forces the researcher to become intimately familiar with those data” (Marshall & Rossman, 2006, p. 158).

During the phenomenological reduction, the researcher recorded thoughts using the comment feature of Excel, thus linking the idea to a specific point in the worksheet. These thoughts amount to what Marshall and Rossman (2006) call “analytic memos” that allow the researcher to generate “unusual insights that move the analysis from the mundane and obvious to the creative” (p. 161). These comments also aided in organizing the researcher’s thoughts over the time it took to complete the data analysis.

Using this methodology, the themes were categorized and classified by making copies of the worksheet and sorting according to themes. For example, a theme of “personal meaning” emerged from the data. Using the sort feature in Excel, columns with relevant headings were sorted from largest to smallest. Since key statements were tagged with the number “1,” those statements sorted to the top of the spreadsheet. Any statement not coded with the number “1” sorted to the bottom of the spreadsheet. In this manner, all key statements from all participants bubbled to the top for easy retrieval and analysis. Clustering the data in this manner developed what Marshall and Rossman call “textures of the experience” (2006) that aided in the emersion of themes and allowed for quantitative analysis.

During the final “structural synthesis” phase, the researcher explored “all possible meanings and divergent perspectives” (Creswell, 1998, p. 150) and sought the alternative explanations that will always exist. Through this immersion in the data, the five main themes emerged and revealed the “essence of the phenomenon” (Marshall & Rossman, 2006).
After reading, classification and structural synthesis was complete, the researcher presented the findings in Chapter 4 using a written, descriptive format. “Interpretation brings meanings and coherence to the themes, patterns, categories, developing linkages and a story line that makes sense and is engaging to read” (Marshall & Rossman, 2006, p. 162). The report that follows provides a description of each participant’s experience and then merges them into a composite description of the “meanings and the essence of the experience” (Creswell, 1998, p. 150).

The Researcher

The description that follows is an accounting of the researcher’s experience relative to this study. Such documentation allows the researcher to “gain clarity” from his own preconceptions (Marshall & Rossman, 2006, p. 105). In this process, called “bracketing” or “epoche” the researcher acknowledges and then sets aside all prejudgments and personal experience. The process of bracketing allows the researcher to suspend or “forget” all that he knows about the phenomenon and experience it “as it is” (Burke & Christensen, 2004; Schostak, 2002).

The researcher has spent 33 years in or affiliated with the HVACR industry, beginning with an associate degree in HVACR from a junior college and following a career path that began in an apprenticeship program as a third-generation sheet metal worker. Experience in education began 12-years later as a sheet metal apprenticeship instructor for a local union. While teaching in the apprenticeship program, an evening program at an off-campus location provided an opportunity to earn the Bachelor of Science in HVACR Engineering Technology. After 11 years as an apprentice instructor, including seven years of evening college work, the baccalaureate degree paved the way to
a position at Ferris State University as an assistant professor and department chair in the HVACR Department.

Having spent 11 years as the chair of the HVACR department at Ferris and now teaching full time, the researcher has been involved in many aspects of the HVACR programs, including the design of the academic building that houses the programs, the launching of the online version of the baccalaureate degree, the hiring of all but two of the current nine-member faculty, and the redesign of both the associate and baccalaureate degree curricula. As a graduate of HVAC-ET at Ferris, the researcher shares a common bond and some common experiences with the graduate subjects of this study. As a professor of HVACR at Ferris, the researcher holds a keen interest in the outcomes of the study. This high level of personal interest, known as bias in traditional research, can be advantageous when gaining access to subjects (Marshall & Rossman, 2006). At the same time, bias is a threat to validity. This accounting summarizes and “brackets” the researcher’s experience relative to this study. The researcher suspended all prejudgments based on these experiences and allowed the phenomenon to emerge from the study by relying instead on “intuition, imagination, and universal structures to obtain a picture of the experience” (Creswell, 1998, p. 52).

Summary

The researcher has had countless conversations with graduates and stakeholders over the years, most of which have focused on the technical aspects of the curricula and few of which have discussed broader educational outcomes. Despite these conversations and the numerous surveys of industry stakeholders conducted for Academic Program Review or curriculum quality improvement over the years, and in-depth, qualitative study
to gather subjective data had never been conducted.

This study was conducted as a phenomenology, designed to discover how graduates perceive they were prepared for work and how the HVAC-ET program aligns with the industry for which graduates are prepared. A goal of the study is to provide data for program improvement. Data was gathered using in-depth telephone interviews using open-ended, conversational questions. These data supplement quantitative data collected during Academic Program Review studies conducted on a cyclic basis. This study probed deeper and gathered information that is richer, and in some ways, more valuable than numbers. In the end, this study may serve as a model for other researchers who that wish to learn more about the alignment of a particular CTE program with its industry.
CHAPTER 4
RESULTS

Introduction

The purpose of this study was to learn more about graduates of the HVAC-ET program at Ferris State University in Big Rapids Michigan, and the alignment of the program with the industry for which it prepares students as viewed from the perspective of the graduates. An open-ended interview protocol was used to gather in-depth information about graduates’ experiences both in school and at work, what motivated them to pursue this particular career path, how they felt they were prepared for the world of work, and what emerged as essential elements of the program.

This chapter provides the results of the research findings along with an analysis of the data resulting from open-ended telephone interviews with 18 graduates of the HVAC-ET program who have been employed in the HVAC industry for at least one year. Ten of the subjects are graduates from the campus-based program, while the remaining eight are graduates of the online program. Data were collected during the months of June and July 2010. Questions asked during recorded telephone interviews were open-ended and designed to elicit in-depth responses. On several occasions, follow-up questions were asked to probe for deeper meaning and provide a richer narrative.

Four research questions formed the basis for this research. The intent was to: (a) discover what the HVAC-ET program meant to its graduates on a personal level; (b) determine how graduates perceived they were prepared for their careers; (c) identify the essential core-academic, general education, and non-academic elements of a relevant HVAC-ET program; and (d) identify changes that would improve the HVAC-ET
program from the perspectives of pedagogy and relevance.

Based upon the responses to these research questions, the researcher generated categories and themes using the phenomenological reduction process (Creswell, 1998). Salient points, statements and key ideas were coded according to themes. As a result of this analysis, coded statements were clustered and five common themes emerged for campus-based graduates and online graduates alike. In general: (a) graduates think positively about the HVAC-ET curriculum; (b) general education does not contribute significantly to the HVAC-ET experience, (c) graduates find deep personal meaning in the HVAC-ET experience; (d) assets and attributes of the program and the university contributed significantly to the positive experience of the graduates; and (e) graduates are well-prepared for work. These themes are discussed in depth in the following sections. Pseudonyms are used whenever a subject’s name appears to provide anonymity.

Data Reduction and Bracketing

Chapter Three provided a discussion of the data analysis processes and procedures from a somewhat generic perspective. A fuller description here provides information more germane to this study. During reading of the transcripts, any statement or phrase that seemed to be significantly related to the research questions was tagged as a salient point. These salient points became the raw data for the research.

Each salient point was coded with a label that had meaning to the researcher. For example, a number of subjects spoke of the pride they felt in earning their degree, with phrases such as “I was proud of myself,” “my resume proudly states . . .,” and “I’m proud of that.” Those phrases were identified as being significant statements related to meaning of the degree from a phenomenological perspective, and were coded as “pride in degree.”
As data analysis progressed, salient points were clustered into themes using the reduction process. For example, statements described above and coded as “pride in degree” were clustered with other salient points coded as “gratitude, meaning of degree, credibility, validity, and self fulfillment into a theme coded as “personal meanings.” In this case, the language used by the researcher to describe the theme as “personal meanings” was derived not from the language used by the subjects, but as a descriptor that described the feelings communicated by the subjects in this cluster of salient points. At the same time, the salient points were coded using words used by the subjects in their statements, such as “pride, gratitude, credibility and validity.”

The language used to name other themes was either taken directly from the subjects’ transcripts, or was developed by the researcher to describe the cluster of related salient points. Graduates think positively about the HVAC-ET curriculum emerged as theme one, and used language extracted directly from the transcripts, such as “that is a positive experience,” having a degree from Ferris state university is definitely a positive aspect,” “my experience with all that was positive,” and “My experience with Ferris in as much as the HVACR department is concerned has been one of the most rewarding and positive aspects of my life.”

The researcher used the word “ambivalence” to describe the subjects’ feelings toward general education courses. Though none of the subjects used the word “ambivalent,” the researcher chose that language to communicate the indecisiveness of the comments. While some subjects made positive remarks about their experiences with general education courses, others had negative comments. In some cases, the same subjects made both positive and negative comments on the topic. Because the word
ambivalent can be thought of the mean “of two minds,” it was chosen by the researcher to communicate the fact that general education did not emerge as an essential element of the subjects’ lived experiences with HVAC ET and their subsequent employment.

In a similar fashion, the language to name theme four was chosen by the researcher to describe the clusters of salient points that emerged from the data. Theme four clustered salient points about the assets and attributes of the program that contributed to the positive experiences of the subjects. “Quality and supportive Ferris educational assets” is a term that none of the subjects used, yet is used by the researcher because it sums and describes the comments made by the subjects about significant elements of their experiences that were not related directly to the curriculum.

Theme five clustered salient points made by the subjects related to their perception of their preparedness for work, and the name “well-prepared graduates” was a paraphrase of language used by several of the subjects. “I felt like my education prepared me for the real world,” “I certainly cannot think of any other situation in which I could have been better prepared for the real world,” and “Definitely prepared me for working” are examples of language used by the subject that led the researcher to name the theme. Though the subjects did not feel well-prepared for the business aspects of their jobs, that point emerged under theme six. All other comments related to work indicated that the HVAC-ET core courses had prepared the subjects well for their jobs.

The language used to name theme six was chosen by the researcher to cluster negative comments about the experiences of the subjects. The overall findings of this study indicate a very strong positive experience, but the name “HVAC-ET is not perfect” provides the caveat that the subjects did not describe their experience as a nirvana and
clusters negative salient points under this theme. This theme also indicates the effort employed by the researcher to bracket his own experiences and eliminate his influences on the themes. As with all the salient points, negative statements were made in response to open ended questions that allowed the subjects to respond in any manner they chose.

Five central themes were ultimately condensed from the original 58 salient points in a process that involved several iterations of clustering and re-clustering until no further condensing appeared possible and a final logical set of themes emerged. The themes were cross-checked against the original transcripts to ensure that every significant statement made by the subjects was accounted for, and to ensure that the themes did not suggest anything that was not contained in the original transcripts.

The Subjects

Though all subjects are graduates of the HVAC-ET program, 10 graduated from the campus program while the remaining eight earned their degrees online. As it turned out, the same two groups are segregated by age. The campus-degreed students ranged in age from 23 to 35 at the time of the interview (22 to 32 at graduation), with a mode of 24 (22 at graduation) and an average age of 26.1 (24.2 at graduation). The age of the online-degreed students ranged from 34 to 54 (31 to 51 at graduation), with a mode of 50 (at both interview and graduation dates) and an average age of 46.6 (44.1 at graduation). At the time of graduation, the oldest campus subject was one year older (32) than the youngest online subject (33), and the average ages of the two groups were separated by 20 years (24.2 and 44.1 respectively).

A further distinction separates the online subject from the campus subject: All of the online subjects had industry experience prior to beginning their education at Ferris.
Their years of experience ranged from two to 30 with an average of 15.5 years. In comparison, only two of the campus subjects had any experience prior to enrolling at Ferris with a relatively few two and six years respectively, averaging only 0.8 years of experience across all campus subjects. There is a caveat: three other campus subjects reported “under the table” experience while working in the industry during high school. For the purpose of demographics, this was not counted as full time employment, and has not been included as industry experience in this study.

The experience of both campus subjects was considered entry level as it involved installation and service technician work. In contrast, the experience of the online subjects was diverse, extensive and impressive. One was a vice president and partial owner of an international corporation with six offices in the United States and two in India. Another holds “a couple of patents” and worked as a product manager for an international company that manufactures major HVAC equipment. A third worked as the director of facilities and then a facilities consultant for a large global oil company. Three of the online subjects currently teach in the HVAC industry at various community colleges located throughout the United States, and three of the online subjects worked as senior service technicians prior to enrolling at Ferris.

Of the 10 campus-degreed subjects, only three began their college studies at Ferris in HVAC and graduated four years later with their baccalaureate degree. The other seven had transferred to Ferris from other institutions. Four of the seven transfers earned their associate and baccalaureate degrees from Ferris and studied non-HVAC curricula before transferring to Ferris. One spent a year working on a mechanical engineering degree in another state; another earned a two-year agricultural-related certificate; and the
remaining two spent one and two years respectively taking courses at other institutions in Michigan while searching for a major.

![Graph showing subject demographics](image)

**Figure 2. Subject Demographics**

Of the remaining three transfer students, two earned their associate degrees from different institutions in Michigan, while the third earned his from an institution in Illinois. Two of these three subjects were also the only campus subjects with any previous industry experience.

In all, 70% of campus subjects earned their associate degree in HVAC from Ferris, 80% were from the State of Michigan and 90% earned their associate degree in Michigan, with only the subject from the neighboring state of Illinois earning his outside of Michigan. In contrast, only 25% of online subjects earned their associate degree in HVAC at Ferris (and in Michigan) and only 12.5% were from Michigan originally. Only one earned his associate degree in a neighboring state (Indiana), while the others transferred from institutions in the states of California, Florida, Georgia, Pennsylvania, South Carolina, and Texas.
In summary, the campus and online subjects varied by age, geography and industry experience. Campus subjects were younger by an average of 20 years. Most were traditional students from within Michigan who earned both the associate and baccalaureate degree in HVAC from Ferris. They had little or no previous industry experience. Online subjects tended to be older, non-traditional students from states other than Michigan who earned their associate degree from an institution other than Ferris in a state other than Michigan. Most had extensive industry experience. There is one demographic that proved to lack any diversity at all: every subject was a male Caucasian. Of the 111 potential subjects contacted (all of the graduates from the years 2007, 2008, and 2009), only nine (10.8%) were non-Caucasian, none were female, and none chose to participate in the study.

The Campus-Degreed Graduates

**Theme One: Strong positive attitude toward HVAC-ET**

The strongest theme for graduates of the campus program was the curriculum. Every subject commented with strong positive thoughts about the curriculum. A number of sub-themes emerged related to the curriculum. Foremost, for all these subjects, the program aligned with their interests and skill set. Subjects used words like “niche” “fit” and “clicked” to explain how they chose HVAC-ET as their major. Nick described spending two years at two different colleges while figuring out what he wanted to do. Upon hearing about Ferris from his father during the summer, he visited, toured the Granger Center, felt like he had found his niche and enrolled the following week.

Brandon, David, and Brian transferred to Ferris when they discovered the HVAC-ET program after having studied other programs at other institutions. Brandon described
starting at a local community college “because I really didn’t know what I wanted to do.” Wanting something more hands-on, he transferred to Ferris because it “that seemed to fit.” David, after studying engineering for one year in his home state, said he “decided to change my major...to a degree that was much more focused on HVAC as I had a passion/interest in that industry.” Brian had been working in the agricultural industry after earning a two-year certificate at another university in Michigan, and wanted to transfer to a field where he could further his career without working outside all the time. Career assessment test results pointed him toward mechanical engineering or HVAC. Wanting a more hands-on and career-focused curriculum “rather than mechanical engineering being very broad,” he chose HVAC.

Josh, Jack and Austin followed their fathers’ footsteps into the HVACR industry. Austin also had a grandfather in the industry and worked driving a truck and assisting service technicians while in high school. After high school, his father led him to Ferris. After being “impressed with everything that was there,” he looked no further. Josh followed a friend on a campus visit during high school, and after touring the Granger Center and hearing how he could learn about HVAC systems and how to control them, found that “it just really interested me.” Jack originally was interested in Ferris for the “trade school” and “hands-on” aspects of the two-year program and planned to stop after his associate degree, but after seeing the opportunities available to the HVAC-ET graduates and learning what that program of study entailed, changed his plans and stayed the additional two years to earn his baccalaureate degree.

John and Jordan, both transfer students, were the only graduates of the campus program who enrolled with prior HVAC industry experience. John saw Ferris as “the
next step in my career” and felt that “there wasn’t a better program for me. It was the perfect match.” Jordan had found himself in a dead-end job while working as an installer and service technician for a small residential/light commercial HVACR company that was privately owned by a “couple of family members.” He reflected that he “just saw myself not being able to go anywhere, so I looked to further my education so I could get out of college and get a better job.” The final subject, Tony, finished his associate degree at a community near his home in a neighboring state, worked briefly for a local contractor, quickly decided “that wasn’t exactly what I wanted to do,” and discovered Ferris in the ensuing search for options.

Every subject who graduated from the campus program chose the degree because it seemed to be a fit, piqued their interest, or allowed them to advance themselves in their career. Of the factors cited for making their decisions, subjects often spoke of the concentration on HVAC and the narrow focus of the program. Often, the closely related field of mechanical engineering was used as a benchmark or comparison.

Nick described how Ferris helped him find a direction in school: “It’s an extremely focused program... what I needed was a focus, because I was just aimlessly taking classes at the other two colleges.” Tony used the words “narrowly focused... specific type of study that we had, just being in the HVAC” when describing how the program has given him an advantage over graduates of mechanical engineering programs that “just taught theories” and were “broad spectrum” whereas Ferris was “very precise.”

Brian used similar language when describing his rationale for choosing HVAC-ET at Ferris: “I was looking for something a little more hands-on and more focused toward an actual career path, rather than mechanical engineering being very broad.”
When discussing the pros and cons of the two programs, he cited diversity of study within a mechanical engineering curriculum as a positive aspect, “but if we look into our program, there’s a diversity of...project management, controls, sales, marketing...generally concentrating across HVAC....I think the degree...says that I have a knowledge of this industry and that I’m concentrating on this industry.”

Though several subjects cited the narrow concentration of the program on the HVAC industry, they also discussed the diversity of study within the HVAC industry, just as Brian had. Austin talked about learning the disciplines of system selection, design, and control. Brandon was less specific, but thought that he had learned “such a good array of industry going through there.” Nick liked how the program prepared him for various sectors of the industry. “You can go into systems design, like mechanical design, work for a consulting engineer, or you can go into controls, or you can go into sales.” Josh itemized nearly the same categories: “You get to touch all aspects of the HVAC field. You’re doing controls, you can go into design, you can go into management, you can go touch in sales if you want to. I mean you can do a lot with the degree.”

**Challenging curriculum.** Subjects liked the curriculum for its real-world feel. Though some said they were good at it while in school, they also found it “challenging” or “difficult.” At the same time, they saw the value in the challenge via the knowledge they gained. Tony thought, “it was pretty difficult...definitely challenging...well beyond any of the other classes I had at Ferris.” To him, this was not a negative comment, “I learned just a ton.” Josh thought the curriculum “really challenged you and made you think. You had to work hard at it. You had to put a lot of time in out of class.” Brian, who had some practical knowledge from his experience in agriculture, was “able to do really
well starting off in school,” which gave him confidence for subsequent courses. Overall, he felt that the curriculum was challenging, “But the challenge also provided the drive to determine what the answer was.” As he explained:

There was a technical challenge in the four-year program…it was just something that I wasn’t used to doing, setting there writing a lab report on something that you determined. I mean before [in the two-year program] either the system operated or it didn’t, and that’s how you knew if you passed or failed, where here we’re writing a lab report to actually break down what we’ve done here, or analyze the system and break that down to determine what makes that system operate, or what could make that system operate even better, or more efficient. So there was a different mindset going into that, of actually thinking beyond what the system is mechanically doing.

Austin found the going easy, though as he progressed, he found that he created his own challenge in learning the material:

It obviously got tougher and tougher and we learned new things that I hadn’t seen…[the HVAC-ET program] was definitely more challenging than the first two-years. I still had it luckily come to me pretty easily…I didn’t have to set and study day in and day out to keep up. I sort of caught on I guess…but it definitely still challenged me. There’s always different challenges to it, and the harder you want to work at it, the more challenges you can make.

John described the curriculum as “these really hard classes that are rocking and rolling.” When asked to elaborate, he explained further, “It was really, well…not so hard. I think challenging is a better word…because they [the classes] were well thought
out, and you could always get help…with tons of resources…They were hard but not hard in a bad way like, ‘oh, you’re setting up to fail us.’ They were challenging.”

Although he described his first semester as a little rough, once he got “into the swing of being at a university” he found it to be “pretty easy and then it was just a lot of fun.” In all, he summed his education by saying, “I learned so much.”

Josh found college to be “pretty easy,” though “it really tested your knowledge.”

In describing why he liked the program, Nick said, “for one thing, I was good at it!...I gained more enthusiasm for the industry the longer I spent in the program.”

*Individual courses.* The overall curriculum was cited by every campus student as having significant meaning when asked to describe their experience in HVAC-ET program. Subjects talked about the curriculum as a whole, but also used individual courses to make their point from time to time, whether talking about their experience in school or on the job. The first course taken during the first semester of the HVAC-ET program (HVAC 331 Secondary System Selection and Design, see HVAC Course Descriptions in appendices) was described by some of the subjects as somewhat of a gateway course to the program. “First semester was pretty difficult,” is how Tony described his introduction to the program. To him, HVAC 331 “wasn’t the easiest class I’ve ever been through, but definitely learned a lot and definitely benefited from it.”

Jordan was a bit more blunt, “starting out with 331…you either live or die…you either pass or fail… the 331 class was definitely an eye-opening awakening of what you needed to know…and what they [faculty] expect.” Jack knew the reputation of the course from stories that other students had told, “I had heard a lot about how hard [it was], but I really enjoyed it. I loved the pace.”
When describing how the program had prepared him for work, Brian said, “it was a good introduction looking at secondary systems [HVAC 331], primary systems [HVAC 462], what goes into a load calc. [calculation, HVAC 342].” To emphasize the depth of learning in HVAC 342, he remembered “we took a look at not only [two proprietary software programs], but we actually took a look at how that was manually done by doing the CLTD [Cooling Load Temperature Difference] method…and actually going through the steps to learn…what the computer is doing behind the scenes.”

Many of the subjects who had earned their associate degree in HVACR from Ferris talked about the hands-on aspect of that degree before they began to discuss the four-year program. Brandon spoke of the controls courses to explain how hands-on learning continued into the four-year program. “I took a liking to control systems quite a bit…The hands-on didn’t completely go away. I mean, that’s when I really picked up controls. I jumped on that aspect of it, and still tried to stay hands-on, because we had a lot of things going on with [our controls lab].” HVAC 312 Control Theory and Applications and HVAC 415 Digital Control Systems are the two controls courses in the HVAC-ET curriculum. Neither course was mentioned specifically by subjects, though the controls portion of the curriculum was cited by Brandon and others on several occasions.

Brandon continued that he and another student enjoyed the controls aspect sufficiently to volunteer their time working with controls in other courses. “There were a few times when [another student] and I helped [one of the faculty] do little control sessions in his class…so I stayed pretty heavily involved in the controls part of it.” Brandon’s involvement with controls ultimately helped him secure employment, when he compiled a portfolio that contained among other things “controls and design” in
preparation for an interview with his future employer. Though he ended up with a sales engineering position, Brandon’s references to his controls experiences illustrate the meaning of those individual courses to him, describing them as a “big help.”

For Josh, the controls portion of the program was a deciding factor to attend Ferris because it was related to electricity, which was his area of interest in high school. During his tour of campus, he learned from the guide that, after earning his associate degree, he would be learning about controls when he studied in the HVAC-ET program. The courses lived up to his expectations, and he thought the direct digital controls (DDC) courses were “great…an excellent area, not just electrical but how to actually control [HVAC systems].” He liked the study of controls because it was both “hands-on,” and required “a lot of your head.” Though he found the other courses interesting and challenging, he said, “I was really interested more in the controls.”

Where subjects saw HVAC 331 as a gateway to the degree, they saw the capstone course as culmination of their learning, and sometimes as their rite of passage. David, speaking of the capstone course, thought that “it was a tough one, but I worked real hard…and seeing the whole design process come together; I enjoyed that.” Josh mentioned 499 three times during his interview. He said it “challenged me” and “really tested your knowledge.” More significantly, he saw it as a catalyst for him grow up and mature:

Senior year rolled around and…I really wanted to do good in the HVAC program. We had 499 coming up and it really meant a lot to me to feel good and to better myself…I think that the program and the teachers in the program really helped me to…become who I am today.”
HVAC 499, as the capstone course, allows students to concentrate in an area that is of interest to them, a feature that Nick spoke of. For him, that flexibility to explore had significant meaning.

I was introduced to AutoCAD and I think that became my strongest area of expertise, taking that HVAC architectural class where we designed mechanical systems. I really had a feel for AutoCAD. And then I ended up doing the thesis project, all centered around REVIT [a Building Information Modeling software], creating a whole 3-dimensional model. I think that was what I enjoyed most, and now I interface with AutoCAD on a daily basis. Senior year when we did the ASHRAE competition, I basically spent that whole semester using REVIT. So it was flexible in that sense, the program and the class, in that it let me focus on my area of expertise.

When talking about the program and his memories of it, Tony listed several sectors of the industry that he learned about:

499 really stands out... just taking a project, going from start to finish with it... it definitely stands out because [the] mechanical engineers here at [Tony’s place of employment]...sat in a thermodynamics class, and... never got those experiences that we did.

Earlier in his interview, Tony described 499 in the same sentence that he had used to describe 331. While he found the entire curriculum to be robust, to him 331 and 499 were:

Definitely challenging, well beyond any of the other classes I had at Ferris. Not to say [other] classes weren’t exactly challenging. They had their moments, but 331...
and 499 definitely take the cake as far as how much we’ve learned and the expectation of those classes.

Each year, students of the HVAC-ET program submit their HVAC 499 capstone projects to be judged in the international ASHRAE Student Design Competition. “The ASHRAE Student Design Competition recognizes outstanding student design projects, encourages undergraduate students to become involved in the profession, promotes teamwork and allows students to apply their knowledge of practical design” (retrieved from http://www.ashrae.org/students/page/1852). This competition is open to undergraduate students who are studying engineering or architecture and attracts entries from around the world. Like Tony, students often use HVAC 499 and the ASHRAE competition synonymously in their conversations.

To David, the most significant part of his education was being a member of an ASHRAE Student Design Competition that won first place. During his interview for this research, he spoke at length about the competition, the project, and the technical aspects of his team’s submittal. As the following quote attests, he did a poor job hiding the pride he felt:

The project won first place in the design division, and with our team winning that award I was flown to New York to receive it from the president of ASHRAE himself, in front of the body of engineers [in attendance]. I still display that plague proudly on my desk to this day. I can easily cite that as the highlight of my college education in as much as the HVAC program is concerned... it was a humbling, honorable experience to be able to be a member of the team that took the cake and that’s not a memory that will soon leave me.
HVAC 499 and the ASHRAE design competition brought the program into focus for Brandon, just as it had for Tony. And like some of the others, Brandon listed HVAC 499 as having significant meaning for him:

When I first started to realize I liked what I was doing was in the very last semester of school when I did the ASHRAE design competition. And what happened there is our group was ah, it was a tough one, but I worked real hard...that was kind of, like my baby, the whole project was... just seeing the whole design process come together, I enjoyed that.

For John, HVAC 499 had the same effect. It focused the program, it had significant meaning for him, and it provided him with insight for his career. When asked what was significant for him, he replied, “I think it had to be...499, the capstone class.” He described his experience as a “defining moment” when he realized “I get this stuff, it’s what type of engineer I’m going to be... and not only that, I’ve learned it, I’m starting to master it, I’m good at it.” John could not contain his enthusiasm during this conversation, and had a hard time finding words to express his thoughts:

Do you understand what I’m trying to communicate there, or do you kind of get the idea what I’m trying to say? And I think that’s probably the defining moment when all the pieces of the puzzle fit together, when you know this is what you’re going to be, and you have all the tools there, you know how to use the tools...and actually be an engineer.

Though the words came hard, his meaning was clear. HVAC 499 was the culmination of everything he had learned and funneled everything together where it all made sense to him. More importantly, it “turned on the light” for him when he saw what
he could do for his career. The meaning of the degree suddenly became clear to him, in what he described as a “defining moment.”

It is important to note here that, like David, John was also a member of a winning team in the ASHRAE design competition, yet he did not mention that as being significant. To him, the competition was far overshadowed by the experience he had in HVAC 499, and the realization that he had acquired a skill set that he could use. As he eloquently put it, “Holy smokes, [with] all the stuff I learned, I can build something! I can make something!” To John, the win was frosting but his learning and the confidence he gained was the cake. “Looking back, that seems better, the confidence you gain…you learn that confidence that you know you can do it…and just being able to believe in yourself…is more important than the competition.”

Jack was not as poetic or verbose as some of the other subjects, but he also cited HVAC 499 as significant during his education, perhaps summing up the thoughts of others. “I think finishing the 499 project was a great accomplishment, because that is a senior report and a lot of work goes into it… that was the last hurrah. I guess that is why it stood out.”

**Theme Two: Ambivalence toward general education**

In this study, the researcher was interested in a holistic view of the HVAC-ET degree. This includes not only the core courses just discussed, but the general education courses that are an integral part of the degree and are required for graduation. It was anticipated that general education would be discussed as a result of the open-ended interview protocol. However, beginning with the first interview, subjects instead focused on their experiences with the HVAC curriculum. When no mention was made of
experiences or meaning about the general education portion of the HVAC-ET experience, the researcher added this follow-up question to the interview: “Let’s talk about the general education courses. Please tell me what you thought about them, what they have meant to you, and what utility you have found for them.” As Creswell (1998) wrote, “we refrain from assuming the role of the expert researcher with the ‘best’ questions. Our questions change during the process of research to reflect an increased understanding of the problem” (p. 19).

The responses to this question were often somewhat hesitant, perhaps in part because the question was not part of the original interview protocol that had been sent to the subjects. As such, the participants did not have the opportunity to collect their thoughts prior to the interview. A transcript of each subject’s interview was sent to them, with the invitation to elaborate or clarify, thus giving them the opportunity to expand on their thoughts related to general education. However, none chose to do so.

Overall, the responses were mixed. Unlike conversations where subjects remembered specific HVAC courses and even details within those specific courses, they sometimes struggled to remember specific general education courses they had taken. Others did mention a specific general education course as having meaning to them, or piquing a personal interest. Two subjects drifted from discussing general education courses and described how helpful their minor in business was. Most often cited as helpful were communication courses.

Brian thought that general education courses “were just filler to meet a requirement.” He did take a Small Group Decision Making course, which as he said “definitely helped. Any time you have that personal interaction, you’re working on
communication, it’s gonna help. … But as far as the cultural enrichment social awareness, no not at a work level.” He explained that when he scheduled courses, he set his schedule up around the HVAC courses and then selected general education courses with “whatever of those classes that were available that could fill in.” When asked if his employer valued the cultural enrichment and social awareness courses, he mentioned that he works with diversity within the company, but thought that different people have different thoughts about those types of courses. He felt that it is good to get introduced to such subject material, but felt that “restricting you to certain classes I don’t think is going to help with that.” Brian elaborated by explaining how, when he was hired during his internship, his employer helped him select his electives for his coming senior year. When they “had looked down through the classes, it was looking at the HVAC courses, and not at the social awareness and cultural enrichment.” The company did recommend additional general education courses in the areas of math, English and physics, and Brian was able to pick up an additional composition and physics course.

Josh remembered liking his math and history courses, and struggling with English. Overall, he had little to say about general education, summing up his experiences by saying, “I don’t even remember everything I took.” Austin was one of the subjects who switched to talking about his minor in sales and marketing when asked about general education. As far as the actual general education courses, he said, “I can’t say I can directly see how they’ve helped me as far as like the chemistry and history courses, but I guess you could say it helps you become a well-rounded person.”

John saw general education as “very important.” He felt they were part of a bigger “university level skill set” that enable him to “look at a problem analytically and
holistic.” He cited the problem solving skills he learned in Sociology and Anthropology courses as a “different type of thought, but it’s important, once you get out in the world.” From his perspective, the general education courses were more “big picture” and with the learning about “people and communication, “they were “just as important as what you learn in HVAC to make you a valued employee.” It may be important to note that John was the oldest campus graduate subject at 35 years of age. It is possible that his somewhat broader perspective of general education has benefited from earlier work experience and an average of 9 more years of life experience than the other campus subjects.

Jack thought the general education courses broadened his horizons. Before college, he was “more of the hands-on guy,” but the math and English courses he took “ended up helping me out.” Other courses sparked an interest in learning. “I took a psychology class. It makes you want to, you know, educate yourself on other things other than just HVAC.”

Brandon, who gives presentations as part of his job was another subject who found the communication courses helped him with his preparations. He was one of the few subjects who mentioned any personal satisfaction, citing courses that studied weather, Great Lakes Geography, and “another one that had some meaning to me… the kind of stuff about the environment and nature.” However, when asked if other courses had meaning for him, he replied,

Not many of them.... Some of the other classes, the math and physics, I’ve never really used since. Um, didn’t have much meaning. It’s nice once in a while when I hear somebody say something, and, I’m like, ‘oh yeah, I know that.’ But other
than that they were just kind of a little road block that I had to jump through....

Just taking them because they’re required to take to get your degree.

At Ferris, all graduates with a Bachelor of Science degree must earn nine credits (three courses) designated as “social awareness” and nine credits (three courses) designated as “cultural enrichment.” Of these six courses, one must be designated as a “global consciousness” and one must be designated as a “race/ethnicity/gender” (REG) course. For some reason, Jordan found himself in senior year with one remaining general education course to take and several requirements yet to meet. To him, the university’s rationale for the requirements was lost in the hassle of finding that course. “I struggled at the very end. I had to take one special class just because it met all the requirements that mean, whatever those, you gotta meet those special letters.” Rather than taking a course that he enjoyed or would have helped him, he “had to end up taking a Children’s Lit. class.... I mean I was kind of stuck with that just because I had to meet all those special letter requirements.” He understood the need to take the courses because “it is a full four-year degree and they require physics and math and all that,” but he has not found utility for the courses in his work because “that’s not what we do.”

Tony was another subject who thought a communication course was helpful, though he felt it was too “business based.” He did not think some of the electives were helpful because he did not learn something that he would actually use, citing the example of “sex, race and gender in film.” At the same time, he understands that “the university requires some of those.” His conversation quickly shifted away from general education and focused back on the technical aspect of his degree, wishing there had been more electives related HVAC, for “someone like myself that wants to learn more about energy,
or someone [who] wants to learn controls.” When asked if any of the courses have helped in his career or broadened his mind, he replied that of the general education courses he took, he would probably say “two did.”

Theme Three: Personal meanings - pride, gratitude, self-fulfillment

For the campus graduates, the strongest personal meaning was a feeling of pride in earning the degree. That feeling was not always explicitly stated, but was inherently obvious during the conversations, particularly when the subjects described their accomplishments on the job and their skills relative to coworkers who had earned their college degrees elsewhere. Josh, Brian, David, Brandon, Jordan, and Tony had all used coworkers or other graduates as a benchmark for their skill set. These comments will be explored under theme four. Of the four subjects who came right out and proclaimed that they were proud, two did so with relatively simple statements. Jack had said, “I am proud of myself, I enjoy the fact that I worked hard to get that.” Brandon was equally concise, “It was a big step in my life. I was proud of myself.” Austin and Brian both provided a bit more explanation, and both mentioned having their degree mounted on the wall. Austin:

Well, I’m proud, I mean, its hanging on the wall in my office. I’m proud of it just to say that I did four years at one of the top notch schools in the country as far as that degree, and to be able to graduate with it four years later and find a job right out of school. I take a lot of pride in that.

Brian:

I was the first one in my family to have a bachelor’s degree and then to graduate with honors is definitely something that I… am very proud of. I have my degree hanging in my office here…it’s something nobody can take away. I’m definitely
proud of my experience I’ve received from Ferris State.

Two of the subjects mentioned a feeling of gratitude, almost as if their accomplishments were not of their own doing. Josh was relatively brief, simply stating, “I owe a lot to the HVAC program that we did there.” David had much stronger feelings and spoke at length about his gratitude, saying that the program and the faculty:

have contributed to an excellent three years in the real-world and a great excellent four years in the college world as well....[It has] put me in many of the positions of success that I enjoy to this day, and I am very, very grateful...I do owe...a great deal of gratitude and thanks for the things that I get to enjoy in life now.

For others, the degree represented an opportunity to grow, a feeling of accomplishment, and perhaps even self fulfillment. Tony thought the experience “was pretty significant.” He explained, “I never thought I would be graduating with a bachelor’s in anything. I felt that it was definitely a significant change that someone like me who is technical based, um, you know, struggles in English, struggles in just schooling in general that wasn’t technical....I never thought that I would be able to do something like that.” Josh saw the program as a chance to grow. He said, “the program really helped me to become who I am today....I thought it was great and I would encourage anybody to go to Ferris and get their degree.” Brandon discovered that the degree was simply the means to a more meaningful experience. As he said, the degree “is what I was going for. It’s the reason I went there, but...the stuff ...that has the personal attachment to me, is the experiences I underwent in the program.” For Jordan, the degree “meant a better future and a better career in the HVAC industry. ...I went to Ferris to look for a career and ended up finding one.”
Theme Four: Quality and supportive Ferris educational assets

“Ferris assets” is a term to describe the characteristics of the experiences that had meaning for the subjects. The curriculum is a prime example of a characteristic that subjects described as significant to them. However, the curriculum was the strongest theme in the study and was discussed at length by every single subject, so it has been separated out as its own theme. This theme contains the remainder of the characteristics, qualities or features that subjects spoke of when asked what they felt was significant about their experience in the HVAC-ET program.

Great professors. For many, either a favorite professor or the faculty in general stood out as significant. Jack spoke both of his feelings for the faculty and of his perception of their attitude: “I liked every single teacher, they really did put a good effort into wanting you to learn the subjects.” For Josh, the faculty were included as factors in his personal growth: “The program and the teachers in the program really helped me become who I am today.”

For Nick, it was the teachers that made the program click for him. “I got along with the teachers a lot. When I first started, it was [two faculty]. They’re really nice guys, really enthusiastic. They’ll spend time out of the class with you if you need it.” He went on, “there’s basically always a staff member who has experience in one of your certain focus areas. And that’s what I would say was really helpful. There’s different people that you can really develop a relationship with. They’ll give you more of an idea about what it is like in the field doing that particular assignment.” When asked if anything else stands out as significant, Nick returned to the faculty: “As far as the program itself. I’m just gonna stick with the staff. I really got along with the staff, and I really liked how focused
they were on our success, and how much, if we wanted to spend time out of class, there was absolutely no problem.”

David was more expansive in his discussion about the faculty, providing detail about why his experience was meaningful.

My experience with Ferris in as much as the HVACR department is concerned has been one of the most positive and rewarding experiences of my life. Going in, the personal touch if you will of all the professors continued from my initial showing up on campus…. The professors endured me with interest in ensuring that all students were successful and certainly would spend extra time with students that were willing to spend extra time learning material. I don’t know that I had a bad professor at any point in the HVAC program with the only exception being perhaps an adjunct professor not familiar with education in my very first semester…. But certainly… both through the two-year technical portion of the program and the 3 year [sic] engineering technology portion of the program, all assistance that I needed was immediately received.

There was pleasantness in the professors. I would say there was a genuine interest in ensuring that we were, you know, I guess the best way to put it is human relationship. It wasn’t your stereotypical college professor/student relationship. We took an active interest in each other’s lives, we actually hung out personally with several professors on many occasions and there was, I think there was something more there than just your typical you know, I am the teacher, you are the student, set down and listen to me type of college. We both wanted the same thing and that was to feel like we were going to get a quality education so
that we would be prepared for the HVAC industry.”

Social/atmosphere. Several of the subjects discussed the social aspect of their campus experience, including personal interaction with faculty, such as the comments just offered by David. Austin said, “

I personally felt like I was a part of the family there. Everybody was very friendly. I knew all the teachers very well personally and they all knew me really well personally. I always tried to stay as active in everything I could with the program and doing everything I could to help it. And saw return from the program….So I felt that it was a very good relationship that I had, very welcoming.

Brandon found the HVAC lectures, with a maximum of 32 students, and the HVAC labs, with a maximum of 16 students to be a good fit based on his background.

I went to a small school in high school and even at my first year of college just having small classes where you got a lot of time to spend with your classmates and the teacher and get to know everybody. It kind of began its own little community.

With a campus student population of 9,685, Ferris State University has a population that is roughly equal to the surrounding city of Big Rapids, with approximately 10,700 residents (Ferris State University, 2010). Tony ultimately liked that size and thought it fostered social interaction. “Ferris overall I thought had, you know, a great feeling to it. It was small enough where the guys that I spent the majority of my time with in the Granger building, we would see each other across campus and it was easy to make friends that way.” That was not always the case for Tony. “I’m from [a
large city], so it was definitely a culture shock, moving up to Big Rapids, the small town, the type of housing that was there….Not necessarily that the school was smaller, just the surrounding town was smaller.” In his case, he arrived alone but soon made the friends he needed to help him settle in.

Was sort of nervous. I didn’t know anyone up there. I was alone there, didn’t know anyone from home….First couple days of class, got hooked up with a bunch of guys. Some from [my] area, some weren’t. Just sort of got hooked with those guys, made some friendships and got through classes.

The small surrounding community was not a draw for all students. Brian, who had transferred from a much larger school, arrived because of a social network that already existed for him. Knowing that he wanted a change of careers, Brian took career assessment tests at both his alma mater and at Ferris. When asked why he took one of the tests at Ferris, a university he had no previous connections with, he said “the only reason I had taken it at Ferris was because I knew friends and family up in that area.” The results showed interest in mechanical engineering and HVAC-ET. When faced with the choice between mechanical engineering at a larger university or the HVAC-ET program at Ferris, he chose Ferris.

Similar to Brian, Austin had a social network readymade when he arrived. Describing his transition from high school to college, he said,

Mine was actually probably easier than a lot of people. I went up there with one of my best friends, who I roomed with and then two buddies that I knew really good through high school that were our suitemates. So I think it was probably easier for me than a lot of guys. I had no problem transitioning. Actually I had a
lot of fun with it, you know, getting out on your own, getting to make your own decisions and take care of responsibilities, I enjoyed it a lot.

Friendships were forged that had meaningful impact on the lives of others. David’s story provided a perfect example. He actually landed his job based on information received from a friend. “It happens that one of the people they seriously talked to is a very good friend of mine...who offered to take my contact information and hand it over to them.” John tied in the themes of atmosphere, general education, culture and core academics in the following discussion. “It wasn’t just the program itself; it was the whole university atmosphere...for me it was the whole university experience and the resources available... I had all the resources I needed.” John spent some time trying to explain the difference between his community college experience and his experience at Ferris.

It’s a totally different...type of atmosphere at Ferris State University. It’s a university atmosphere where you’re at college with everything. It’s a holistic ideal, where the whole goal is not always just your degree, but it’s the college experience, where at [my community college], it’s very, very, purpose driven. Most guys are there because they’re trying to get a job...and just learn some basic skills. It’s not the life changing experience where going to Ferris State has all of that.

Josh spoke of a totally non-academic, yet uniquely college characteristic that led to the development of friendships. “I’m glad that they had you stay in the dorm. I’m glad about that, I did have some really good friends that way and we’re still friends today.” Beyond the friends he made, Josh found that Ferris was a pretty good fit for him. “I liked
the atmosphere at Ferris because it’s not a large city….I grew up in the country, grew up with farms all around me so I liked the atmosphere of the city there and I liked the building.”

Granger. Josh’s last comment segues nicely into the next theme: the facility that houses the HVAC-ET program. Bearing the name Granger Center for Construction and HVACR and known to the subjects simply as Granger or The Granger Center, the facility was new in 2003 and was designed with the mechanical, electrical and plumbing systems exposed to facilitate teaching and learning. The subjects involved in this research were among the first students to take courses in the new structure and the features of the building resonated with them.

Tony stated quite simply, “Loved the building, great building.” For Josh, like many of the subjects, the building helped him decide to attend Ferris. He came to campus for a tour “when the new building was being built.” While the normal campus tour was supposed to visit a dorm, Josh asked if he could go see the Granger Center. He reported, “I was really impressed with the building and what the program had, all those…labs, and I was really impressed with all that.” Brian’s story is nearly identical:

The first thing I looked at when I went up there was the facilities and with the Granger Center being brand new, there was a great place to go and learn. Just looking at the labs at that time, I didn’t know what they meant, but they looked impressive, the aesthetics of it.

Austin was the third generation in his family to work in the HVAC industry and heard of Ferris through his father. “My dad had heard of the Ferris program and set up a walk-through up there to see the facility and I was very impressed with everything that
was there.” Though Nick had no family in the industry, he also heard about the building from his father, who had been on campus for educational purposes.

He [my father] took a tour of the Granger building and thought it was a really neat building, and thought that since I knew I was going into some sort of engineering field, that that should be a place that I should check out. So a week later, we went and [got] a little private tour of the building and talked about the program more, and I ended up registering that week.

David was quite descriptive in his discussion about the facility. Though some of his claims may be a bit exaggerated, they are included here to illustrate the level of pride and ownership that some attach to the building in which they studied.

We... had a tour of the then under construction Granger Center for HVACR and Construction, and I was in awe of the environment....[Ferris had] apparently specified construction materials and mechanical systems exposed – glass mechanical rooms, glass walls where plumbing could be easily seen and discussed. The building was a living laboratory. It was certainly something that I was expecting it to be and more... Certainly, aside from the professors the laboratory-type setting that the Granger Center provided was the highest quality of any institution of higher learning that I have ever seen, specifically related to this field. There is simply no other institution that I am aware of, and lord knows that I’ve looked around, because this was something that was very interesting to me and something that I do have a passion for, there just simply is no other institution in America that has the facility that FSU does in terms of the HVAC department and the resources that the students have exposure to...[including]
everything from the transparent mechanical room where you can clearly detail how systems are applied all the way down to the DDC control lab that’s offered, to the energy center.

*Student organizations.* All but two campus subjects mentioned student organizations as significant in one way or another to them. These student organizations provided opportunities for the subjects to get involved while they were on campus. Each organization is officially registered on campus as a Registered Student Organization (RSO) and is sanctioned by a national or international association or society. There are three student organizations related to HVAC: The Air Conditioning Contractors of America (ACCA), The American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), and The Mechanical Service Contractors Association (MSCA). In addition to activities on campus, each organization hosts an annual conference, convention or exposition at various locations throughout the United States. Students attend by raising funds or finding sponsors to fund their travel expenses. Some of the organizations also sponsor student competitions, including the ASHRAE design competition that subjects spoke of on several occasions. Involvement in these organizations proved to be a significant element of many of the subjects’ experience, particularly the opportunity to travel. Through the student organization-sponsored trips, the subjects saw different parts of the country, developed their network, and discovered opportunities previously unknown to them within the industry.

As David explained, “Ferris offers student access to three student organizations: ACCA, ASHRAE, and MSCA. Through those organizations I was able to network with a
number of companies scattered all across America.” For Josh, the trips he took as a
student member of MSCA were a highlight of his school years.

What stands out during school is those MSCA trips we would go on, where we
would meet and greet with all the big wigs from all those companies….When
your university is able to do that I guess that is just really nice, that we could
leave for a week and we could go mingle with these people, who were heads of
their companies. That really impressed me that we were able to do that.

Through ASHRAE and MSCA, you get to see a lot of conferences and
you see everybody in the field and you see how important the job is or how
important the degree is and you see how you can take it into the field and into the
workplace.

Like Josh, Austin was very involved in MSCA. “Student organizations, that’s one
of the things that I remember a lot that I’m pretty proud of actually, too. They have
followed me into the career actually, being a part of MSCA, what I was the president
for.” Austin continues his involvement with MSCA at his company, and has been
actively attending meetings as a contractor. He remembers travelling to the conferences
and conventions as meaningful, as Josh did, and he encourages current students to
become involved and attend the conferences. He tells them,

It does expose you to all the different personalities and different companies out
there, all the different things that are done in our field, makes you realize that it is
not just temperature controls and not just equipment selection. There’s a lot more
to it than that.
Particularly meaningful to Austin was the MSCA tradition of partnering a contractor with a student to act as a mentor during the conference. Part of the mentor’s responsibility is to “take the student under their wing” and answer any questions they may have. Contractors always attend a dinner with their local association while at the conference, and the student protégé is invited along. This provides the opportunity for the student to interact with not only his or her mentor, but also with other contractors from the region in an informal and intimate setting. As Austin put it, “MSCA conferences are great because you get to be right with one of the contractors and they open your eyes to the real-world [and bring] you up to speed in what’s really going on because they do it every day.”

Jordan liked the opportunity to get involved, and like Austin, ended up being president of one of the organizations. “The obvious thing was just to not set back and make the experience of being a college student, but more getting involved in different societies and different groups… I got really involved in ASHRAE and also in MSCA, and ACCA and just wanted to further what I knew and wanted to involve myself outside of just the regular class time. And so as I evolved in ASHRAE, I ended up my senior year being president. So that was a key for me, was to just get involved and be involved”

For John, being involved in ASHRAE was important when he was a student, and continues to be important now that he is working. As a student, his involvement included the ASHRAE design competition and a second place finish, which brought national attention. He now uses ASHRAE to stay involved in the professional community as a means of networking, and as a means to stay current in the industry. John was also involved with the other student organizations. As he said, “MSCA and ACCA are really
important too…Everything in what we do is rapidly changed, so they do a good job in keeping everything abreast.” Like others, Brandon found ASHRAE to be meaningful for the opportunities to network and for the student design competition.

Involvement with ASHRAE was very helpful as well, in going to the ASHRAE, or the AHR [Air-conditioning, Heating, Refrigeration) Expos, actually getting to go around and see different parts of the country, meet different people, different manufacturers. Just see how much there really is out there.

When asked what stood out as signification to him during his education, Brandon replied, “The two would be my internship and the ASHRAE design competition.” The student organizations also helped Nick connect with the industry: “I gained more enthusiasm for the industry the longer I spent in the program. I became active in ASHRAE….participating in ASHRAE was a really fun part of it. Going to the different areas for the AHR expo. I really enjoyed that. I went to Dallas and then New York.”

Tony felt the same. Speaking of the trips he took, he said,

I think that was a great experience for everyone…because of the networking that we’ve done there….Just the exposure that we had to the industry was very, very useful and I for one have definitely taken away a lot from those types of experiences, just seeing the type of equipment that’s out there, as well as seeing the kind of opportunities that are out there.

**Theme Five: Well-prepared graduates**

The overarching question for this study was: How do graduates perceive they were prepared for the industry as measured by what they know and know how to do as compared to what they need to know and be able to do? This theme answers that question
though the researcher discovered that it was often difficult if not impossible to extract and then separate salient points related to curriculum and work. Subjects used work examples to make their point when discussing the curriculum, and they used the curriculum to make their point when discussing their work. Though the discussion about the curriculum and the workplace were inexorably intertwined, two distinct yet related themes emerged. Theme one: graduates think positively about the HVAC-ET program; and Theme four: graduates found themselves well-prepared for employment in the industry.

To qualify for this study, subjects must have graduated from the HVAC-ET program in the classes of 2007, 2008, or 2009, and must have been employed for at least one year in the industry. It is no surprise then that each campus subject found employment in the HVAC industry. Josh, Brian, Austin, Jack, and Tony parlayed the internship they served between junior and senior years into full time employment upon completing their last year of school. A mock interview held during an advisory board meeting led to an official interview and subsequently a job for John. David was given contact information for the company that became his employer by a classmate who had toured the company. Brandon connected with a FSU alumnus who was recruiting for his company at the Ferris Career Fair. Jordan found his job through the classified ads in his hometown paper, and Nick, who knew who he wanted to work for, found a posting on the company website, applied and was hired.

From a phenomenological perspective, these facts are not remarkable nor relevant to the essential meaning of the HVAC-ET experience, but from a quantitative viewpoint, it is interesting to note that exactly half of the subjects served internships that turned into fulltime employment. Another point of interest, and perhaps a commentary on the state of
the economy in Michigan at the time this is written, is though all but two of the campus subjects are from Michigan, all but two were employed outside of Michigan during this study. Of those from Michigan who are now employed in other states, one is in Texas while the others are in the neighboring states of Indiana, Illinois and Wisconsin. The two subjects who were originally from a state other than Michigan now work in their home states.

**Internship.** The researcher chose to begin this discussion with the internship because, as both a required course and work experience, it illustrates the intricacy of the relationship between school and work in the HVAC-ET program. As the first exposure to a full time work experience for many subjects, the internship made the all-important connection between the world of school and the world of work, and indeed, directly linked to full time employment for half of the campus subjects. All HVAC-ET students are required to serve an internship between junior and senior years, working for an employer for a minimum of 10 weeks during that summer. Job responsibilities are to be related to the learning objectives in the HVAC-ET program. The internship is a four-credit course designated as HVAC 393. Students pay tuition for the course and earn a wage from their employer. Faculty assist in securing the internship, but the responsibility for finding one lies with the students. As such, students make the contact with the employers, proceed through the hiring process and negotiate their compensation package. In this manner, the internship initially serves as training for the subsequent search for full-time employment. A faculty internship coordinator oversees all of the internships and makes contact with each employer during the course of the summer. Most contact takes place through a site visit. However, interns are placed across the United States and
resources prevent every site from being visited. Students are required to log their activities and submit a report to the internship coordinator each week.

Many of the subjects spoke at length about the internship and their experiences. In the following example, a long quote from Josh’s interview demonstrates how the internship provided the opportunity for an individual to transition from an uncertain young college student to a confident young man ready to tackle the work force:

I did my internship with [a controls company] and when we first came on board we were really well welcomed...I actually went off and followed a technician around and ah, you know, [the] firsthand experience of working with a technician and what he does, you know, they go out, they commission all the HVAC controllers in the building and they program them and get them up online working and turn a building over to the owners. I went through that whole process during my internship and it was a little overwhelming at first, trying to get all the parts terminology. [There are] a lot of acronyms in our industry. But I’d say by the end of the three months, I really... felt comfortable, and I...thought I could even almost of stayed.

The experience was particularly meaningful for Josh. Not only did it give him confidence on the job, but it helped him to mature. In addition, he is one of the five subjects whose internship converted into full time employment. The following quote demonstrates his feelings for the internship, his comfort level at work, and his feeling of gratitude toward the HVAC-ET program:

That was between my junior year and senior and that helped me to really grow up to, really be out in the field, so the internship I think is a really big important part
of the program. But then coming into my job after I graduated, I called them up and I asked if there was an open position. I was interested in a position with them and they said yeah, and they gave me an offer...I really like it here, now that I’m two and a half years into, two years and a summer. I felt really comfortable with my job and I owe a lot to the HVAC program that we did there.

Brian and Austin shared very similar experiences. Brian’s potential employer interviewed him first on campus, and then flew him halfway across the country for an interview at corporate headquarters. In describing how well his internship went, Brian said, “I was actually hired on permanently when I was in my internship, so when I went back to school, I had already had the position.” Austin’s experience was more like Josh’s. “I got my job, it all started with my internship from college... They had an interview with me and had me do an internship with them. So that got my foot in the door and then the next year I interviewed with them and they offered me a job.”

Brandon was one of two subjects who interned with the physical plant at a large institution, though not during the same summer. Neither ended up working there full time, yet both had glowing things to say about their experience. In fact, Brandon listed his internship as one of the two most significant experiences of his college years (the other was the ASHRAE competition). During his internship, he gained experience with one manufacturer’s controls in particular and learned controls using equipment from another manufacturer in the labs at Ferris. Though he did not go to work for either company, his portfolio documented his internship experience and helped him secure a job upon graduation with a third controls company. Since he “already knew two of our competitors’ control systems,” he found that the knowledge and experience gained
through the internship and at school “helped out in certain scenarios.” For Brandon, the internship had sufficient meaning that he asked, “I’m sure you’re still doing [the internship] with [my boss] over there?” He went on to explain:

You learned a lot about systems. You really learned how buildings and systems operate. And how you can control them, how you can commission and troubleshoot them. And it, yeah, that was probably one of the most significant experiences going through the program.

Nick is the other subject who interned at the same institution as Brandon and had essentially the same experience. Unlike Brandon, Nick wanted to work for the company who dominated the controls installations at the institution. He recounted, “That is what really got me into the controls aspect of the industry, and further more into [my company]. And I pretty much knew from there exactly what I was going to do. And ended up working as a system design engineer,” where his experience “put me even further ahead of the curve since I already knew [the] product. And that helped a lot.”

Tony was another subject whose internship ultimately led to fulltime employment. Though he did not have his job in hand at the end of his internship like Brian did, there were pretty strong indications that a job would be waiting for him upon graduation:

[I] worked with them throughout the internship. Had great success with them. Our personalities meshed. Had great relationships with my boss, my manager, the owner and some of the other people here so well that they trusted me to return to Ferris and work remotely on some research, and doing loads, and doing some other things that I helped them out with during my summer…
...Um, when time rolled around when my senior year was coming to an end in the second semester, we um, sort of had some conversations about me returning and had some negotiations with them and came back and started full time with them right after graduation.

In hearing of the internships from the viewpoint of the subjects, it became evident that experiences were particularly significant to them. The internship seemed to be the transformational point in their lives where they experienced their first real-world job, and as Josh articulated, grew up. It also gave them a chance to apply their knowledge and gave them confidence in what they knew and could do.

At the core of CTE is preparation for a specific vocation (Rothwell & Gerity, 2008; Reese, 2002; Rojewski, 2002; Stone, 2002), yet as Zinser (2003) had noted, little is known about how well individual programs align with the industry for which graduates are prepared. During the interviews for this research, the subjects provided rich data that addressed the school-work alignment questions head on. As Jordan put it:

I think people look at our degree and say hey, they know something. And I think that...when [my boss] first hired me, he thought there was going to be a lot of training he was going to have to do and, I mean, just from my degree and the stuff that Ferris taught us, definitely showed him that, hey they teach you quite a bit there, so I think that’s a kudos for Ferris and what they’re teaching.

A common thread among the subjects was a description of how the curriculum introduced them to, and prepared them for, the world of work. In describing his employment, Jack felt he had a “very good understanding of the entire field” and that “it helps me in my job.” John stated that “I’ve used stuff I learned every day.” Brian related
the diversity of study to employment, stating that the HVAC-ET program “kind of opened up the opportunities that you have in front of you….I think that the program does a great job with offering [students] a broad variety of courses within a certain trade.”

Austin used a similar line of thought when he stated “it kind of opened you up to…different manufacturers, different companies.”

One of the reasons the program was cited as good preparation for a career was the “real-world” nature of the curriculum, or as Brandon put it, “a pretty good portrayal of the stuff you’d see in real life, and that really gave me a head start.” In school, Josh enjoyed the controls courses sufficiently to find work in the controls industry: “I feel really comfortable with my job and I owe a lot to the HVAC program that we did there.”

The concentration on HVAC in the curriculum was also seen not only as a solid foundation for work, but as a critical element for securing employment upon graduation. As Brian explained, “When I…hired on here, we went through the classes that I had taken [and the company] was looking at the HVAC courses.” He also saw the HVAC-ET program as “stepping away from being an installation or a service tech.” Though the associate degree presents excellent opportunities for employment, he thought the HVAC-ET program, with its additional two years of college, provided a broader array of possibilities, opening the door to find work as “a controls tech, or a designer. It is definitely a step up.”

When searching for a school, Brian’s decision to choose the more focused HVAC-ET program over mechanical engineering was supported during his subsequent internship and full time employment, when he assessed his skills and abilities in HVAC as superior those of mechanical engineering students and graduates. “The problem is that
they go through their program and there is not a concentrated level at what industry that they want to have their career in.” The comparison that Brian made between himself and graduates of other schools emerged as a theme during this study, and will be explored shortly. Subjects used this strategy to explain how they felt the HVAC-ET program prepared them for their HVAC specific job.

Another comparison between a Ferris graduate and other graduates was offered by Tony, who described how the limited expertise that he gained in HVAC 451: Energy Analysis and Audit (see HVAC Course Descriptions in appendices) has led to big responsibilities for him on the job:

I am the only person at [my company] that has done any energy modeling...we’ve got a full floor upstairs above me that is project engineers, project managers and full blown P.E.s [Professional Engineers] and they’ve never done energy and that is something that they really look to me...to help them...justify energy programs and energy projects and...retrofit opportunities.

Like Tony, John has found himself directly involved with job responsibilities as a result of his experience in energy auditing from HVAC 451:

I’m working for a company where I do a little bit more building sustainability and certified energy management... people pay for our services a little bit more of a premium because they want the best. I like being in that situation, because you get to think out of the box and use the best technology...I feel like this is the best job I’ve ever had in my life. I’m really happy with it.

Where doing energy auditing has simply been added to the responsibilities of both Tony and John, David actually carries the title of Energy Engineer. This is a position he
secured because of the knowledge he gained through the HVAC-ET program and HVAC 451 in particular. David’s description of his duties read like the 451 course description:

I am an energy engineer, and in that role, my title, my job is to audit buildings… and I analyze that building’s electromechanical systems… for their efficiency and then recommend energy conservation measures and water conservation measures as appropriate in order to make these facilities more sustainable.

Brandon described in detail how he applies the knowledge and skills learned in HVAC 451 (and HVAC 342: Load Calculations and Energy Code) to generate output data using computer simulation models, and then uses these data to help his clients earn Leadership in Energy & Environmental Design (LEED) points in two categories. In the first category, these data quantify energy performance as required under Energy & Atmosphere (EA) Prerequisite 2: Minimum Energy Performance, and EA Credit 1: Optimize Energy Performance. In the Indoor Environmental Quality (EQ) category, Brandon calculates ventilation rates as required by LEED to meet or exceed standards set by the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), specifically ASHRAE 62.1-2004, Ventilation for Acceptable Indoor Air Quality (U.S. Green Building Council, 2005). This description, though technical, illustrates the application of HVAC-ET learning outcomes directly in the workplace.

The following quote from Nick is repeated from Theme One, where it was used as an example to show how aspects of the curriculum contributed to the positive attitude held by the subjects. It is repeated here as an example to show how a positive aspect of the curriculum translated to the workplace:
I was introduced to AutoCAD and I think that became my strongest area of expertise, taking that HVAC architectural class where we designed mechanical systems. I really had a feel for AutoCAD. And then I ended up doing the theses project, all centered around REVIT [a Building Information Modeling software], creating a whole 3-dimensional model. I think that was what I enjoyed most, and now I interface with AutoCAD on a daily basis [italics added].

In another example, Tony saw the parallels between 499 and his job, and described starting with a “piece of paper” and proceeding through the project until “it’s something that’s measurable and tangible that we can see.” To Tony, the project aspect of the course and the job, and his ability to work through problems as they arise is “really significant to what keeps me going and what makes looking forward to the next one.”

Deep end of pool. Many subjects found themselves with significant responsibilities soon after beginning their job. Most often, though not always, this was a confidence builder for the subjects. For Tony, as the only employee at his firm capable of performing energy audits, the knowledge that he acquired in HVAC 451 amounted to a double-edged sword. Out of school only one year, the responsibilities that he had gained were a bit intimidating, yet through his knowledge, limited though it is, he has gained the trust of his superiors and colleagues:

Sometimes I feel that I don’t even know enough right now, or I don’t have enough experience in it...to be that one go-to person in the company that can take one of these energy projects and run with it far enough where we could take it to some sort of a conclusion.

Only six months into his job, David was asked to aid the short-staffed mechanical
engineering department when his company “won the contract to do all of the engineering, all of the mechanical installation, and all of the building automation installation in a no-bid context.” Following is a lengthy narrative with excerpts from David’s interview, included here in part to provide some detail of job responsibility, but mainly to illustrate the preparation that David received in school, and the pride that exudes from his words:

I went right to work and we spent about 60 hours a week for the next six weeks getting construction documents ready….I did everything from perform psychrometric analysis [psychrometry: the science of air-water mixtures], select equipment, to sizing pipes and ductwork to you know, even assisting with the AutoCAD in order to insure that this project got out the door….I selected 109 heat pumps myself in that building, and also assisted with many of the calculations involved….We got that contract, we built that school, and we have a client that is our biggest cheerleader and has volunteered to write letters of recommendation, has volunteered to travel with us to the continental 48 states to sing praises about how we did the elementary school right….You know the engineer who was in charge of that project, you know, I very much impressed him. I think that he initially, although he did not state it, I think he was pretty skeptical of what I could bring to the table. Wasn’t really sure what this kid just coming out of college could really do. I think, was probably aware of the fact that most engineers at that kind of a junior level are not prepared to be very productive, and needing a lot of guidance and needing a lot of instruction before they were able to really contribute to a project, especially one of this scale. Yet I think he found, pretty quickly that I was able to be assigned a task such as
selecting 109 heat pumps and be able to do so without much guidance at all.

Matter of fact, you know he was asking me why I was making the decisions I was, and after only a few days of explaining how this was more beneficial or that was more beneficial, ah, he just entrusted me with going, “you know what you’re talking about, you know what you’re saying, you’ve got the speed up, you’re going to run with this, just let me know what you come up with,” and letting me have the reins over certain portions of the project.

Jordan provides a similar, though less lengthy, example of translating school to work soon after employment began:

The stuff I was doing was a lot that I learned at school. I got involved right away with helping out as a project sales engineer in the group and pretty much, they had me doing the engineering on all of them just because my boss was so busy and I had the knowledge right out of college to do the engineering piece so I did a lot of mechanical engineering right out of school. So, I mean stuff that I learned at school was definitely viable stuff to use in the field.

Brandon, who graduated in 2008 provides the final example of early responsibilities on the job, though like Tony, did not have the self confidence displayed by David and Jordan:

[I] started out in inside sales… estimating big jobs… and learning as much as I could about the products and the way that the business works… when… just about 6 months out of the [corporate] training program, started to move outside… so I was out calling on engineers, doing a lot more face to face time with contractors and customers, which I really wasn’t experienced for, but I got thrown out there
anyway...[Now] I’ve got about 10 mechanical engineers that I call on and...help support them with equipment, help them with the design process...I’ve... done lunch and learns on heat recovery chillers, and the design process, dedicated outdoor air systems, one of [our] high efficiency screw chillers...and one on control systems.

These examples are provided to demonstrate the confidence that employers have had in the subjects soon after graduation, and to give voice to the knowledge and mixed levels of confidence displayed by the subjects as they describe some of their early experiences on the job as graduates. Of note is the fact that the trepidation of Tony and Brandon is related not to the technical aspects of the HVAC-ET education, but to the sales and business side of their responsibilities that were not a part of their schooling.

_Ahead of the curve._ Needing a benchmark against which to measure their expertise, subjects often turned to mechanical engineering. As discussed on page 6, the HVAC-ET program is essentially a subset of the mechanical engineering field, with a course of study that zooms in to tightly focus only on those engineering principles that apply to the design, operation and control of mechanical systems in buildings. In contrast, a typical mechanical engineering curriculum provides a wide-angle focus across the spectrum of all that is mechanical engineering with little direct focus on any one area.

With Ferris offering one of only two baccalaureate degrees in HVAC, most designers and engineers in the HVAC industry are educated as mechanical engineers, thus providing the research subjects with a likely and available frame of reference. Four quotes are provided, which all essentially say the same thing. The campus graduates felt they were
better prepared for their HVAC-specific jobs than their counterparts from large and sometimes prestigious engineering schools.

Josh:

You compare me and [another Ferris graduate] to the guys that got their degrees from [other colleges], and they struggle with the controls….Me and [the other Ferris grad] picked it up real fast. You know, we had those Ferris classes.

Jordan:

I work with a guy that graduated from [a large Midwest engineering school], like last year, and he got an engineering degree, which he can go and get a P.E. [licensed or registered engineer, i.e., Professional Engineer] with, but I mean he learned thermodynamics and fluid dynamics and all that, but to know HVAC equipment? I mean he still asks me questions just because, I mean yeah, they can learn theory all day long, but when you learn practical real-world, it’s the key I guess. And so I mean, they take a ton of math classes and Physics classes just to become an engineer, but, I mean is it really used in everyday life? I don’t think so. Math, yes, the physics and sciences, no. I mean I guess if you’re trying to figure out how a ball swings or a pendulum swings or something, I guess that would be real-world. But that’s not what we do.

Nick:

As far as reading through plans and specs, and designing HVAC systems, coming up with sequence of operations. I was way ahead of the game. Now I’ve mentored people coming in…doing the exact thing as I have. Now…they might be able to pick up software at the same rate as I was, but as far as looking at mechanical
systems and understanding what was going on, they were way behind where I was when I first started.

Brandon:

I started to see all the mechanical engineers, the students with the mechanical engineering degrees... how little experience they had in HVAC, or the business, and how many of them were actually going into HVAC, so I realized I had a big head start... I was way ahead of everybody, but they all had mechanical engineering degrees from pretty big schools... The kids picked everything up, I had a huge head start on all them, and... I believe it really helped me out getting into my sales position because I already had a lot of the hands-on experience and I already had done a lot of take offs and design projects that our professors set up for us at Ferris that were a pretty good portrayal of the stuff you'd see in real life, and that really gave me a head start.

Job security. Another meaning that was evident, though not always articulated, was job security. In most cases, it went without saying, but was evident from the feelings of confidence that subjects described, the ease with which they have found their jobs, and the number of job offers they had received. As was seen earlier, five subjects, including Josh, Brian, Austin, Jack, and Tony parlayed their internships into jobs before they left school. John, David, Brandon, Jordan, and Nick all had jobs before they left school as well. This is a significant meaning due to the poor economic conditions in Michigan during the years the subjects graduated.

Austin spoke of confidence as an indirect method of describing job security. “But the degree has meant a lot as far as knowing that I had a good... background and helps
you build confidence when you’re going into a job, especially in my field, in my position, because I’m younger than a lot of guys in my line of work as far as project management and estimating, so it gives you a little security.”

John was quite to the point: “I never worry about finding a job. I know I have the degree in my skill set, at a personal level, I mean it’s that security, it’s worth its weight in gold. I can honestly say…its gonna be really rough for me not to be able to find work, ever… that degree really…seals the deal for me.”

Nick spoke of his feelings and those of his colleagues, echoing John’s sentiments: “I felt completely safe in my job. I never felt as if I needed to work for my job, umm with you know questioning I’ll have it tomorrow. And I think that all out of my colleagues probably feel the same way as I do. It’s really gotten us into a really stable industry that does see ups and downs but not as bad as others….One of my friends went to law school, lost his job last week. You know, I don’t worry about that kind of thing.”

**Theme Six: HVAC-ET is not perfect**

A phenomenology was chosen for this study because of the opportunities to interact with subjects on a human-to-human basis, to explore further if necessary using follow-up questions, and to arrive at conclusions post hoc rather than a priori (Creswell, 1998; Lancy, 1993). Kahn and Cannell (1957, p. 149) as quoted in Marshall and Rossman (2006, p. 101) describe the in-depth interview as a “conversation with a purpose” employed to discover the perspective of the phenomenon from the point of view of the subject (Marshall & Rossman, 2006). Such a strategy allowed the researcher to explore the subjects’ perception of the HVAC-ET program to whatever depth seemed appropriate.
Through the use of open-ended questions, the researcher anticipated that subjects would share both the positive and negative aspects of their experience in the HVAC-ET program. Near the end of the first interview, it became apparent that the subject had discussed only positive characteristics of his experience. Taking advantage of the systematic yet flexible in-depth interview structure used in a phenomenology (Marshall & Rossman, 2006; Burke & Christensen, 2004; Bogdan & Biklen, 2003; Patton, 2002; Creswell, 1998), the researcher added a fifth and final question to the interview. Asking “What would you change about the program?” enabled the researcher to obtain a richer and more in-depth narrative describing the experiences of each subject.

While the subjects were enamored with the faculty, the facility and other characteristics of Ferris and the HVAC-ET program, they acknowledged that it was not perfect. Despite being encouraged during the interview to pull no punches if they felt there was room for improvement, they had a difficult time, if not finding fault, then finding a way to articulate their thought without apologizing, as if they feared they might desecrate something dear to them.

Two main subthemes appeared for the campus subjects as suggestions for changes to the program. First, a number of subjects talked about ABET accreditation. (For a full discussion on ABET, see page 89.) In brief, the HVAC-ET program is not accredited by ABET, formerly called the Accreditation Board for Engineering and Technology. This prevents graduates from becoming licensed or registered as professional engineers (P.E.s\(^1\)). HVAC-ET graduates can do everything a P.E. can, but lack the authority to sign or “stamp” engineering documents and take legal responsibility for it. In some firms, the

---

\(^1\) The term “P.E.” is used in the engineering community much like “Ph.D.” is used in the educational community. It can mean both “I am a P.E.” and “She has her P.E.”
lack of a P.E. serves as a ceiling, beyond which employees who lack that credential cannot be promoted.

All but two campus subjects mentioned ABET for one reason or another. David provided a good example of a subject who both almost apologized for offering a critique and who spoke of ABET.

If there were any one hiccup, if I had had to make one concerned remark, if I was being held down and threatened to be beaten unless I gave one, the only concern I would have would be what seems to be the burning, politically-charged topic of ABET accreditation. The HVACR degree, if you choose to go through the four-year program is not ABET accredited, and therefore many states do not recognize that degree as a degree that leads into the testing for the P.E. exam. So for those individuals that graduate from Ferris that have a desire to continue their career, or to pursue careers in HVACR design, may find a struggle in competing with other persons in their various companies and corporations for job positions that would require that, or at the very least highly recommend that, and certainly state licensing board requiring P.E. stamps on construction drawings. Ferris graduates at this time would not be able to stamp those drawings and so some individuals certainly would see that as a hindrance to the program and a potential roadblock to perhaps taking Ferris over a more traditional mechanical engineering school.

Josh did not suggest that the program become ABET accredited, but asked if there were plans to do so. He said that he would have liked it to be accredited when he was there, but doubted he would have stayed for an extra year to pick up any additional courses that might be required. But he did say that if an option were ever offered where
he could return to school for a year to earn a credential that would allow him to set for the P.E. exam, he would likely “go back in and get that.” Jack echoed that sentiment, saying, “if that ABET ever comes around for Ferris graduates to take those classes, I would be one of the first people to sign up.”

Brian has taken those thoughts one step further, and is now attending a local ABET-accredited engineering school to earn a mechanical engineering degree. His plans are to become a P.E. That is also a goal of his company, and they are funding his education. However, when asked if having the HVAC-ET program accredited by ABET when he attended would have affected his decision, he replied,

With the goals that I had set at that time, I didn’t know anything about it. It wasn’t something that was a decision maker at that time. I don’t think I really realized what being ABET accredited and what the potential of that was until my summer internship, because I was amazed when I came down here and worked with a group of professional engineers. But it wasn’t until that point to where I made the long term decision that I wanted to be a professional engineer and wanted to concentrate on design.

Jordan mentioned the P.E. only because he has had his qualifications and the lack of a P.E. compared to the P.E.s that he works with. He explained that Ferris is relatively unknown at his place of employment because other employees in positions similar to his have typically been mechanical engineering grads from a large engineering school nearby. Referring to the HVAC-ET degree, he said, “it would be nice if you could get a P.E. out of it, but then you’d be adding a lot more math and science classes and that’s not what that degree is about. It’s about real-world and truly it’s about HVAC and I think that
what you get out of it is definitely what you put what into it.” In short, the P.E. would be nice, but the education he received from Ferris is more relevant.

Austin talked about “wanting to be able to say you could have an engineering degree,” but he reflected that he really didn’t want to be “the guy who does straight engineering.” Rather, he is happy doing project management “of jobs that have been engineered by the guys who set by the computer all day.”

The second main subtheme to appear under opportunities for improvement was the addition of a course or at least learning objectives related to the business side of the industry. Nick thought that the “the business side of it... was completely missed,” and volunteered thoughts to incorporate business learning objectives into the controls courses. Tony felt that he was not prepared for “whole management of time and people and resources. I felt like I wasn’t really prepared enough.” Along the same line of thought, Brandon said, “one of the things I felt was a weak point is just learning about the different parts of a job... how the whole bid process works and how a job evolves.” Brandon described how he pretty much has it down now, but when he came into the field, he had no idea “how many different times the price would change for a piece of equipment or a part of a job.” He also mentioned that sales learning objectives would have been valuable for him, and recommended adding them to the program. As he said, “I didn’t have any sales experience,” then joked, “That might be a good thing, now I don’t sound like a used car salesman to everybody!”

John thought that project management was missing from the program, and said that graduates usually go into “the engineering side of the house or the project management side of the house.” The addition of project management learning objectives
would be beneficial to those entering the project management side of the industry. John also thought that sales would be a beneficial addition to the program, as most every graduate is involved in sales at one level or another. He cited his own lack of business acumen related to project management, forecasting and billing, and wished he had been introduced to those topics in school.

The Online-Degreed Graduates

Theme One: Strong positive attitude toward HVAC-ET

For the graduates of the online program, the strongest theme to emerge from the data was the curriculum. Every subject shared strong positive thoughts about their experience while studying in the HVAC-ET program. While only two of the 10 campus graduates had any previous work experience, all eight of the online graduates worked previously, and all returned to college via the online HVAC-ET program for various reasons. Three (Dave, Bill and Tom) needed the degree for teaching jobs. Connor and Steve did not need a baccalaureate degree for employment or promotion purposes, having progressed far into their careers with only an associate degree: they wanted a baccalaureate for reasons of personal fulfillment. However, by the time he was finished with school, Connor found that he would indeed need the degree. Tyler and Greg needed baccalaureate degrees to advance their careers, and Nathan earned his after being laid off due to a corporate restructure. All of the online graduates who participated in this study chose the online option for its convenience. All were employed while earning their degree, and with all but one living outside of Michigan, they were able to continue working and living at home.

The term “perfect fit” was used by a number of subjects when describing how the
HVAC-ET program matched their needs. Two of the subjects (Tyler and Greg) had earned their associate degree from Ferris some years earlier. Steve, Connor, and Nathan had earned their associate degree some years earlier from institutions other than Ferris in states other than Michigan. These five subjects all had extensive industry experience.

Dave, Tom, and Bill all had just recently completed their associate degree from institutions in their home state. Dave and Tom had extensive industry experience, while Bill was a relative newcomer to the industry, having spent most of his career in an unrelated industry. All three of these subjects were getting their bachelor’s degree as a condition of employment for positions as instructors of HVAC.

Steve had worked his way to a fairly elevated position in the HVAC industry, but did so with only an associate degree. He had a personal need to earn a baccalaureate so that he would be on par with his peers. Even though he was successful, he felt he needed the degree to validate his status and success. The baccalaureate degree was a “natural evolution” for Mark, a lifelong learner. Seeking an online degree that could build on his HVAC-related associate degree, Mark said the HVAC-ET program was “a perfect fit” for him.

Connor also used the terms “perfect fit” and “right up my alley” when describing how the HVAC-ET program met his needs. Similar to Mark, he had worked himself into an elevated position with a large manufacturer of HVAC equipment with only an associate degree in HVAC and some military training. He was not even aware that a baccalaureate degree in HVAC was available until a coworker informed him of the Ferris program. For Connor, the online program provided the opportunity to finish the degree, which he had started earlier in an off-campus program but had to abandon when he
moved out of state. A baccalaureate degree remained a goal for him, and he considered starting a business degree rather than finishing his HVAC-ET degree. When asked why he chose the HVAC-ET degree, he explained:

Well, number one I hated to waste the time and effort I put into the Ferris program already. I was a good bit of the way through the program. I was at least at the halfway point, so I hated to just walk away from that. And by then I saw the value in it. A bachelor of science degree in a technical field. I always felt that would be the better foundation for my education than a business degree, because I can always go back and get an MBA….And frankly, Ferris is respected….I felt that I kind of had a leg up on a program that was probably one of the best in country, and I should finish it.”

Tyler experienced his career progressing in tiers. After getting burned out as a service technician working on residential equipment in a southeastern state for “70 to 80” hours per week, Tyler found himself seeking a greater challenge. He also reported that with his associate degree in HVAC from Ferris, “co workers that I worked with weren’t as highly educated as I was, and it was kind of a struggle from an interaction standpoint with those folks.” He found a job with a larger company working on commercial and industrial HVAC equipment, where he said, “it took me about two or three years to get up to speed on that and then I got to another point where it was like a road block.” He found that he related better to the people within his company who had professional positions of more responsibility and wanted to elevate himself into those positions, but “it really required a bachelor’s degree.” When looking for a college to get that degree, he looked first to his alma mater. As he described it, “Fortunately, Ferris offered the four-year
degree program and I could do that online and take some classes remotely, and it allowed me to get my bachelor’s degree without having to relocate back to Michigan for two-years.”

For Dave, the HVAC-ET degree was his second online degree. He had just completed his associate degree in HVAC online through a community college in his home state when he enrolled at Ferris. With a 10-year goal to get a baccalaureate degree, Dave learned about Ferris before he had completed his associate degree. One of his instructors had read about the HVAC-ET program and recommended it to him as the next step. “It’s just that the Ferris program was such a perfect fit for what I was doing,” Dave says of the progression of his education. It “really helped me and it worked well for me.”

Tom had 21 years of experience in the electronics and HVAC industries with formal training from his years in the military, but though he had many industry credentials and certificates, like Dave, earned his associate degree just before beginning the HVAC-ET program. As he said

I started looking around and I looked all over the country to find a good school that would have a good bachelor’s….I found Ferris….I was intrigued at the program… Ferris had the best of everything …and so I applied and was accepted…..I think this degree is the top of the plateau.

For Greg, the HVAC-ET program was not a perfect fit: it was simply the shortest path to a baccalaureate degree. Like Tyler, Greg was a graduate of the associate degree program in HVAC from Ferris and had spent some years working as a service technician in the industry. Unlike the other online graduates, Greg had left the HVAC industry for a job as a manufacturing engineer, but found that he “wasn’t going any farther without
having a bachelor’s degree.” When looking for a college to attend, he “found that Ferris was the easiest way” for him to get it because everything he had taken previously transferred. Ironically, the HVAC-ET degree was supposed to be the shortest path to a baccalaureate degree so that he could advance in the manufacturing industry, but serendipitously, he was recruited back into the HVAC industry, first for a sales and design position with the HVAC company he had worked for as a service technician, and then by chance, for a position with an OEM manufacturer who had found his resume on the Ferris website after he finished his degree. Greg explains the redirection in his career: “The degree helped me refocus… I started taking these classes and realized there was a reason I went into it because it was interesting work.”

Unlike the other online graduates, Bill had relatively little experience in the HVAC industry, having spent 21 years working in an unrelated industry. He entered the HVAC industry when taking a heating and air conditioning course to learn how to fix his own air conditioner. While reading his textbook during that course, he discovered “Ferris State University and their prominence in the field.” With some further research, he learned about the online HVAC-ET program. Setting the degree as a goal, he enrolled in a local community college, earned his associate degree in HVAC and transferred to Ferris for the online program. For Bill, earning the HVAC-ET program “converted the dream of having a college degree into a goal and finally in actuality.” Due to the learning he experienced, he feels “like I have a lot more depth….It [the HVAC-ET program] made everything a lot fuller.”

With extensive experience at multiple levels in the HVAC industry, earning a baccalaureate degree had been on Nathan’s wish list for quite some time, but he never
had the chance to pursue that dream. When he became the victim of corporate restructure and was laid off, a severance package provided the funding for further education. He had known about Ferris for a long time, first learning about it through a HVAC trade magazine. After considering earning the degree on campus, he decided to go the online route since he lived in the south and decided to start his own business while attending school. As he said, “It was an advantage to me to be able to take the online classes of course, as somebody that was working, somebody older, and ah, it, you know utilized my time in the way I needed.”

For the online subjects, the curriculum varied in meaning from the campus subjects. While they certainly felt it was “real-world” as the campus subjects did, they also found it to be enlightening. Though they had extensive industry knowledge, some found there was much more to know and learn. Others found portions of the curriculum to be familiar territory, thus validating the work they had been performing during their careers. For Connor, the curriculum “started opening doors on the commercial side of my education, because my two-year degree was, as I’m sure you’re aware of, usually more a residential based, and just theory and that kind of thing.”

With his extensive field experience, Nathan found the HVAC-ET program to be enlightening. While in the field, he had known enough to “make the stuff work” but he did not always understand why. In his courses, he would be introduced to a concept or even a formula, which would generate the understanding “That’s how that works!” That new depth of knowledge and understanding was “probably the biggest thing” about the program for him. He summed it up nicely, “What Ferris and the program did for me was take my experience and basically help me understand what I had been seeing and how all
those things all fit together.”

In describing the program from a macro perspective, Bill said it was, “very rigorous, very thorough; I had to put a lot of work into it.” When his first course began, he was “somewhat overwhelmed when the materials showed up. I mean there was just a ton of things.” That was only the beginning, as Bill continued, “And then when it started, it was quite intense. Ah, I remember learning more about the subject of HVAC in like the first week at Ferris State that I had known the entire time [in my other program].” The following quote summarizes Bill’ feelings about the HVAC-ET program:

It was very rigorous, definitely felt emersion in the subject material was pretty total and pretty much expanded my world view in that area I guess if you want to call it that, in giving me additional background information and detail as far as that is concerned. I really got the impression that everything that I had studied so far in [in his associate degree program], that it just um, there was so much more to that, and a lot of that was explored in the Ferris State program.

Dave found that he had to work hard in the online program, something that he had not been necessary for him in the past. He said, “I have that ability for memorization. I could usually pick up what’s there and get through a class.” Things were different when he began the HVAC-ET program. “Boy once you got into the online program, you usually had to do it.” He also found that he had to keep up with his studies. “You gotta stay on top of things. If you let something go it’s so hard to get back to it.” Time management became a necessity for him throughout the program. “Keeping track of what is going on really takes some discipline to make sure that you don’t just sort of forget about things for a week or two, where you, you’ll really pay for it.” Tom echoed Dave’s
comments about time management. Unlike a typical residential HVAC course, where as Tom said, “You’re actually there [at school] every day, again for a couple hours every day,” in the online program, “you have to dedicate a certain amount of time to get [your work] done.”

For Greg, the first two courses “weren’t that difficult.” However, as the program progressed, he found himself learning new material, and as he did, rediscovered his interest in the HVAC industry. “It didn’t start getting into the challenging stuff until it got into the energy auditing and things like that which, that’s kind of what made me realize that there’s a need for me to probably stay in this field.” Like Greg, for Steve, the first couple of courses were not that challenging. “[The curriculum was] a lot of what I was already doing in terms of load calculations, equipment selection, duct sizing and pressure calculations, and pump curves, those sort of things.”

Due to the familiar material, Steve said, “As I first arrived into that program I felt confident.” But, again like Greg, he found that when new material was presented, the challenge grew. “I think the toughest course for me was the controls classes, because they were not in my area of expertise or what I was used to, so they really gave me challenge to try to learn and stretch.” He enjoyed learning the new material and speaking of the courses as a whole, thought “they were interesting and a good mix.”

Just receiving the amount of course materials in the mail was a bit of a shock to some of the subjects. Tom reaction provides some insight into the reaction triggered by the content. “When I actually saw the content, I was kind of overwhelmed. I said ‘my God, you know this is a pile of information that we’re going to learn.’” He realized almost immediately that the HVAC-ET program would be beneficial for him. “I started
schooling…and I realized that there was some things that I didn’t know that I thought I knew.” Throughout the program, Tom discovered there was much he could learn. “As time progressed…I learned a tremendous amount of knowledge about our field, and going into in-depth portions of it in the commercial side.” As an instructor of HVAC, Tom found the new knowledge useful. “I still use a lot of that material in my classes. I took some of the material I got in my bachelor’s class and actually incorporated it in my associate classes here for my students.” He has also found application for his education while working in the industry. “I’ve used a lot of my knowledge in the commercial side of it. I’ve used some of the commercial load calculations because I had actually a much better understanding of the load calculations and some of the way chillers work.”

In general terms Tyler thought that “the curriculum that was given to the students during that time was excellent.” Like Greg and Steve, Tyler said, “I did not have a problem grasping that information as much as the other students that were in the courses just based on my past field experiences.” Working as a service technician as he went through the program, Tyler had an advantage because he saw the systems discussed in his courses on a daily basis.

When we started talking about chillers or system design, what’s involved in that curriculum, I had already been exposed to that previously in my day-to-day activities and so it made it a lot easier for me to be able to relate to it. When you start talking about pumping arrangements, series parallel systems, etc., I had seen those systems in person.

As Tyler progressed through the program and learned new materials, he was able to apply his knowledge to what he was doing at work the very next day. “I was able to
look at the building as a whole and relate it back to the curriculum and the program. So that worked out very well for me.”

Others made mention of individual courses, not so much as being challenging, but being meaningful to them because of their structure or application. Tom and Tyler talked about the capstone course with very much the same feelings and the campus subjects. Tom did not provide much detail, but his meaning was clear:

One of the things I was really impressed with is in the final stages where we were sent the plans…there was very little information that was given, and there was some assumptions you had to make and then you had to formulate a plan…for the capstone class, and to me it was a very in-depth learning experience.

Tyler spoke of the same course and provided much more detail. His complete description is provided here because he compares the capstone project to a typical real-world application and draws parallels between the two.

The last class, where we actual took a set of mechanical, or excuse me, general drawings of a business, this one that we did was actually a building, I think it was a library of some sort in Denver, Colorado. And we had to go in with a basic set of drawings and measure the building off of the prints, do load calculations, select the type of equipment that we wanted to use, size all the piping if you were using that particular type of system, whatever system that you decided to choose.

It was really a real-world experience during that class because that’s what you deal with on a daily basis when you’re out working with customers. And the reason why I use that as an example is if I go to a customer later today or tomorrow and they have an issue they’re not the experts on…what you to do is go
in and look at an existing building that may have had a problem since initial installation that was never dealt with, and then you have to look back at the system as a whole, obtain information from the customer and come up with a solution to whatever problem they’re having.

And the situation that you run into in real life is there may be more than one solution to a problem and it’s up to you to decide which solution you want to use to best help that customer. And it’s not text book, although you do use textbooks to come to a solution if you have questions about a particular situation, but they look at you. You have to be able to provide an answer and not, going back to that class, we had a wide array of different solutions and equipment selections for that particular building and all of them were correct, but it was up to an individual to decide which piece of equipment they wanted to use.

Steve found similar interest in the HVAC 451: Energy Analysis and Audit course that he had taken. This course is structured as a project similar to the capstone course, and students are sent pertinent information, from which they perform their analysis and arrive at a solution to the problem.

I also enjoyed one of the energy projects, where you actually got different pieces of a building, a school I think it was. And we had to do an energy audit very remotely, looking at pictures, data, submittals and drawings and I found that to be very, very helpful.

Steve went on to explain how this course in particular has found direct application in his business. He has taken what he learned and turned it into a successful branch of his business. From the perspective of the linkage between CTE and workforce development,
Steve’s story is a powerful one. Not only did he gain from his education personally, but his company developed a whole new service and is now working internationally to increase energy efficiency and human comfort in new and existing buildings.

**Theme Two: Ambivalence toward general education**

Much like the campus students, the online subjects had mixed feelings about the general education courses. A somewhat flippant remark and perhaps Freudian slip made by Connor may be all that is needed to summarize the subjects’ feelings toward general education courses. When the researcher introduced the next interview question and commented that so far, the subject had talked mostly about HVAC courses, the subject laughed and said, “That’s the part I enjoyed!”

Connor actually had a lot to say about general education. He realized that the courses were required as part of a university degree, but had a hard time finding utilization for them. He was not a strong mathematics student, so many of his comments centered around math courses and direct application to the world of work he has been involved in for over 20 years. From the perspective of understanding the requirement of general education, Connor said, “I didn’t feel that the gen eds were unreasonable. I mean it’s a Bachelor of Science degree and you have to be expected to take math and science and things like that.” Later in the conversation and still speaking of general education, Connor argued against himself, saying, “That [general education] was one area that I didn’t see. It’s a collegiate thing not a Ferris State thing. Everybody believes you have to have this.” Speaking in specific terms, Connor relates his experience as an equipment design engineer to trigonometry:

I really just don’t see the use of trigonometry in what we do, I mean I’ve been
doing this for 20 some years and I’ve been in labs working with guys that were
designing cutting edge HVAC equipment and have never had a need for more
than just basic algebra.

From a philosophical point of view, Connor ponders the value of general
education, weighing its advantages against the perceived or real obstacles it creates for
some students. Later, he describes seeking help from colleagues with pedigrees from
prestigious engineering schools, and uses their lack of memory to argue against some of
the math he was struggling with.

I think sometimes, we’re putting up an artificial road block for some people….are
we making them less qualified to sell a chiller, or to be an application person for a
chiller, or to go out and be a facilities director? You know I don’t think so.

I’ve dealt with guys with impressive backgrounds in education [from very
prestigious engineering schools]. A lot of them forgot most of the stuff. As I went
through [my homework] here [at work] later on, I remember talking to a few
guys, and they’re like, “Oh yeah that’s how you do it.” Because I’m trying to
learn [from them], and I’m thinking, ‘You know here’s a guy who has a degree
and everything and he couldn’t do it from scratch either at the moment, so like I
said, with college it’s about knowing which book to go to.

For Nathan, who thoroughly enjoyed his HVAC courses, the general education
courses were a bit more of a chore. He did his best to justify the general education
courses in terms of personal growth and the rationale behind general education, but
ultimately could not find the value in what he had studied.

The general education classes I had to take were, I would say, harder to get
motivated on. It was more of, “Okay, I gotta do this, you know?” I didn’t really see a lot of value at that point, you know, and since I’ve been out in the field so long some of these classes you have to take, you know, it’s a, I just don’t, I don’t see their application a lot of times, you know?...I still have a hard time seeing some of that value in what I was doing in my industry.

One of the issues that Ferris has faced with the HVAC-ET online program was the availability of general education courses offered online. As the department that launched the HVAC-ET program, the HVAC Department had no control over any courses other than the HVAC courses in the core curriculum. When the program was launched in 2003, Ferris as a university was just emerging in the online arena and very few general education courses were available. At the time, the HVAC faculty thought that students would choose to take their general education courses at colleges and universities near their homes, particularly if there were a community college nearby, as this would represent a substantial savings in tuition dollars. While some students did choose this route, many wanted to take their general education course through Ferris. In some cases, there were no institutions at a convenient distance, forcing the students to look for online solutions. In other cases, students simply wanted to deal with the university they were familiar and comfortable with. They did not want to hassle with the bureaucracy of another institution. When Bill talked about general education, he spoke of it from the perspective of availability and then described one course in particular that he thought was done well. It is noteworthy to point out that Bill did not provide specifics about any of the general education courses. Like most of the subjects, the general education courses had faded from his memory.
It was also nice at the time and I’m sure this continues, that Ferris State was working toward putting some of the gen ed requirements, making them available online as well even though I was able to take some of the additional requirements that I needed through the local community college. That worked out well for me but some of the classes that I took online like the, I’m trying to remember the exact name, I think it was like Small Group Decision Making or something like that. They were made, the classes were made interesting. A good job was done of making it feel like ah, you know we actually had a group going on, although we definitely we were at different locations.

Like Bill, Tom spoke in general terms about his general education courses. Unlike some of the other subjects, Tom thought the courses were good. The one specific detail he remembered pertained to a philosophy course in which he had to redo a paper because his professor did not agree with his point of view. Tom thought that was odd, but reconciled the incident in his mind by saying, “this happens with a lot of colleges,” as if to shrug it off as something beyond his control. Beyond that incident, Tom had no specifics to share, but did say, “As far as the general education, it was very good, very complex, and you really had to do your work.”

Tyler painted general education in broad strokes and spoke of it from a macro perspective:

I think what the general education courses do for a person, that’s probably not something that you can measure on a daily basis....I think there’s a lot of things that you do on a daily basis and interactions with people, coworkers, customers that is a result of going through those general education programs versus
somebody who has not gone through that. I just think the general education and
the way you convey yourself as a result of going through that is much improved
versus somebody who has not.

Steve was the only subject who found an example of a direct workplace
application for one of his general education courses. He also gave another example of a
course that had meaning to him on a personal level.

One of the classes that I took was Pop Culture and there was a whole section on
China pop and Japanese pop and we’re doing quite a bit of work now in Asia, and
having that background has helped me to get a little different perspective, a better
perspective I think of my customers there and appreciate their culture. So that was
one that just comes right to mind. The other was an ethics class, which dealt with
some extremely difficult end of life issues. So yeah, I think they were very helpful
in terms of giving me a better appreciation and an understanding of different
cultures.

Theme Three: Personal meanings - pride, gratitude, self-fulfillment

Because Connor was one of the first in his family to get a college degree, he said
the degree was “big for me….for me that was an important thing to be able to do as a
personal goal.” After starting in the off-campus program, taking a withdrawal to move
out of state, and then starting back up when the online version was offered, for Connor
“there was a certain level of pride in seeing it hanging on the wall finally.” As far as the
knowledge he gained, Connor noted that, “You don’t know what you don’t know,” when
referencing the courses and some of the topics within them:

I think, it definitely helped my knowledge…it had me study areas of HVAC that I
probably never would have looked at with my equipment background, so there would be things that would come up and I probably would not have even noticed them had I not had this education….I’d understand things and be able to think of questions to help people in different ways….That’s been a nice personal satisfaction a side of it. And it’s only motivated me to go further education wise.”

Connor had another motivating factor that he spoke of during his interview: a teenage son. He and his wife have completed two college degrees as his son was growing up, so part of his motivation was to provide a good example to help motivate his son to go to college. And he is planning to continue his education with an MBA.

Connor also expressed a feeling of personal gratitude toward his advisor for being “always there.” He remembered his advisor for “calling and talking to me about the program, and, helping me through issues with my ability to get in there.” He said his advisor “could have been a much harder person to deal with and made it much harder for me.” Relating the work of his advisor to his degree, Connor commented, “I mean just a little piece of that degree on the wall is because [my advisor] helped me and I really appreciate that.

Earning the degree meant achieving a goal for Nathan, motivated by the thought: “Hey this is a goal and I’m gonna reach it.” It also meant a “sense of accomplishment….I’m certainly glad I did it, and… I feel good about it….I’m proud of that.” Overall, Nathan’s experience with the program was “positive” and catered to his “passion for…anything with HVAC.” He thought the program was “a great way for people like me in this position, working people who are older that want to get education.”

Bill describes how the degree transformed a dream into reality for him, and what
it has meant to him:

At one time it was a dream, and then it looked like I would be able to fit it into my schedule it became a goal, then it became reality….I feel that having a degree from Ferris State University is definitely a positive aspect or asset that I am most proud of, that I have accomplished, not just in the last few years but in my life.

When asked if the degree had any significance to him, Dave replied, “You know it probably really didn’t before, it’s come to have a lot more meaning since.” He went on to explain that, as one of five children that all went into different trades, he was the first to earn a college degree. He also said the degree “gives me a lot of satisfaction.” From a professional perspective and referring to his current full time teaching assignment, Dave said, “It’s one of those things people read about, ‘Oh, well this guy’s got a degree from Ferris.’ It definitely adds credibility when they know you’re going to be there talking about something or teaching about something.” The degree has sufficient meaning that Dave encourages his top students to consider earning the degree for themselves. “I’ll always encourage them and say, ‘Hey here’s what I did.’” Dave gives the information about Ferris to his students and says, “You might really want to think about this. If you can get through Ferris and get this degree, it’s going to open up so many more jobs for you.”

According to Tom, “One of my goals was to get a bachelor’s degree and it was to be in the field, that was one of the things. And by having it, I have a sense of pride.” For Tom, simply getting the degree was not enough, it became motivation for continued learning: “Since I have the degree, it makes me dig a little deeper and work a little harder to stay up on top of everything so I can be worthy of maintaining that degree.” He went
on to explain what the degree meant to him, and his sense of pride exudes from his words:

I was very pleased to be able to graduate summa cum laude. I think it’s an excellent title to have, and if I had it to do over again, I’d do the same thing and I wouldn’t trade anything, and that’s one of the reasons why I worked so hard to maintain my average. Having that degree, it just means a lot to me. And I’ve got the HVAC engineering ring from Ferris State. It meant so much to me that I felt like the class ring was something that I needed to buy, because it was something I could show off and it was a distinguishing factor among my peers. And so I bought the HVAC Engineering Technology ring from Ferris State and you know it gives my year I graduated and all. To me it’s just a distinguishing degree to have.

Tom now teaches full time at his local community college, where, like Dave he shares his enthusiasm for the HVAC-ET degree with his top students:

I’ve got some of my students, when they finish up their associates degree, they’re gonna follow the same path I did, because I kind of paved the road for them, and so they’re going to transfer their stuff to [Ferris] too. Of course, I pushed [Ferris] a lot.

For Steve, the degree was a matter of self fulfillment and validation. As a vice president and part owner of his company, he had achieved much success in his career with only an associate degree, yet he said he “felt like I was a second class citizen” without a bachelor’s degree. Now that he has the degree, he says, “My bio/resume proudly states that I hold an associate’s degree from [a local college] and a Bachelor of
Science degree from Ferris State.” Though he knew he was competent before he had the degree, he needed that diploma to validate his knowledge and skill. Using an analogy from a famous movie, he said, “It is the Wizard of Oz syndrome: you always had it but you didn’t know it because you didn’t have the paper.”

Tyler, who had earned his associate degree from Ferris earlier in life, felt equally strong about both the two and the four-year programs. Similar to the campus graduates who had compared their skill set to mechanical engineering graduates who were performing similar work, Tyler compared the skill set he gained from the associate degree program at Ferris to that of other service technicians he had worked around. “When you’re out in the field with the guys that maybe have graduated from a trade school or learned the trade hands-on, that knowledge that you learn at Ferris in the first two-years elevates you very quickly.”

Though Tyler is not a HVAC instructor, like Tom and Dave he reveals his feelings for his experience when talks of recommending the degree to others:

I will say one more thing. As far as being a supporter of the program and pushing folks towards that program, that’s not an issue with me. It’s been such a tremendous value to me and if there’s students who are in some way shape or form interested in the program or in the trade, that’s the way they need to go….It’s worked out well for me and I have no problem, if anybody is interested in it, I highly recommend it. It is well worth it, and well worth every penny spent.

Unlike the campus subjects, Tyler was the only online subject who mentioned job security when discussing the HVAC-ET program. His comments continue to show the strong thoughts he has about his experience and the benefits he perceived he gained from
So that’s been just a great benefit to me and I don’t have anything but good things to say about the program from a personal perspective. Because it has helped me tremendously, especially when we’re dealing with the type of economy that we’re dealing with now, but I don’t think, you know, knock on wood, that I’ll ever have a problem keeping employment in the field in one way shape or form. I’ve always got something to fall back onto.

**Theme Four: Quality and supportive Ferris educational assets**

*Great professors.* For the online subjects, interaction with faculty was limited to electronic or phone communications for the entire time they were in school, with one exception. As students, they all started in the fall of their enrollment year with the first HVAC course. During the winter semester they took the second HVAC course, followed by the third during the summer. In August of that first summer, they all traveled to campus for a five day hands-on laboratory learning experience. It was during this time that they met each other, their professors, and their advisor for the first (and only) time.

As students, the online subjects did get to know their professors’ personalities, quirks, and what they looked like via lectures that were video recorded and distributed on CDs and DVDs, and then later on streamed over the Internet. Despite the relatively brief face to face interactions, a number of the online subjects made positive remarks about the faculty.

In describing the faculty in general, Connor spoke of their “vast technical knowledge, and when describing the quality of the electronic lectures, singled out one faculty in particular and described his organized lecture and delivery style as being “very
good.” Using his experience at different schools as a barometer, Connor said:

I’ve been to four or five different schools all together, and I think Ferris, the instructors there, that core team, were always very professional, courteous. [They] set standards and expected you to get done….I felt that it’s always a good program that way.

Due to starting his HVAC-ET experience at an off-campus site, Connor is a bit of an anomaly. However, his description of his first encounter with one of the faculty during his first course involves the same faculty who taught in the online program, so his comments are relevant here. “[The professor] was very gracious and very nice to work with, and was actually probably the perfect guy out of all the people that I’ve gone to school with.” As discussed earlier, Connor also had strong feelings for the help he received from his advisor, crediting a “little piece of that degree on the wall” to him.

His positive feelings were not limited to the professors and his advisor. His overall experience with admissions, the distance learning office and the bookstore were all positive. He used experiences he had with another institution as a comparison to explain why he was so pleased with the customer service he received from Ferris. In describing the difficulties he had elsewhere, he said:

It’s like working with government employees. They want everything perfect, they don’t really want to tell you how to make it perfect, so they’re not telling you what you want. It was so frustrating…it was like they were looking for reasons not to help you.

In comparison, Connor said, “I never once had that feeling at Ferris.” He described his conversations with the distance learning office, and how the people there
were always helpful and courteous. Using the Ferris bookstore as an example, Connor said:

If I called the bookstore, they were always very helpful and they always seemed cognizant of the fact that I live in [another state]. You know, “if I need to get him a book or whatever I need to help him with, obviously he can’t come to the bookstore to help himself”….They were always helpful.

Summarizing, Connor said, “One thing that I will say very positive about Ferris. The team there really customer focused. I hope they never lose that thinking.” Adding a humorous conclusion, he ended this topic of conversation with an analogy that perhaps best explains his feelings: “I never had somebody who made me feel like I was trying to apply for a driver’s license!”

Bill credits his degree in part to “all the help from the people at Ferris State.” Like Connor, he had kind words for not only the faculty: “The people that I worked with were very knowledgeable;” but also for his advisor, who he said was “very helpful as far as pointed out the things that I needed to do…[the advisor] laid out the road map and it got me there.”

Dave actually met one of the faculty personally before enrolling in the program, and credits that professor with counseling him to apply for admission. During the conversation, the professor “really encouraged” him to pursue his bachelor’s degree in HVAC, and so he finished up his associate degree and transferred to Ferris to begin work on his baccalaureate. Dave also spoke of faculty who were memorable to him based on personal interactions and even those who he knew only through electronic lectures and never met face to face. To maintain the confidentiality of the professors, it is not possible
to provide a direct quote from Dave, but it is possible to quote the superlatives he used, such as “Just a great instructor;” “Those guys were just fantastic;” and speaking of one of the sets of lecture disks, “I can still remember listening to that, listening to him go through it, it was just a fantastic lecture.”

When speaking of the support systems at Ferris, Dave, like Connor, had positive comments:

One of things that makes a big deal is the bookstores. You know as far as getting your materials from Ferris, I never really saw a problem. Once in a while you know there would be a little bit of a delay, but I don’t remember that we ever started a class without our material.

Tom spoke in both specific and general terms about his positive feelings about the teaching staff at Ferris. The following direct quote sums up his thoughts about the faculty:

It was really great having a lot of good interaction with the faculty at Ferris. I thought the faculty was really sharp. They know a lot and I was impressed with that. They were very knowledgeable of their areas. They kind of guided me and I learned so much from the college. I appreciate all of the instructors you have working for you there, and I think they do an excellent job.

While he spoke in superlatives about the overall program Tom singled out some of the courses as examples of those that he thought stood out. The very first course was one that made an impression: “We started into the piping, and the pumps....I really thought that was really good. And I thought he [the professor] did an excellent job and along with that the psychrometrics.” He also spoke of a course that was completed during
the summer when the students traveled to campus for a five day learning laboratory experience: “When we were there for the summer, uh the psychrometrics; that was probably some of the best psychrometrics training I’ve ever had. I even brought that back and now I use it.” Finally, he cited the direct digital controls (DDC) portion of the course, which is comprised of two online courses and a summer laboratory held on campus: “I also thought the DDC was great…that was an excellent portion of it, too.”

Social/atmosphere. Many of the social aspects of college can be lost in the online format, particularly when the students are scattered across the country as they are in the HVAC-ET online program. Yet the subjects managed to find social interaction with fellow students and with the faculty and staff of the university and find meaningful relationships in the process. More than half of the subjects spoke in positive terms about some social aspect of their experience with the HVAC-ET program. One theme emerged related to the summer laboratory courses that all online students attend during their first summer in the program. By the time they arrive on campus, they have been working with each other and with the faculty for nearly a year. Their time on campus provides the opportunity meet each other, to see what each other looks like, and to make some human connections.

Connor ended up with a surprise friendship out of the online program. As it turned out, one of the other students lived nearby and is an Army veteran. Connor is also a veteran, so they shared a common bond and a close geographic proximity. What started simply as a study partnership grew into a friendship, much like a typical campus relationship. “We’d go to each other’s home….We studied together, did stuff together…It just kind of worked out.” Connor said, “I was surprised, I really didn’t
expect having a friend out of the deal.” He continued, “I just didn’t expect to actually have any camaraderie or anything with anybody… I think it turned out to be a little more of the normal classroom experience that maybe I would have expected.”

Dave:

Going back there in the second summer was quite interesting. It was a very different experience to go through the cohort with all these different students. But you know you’d converse from time to time and once in a while you’re on the phone talking to them, and then to finally get back there and meet them, ah yeah, that was pretty significant. And then to get to meet the instructors… I think it was well worth it.

Greg:

I really enjoyed the… weeklong [summer] lab session [on campus]. I thought that was great. I hadn’t been up there [to Ferris] since I left in 98, and some of those guys, they’d only seen Ferris on the computer. And I think it helped them out a lot, and me too. Like I said, it was nice to go in there, work closely with some of this technology and get a little more hands-on stuff that I hadn’t had the opportunity to be on so much, you know the controls systems, um, instrumentation and that kind of stuff.

Tom:

As I went on [in the program] I got introduced to students that were online and we formed a network where we could discuss things with people from different parts of the country… We would actually take the assignments and work in the assignments… Then we went up for the summer and it was really great during the
summer session where we actually had hands-on.

Steve spoke of the social aspects of both the summer session on campus and the interaction during the courses. On the summer session:

I thought that, even though it was halfway across the country, I felt it a real good opportunity to see the equipment and investment in technology in the building [and] to meet with some of the other students. I think the benefits are tremendous, just seeing the technology interacting in the classroom was pretty powerful….I think that the time spent at the university interacting was very good.

Though the online subjects in this study were typically non-traditional students who were generally older than the campus subjects, this demographic does not represent all campus and online students. In the following quote, Steve talks of younger online students. They were not subjects of this study, but were students in his cohort. On interaction during courses, Steve said:

The online flexibility and platform of interaction with other students also, some of which were younger and out of school working and looking for an online solution in Michigan, but also other folks around the country who were working in the various capacities, it was good to get to know them and to communicate with them.

*Online assets.* To introduce this section, the researcher has provided some background information to help the reader understand the delivery of the HVAC-ET online program. At the time the program was developed, the researcher served as chair of the HVACR Department and was intimately involved in the planning, development,
coordination, pilot and launch of the online program. The discussion that follows stems from that experience.

Since the HVAC-ET online program culminates with the same degree as the campus program, it was important for it to be identical to the campus program in every way possible. Faculty analyzed each course objective to determine if it could be accomplished online or would require students to be physically on campus. Since most laboratory work in the HVAC-ET program is performed using proprietary industry software, faculty discovered that nearly all objectives could be completed online. Only the first two courses (HVAC 331 and HVAC 312) contained objectives that could only be done on campus. These objectives were “peeled out” of HVAC 331 and HVAC 312 placed into two new laboratory courses held on campus during the summer. New online versions of the courses, designated HVAC 332 and HVAC 313 were created, and each was reduced by one student credit hour. HVAC 332 became the first course the online students took in the fall semester, followed by HVAC 313 in the winter. During the following August, students traveled to campus for five consecutive days to complete the remaining objectives, which had been placed in the two new laboratory courses. These courses each carried one student credit hour to make up for the one that had been stripped from the source course. The laboratory courses were designed as HVAC 333 and HVAC 314.

In total, the HVAC 332 online course combines with the HVAC 333 summer lab course to meet the same requirements as the HVAC 331 campus course. Similarly, the HVAC 313 online course combines with the HVAC 314 summer lab course to meet the same requirements as the HVAC 312 campus course. For all of the other HVAC courses,
As a means of making the HVAC-ET online program as nearly identical in delivery as the campus version, and to make it as personal and human as possible, the faculty had originally planned to video record each lecture as it occurred on campus and then burn the recordings to CDs and ship them to the students. The thought was to capture the essence of the campus experience so that the online students could experience it to the greatest extent possible. The faculty soon determined this to be a poor strategy. A normal classroom contains “chaff” and housekeeping information that does not contribute to the lesson at hand. Questions are asked and information is repeated during the lesson, making for a fairly inefficient transfer of knowledge. Instead, the faculty arrived at a strategy in which each lecture was broken down into short topical segments and recording using a technology provided by a company called Tegrity. The Tegrity system allowed the faculty set up the technology and record videos on their own, without additional support from campus media services. This allowed the faculty to record the lectures at their convenience and without the need to coordinate times and rooms with others. The Tegrity system was also capable of capturing computer screen images, thus allowing faculty to teach software as they navigated through it. The final product was burned to CDs, which was the technology available when the program was launched in 2003.

When viewing the lectures, students were able to navigate similar to a computer media player such as Windows Media Player. When students inserted the CD in their computer, each lecture featured a large section of the screen in which a video image of a white board, PowerPoint, or computer software image was displayed. In this area,
students could watch what the faculty was doing as he proceeded through the lecture. If he wrote on the board as he was recording, that would appear on the students’ computer screen. If he was using a software package, students would see exactly what he was doing as he described the functions of the program. And when he was presenting using PowerPoint, the students would see the presentation on their computers. A smaller “talking head” image of the professor also appeared on the students’ computer screens, allowing for some measure of human connection. A final section of the computer screen contained the file structure of the lecture CD, much like Windows Explorer.

In summary, these lecture CDs provided all of the lecture materials that faculty felt were needed to supplement written materials that were mailed to students. In reality, the written documents were a supplement to the lectures, as each course featured a series of disks containing all of the lectures for that particular course. Faculty discovered an efficiency in this method of delivery as it was possible to record only what needed saying. A lecture that may take an hour in a normal classroom could be cut nearly in half when the need to solicit student feedback or ask questions was eliminated. Faculty and students soon discovered that if a student needed more time to comprehend a portion of the lecture, he could simply back up and watch it again.

In the following discussions, online subjects reference these lecture CDs on a number of occasions. As such, the lengthy preceding explanation was provided as background to allow the reader a better understand of the meaning of the subjects’ comments.

Dave remembered the lecture disks as a positive asset for his learning. He discusses the disks he received from Ferris, as well as other materials, and compared his
learning experience at Ferris with that of his online community college degree. “When I got to Ferris, I thought the Tegrity stuff was great. The lectures were pretty impressive. I still have all the discs. Once in a while I’ll pop a lecture in. I like the disks.”

During his online experience with his community college, “they had no online lectures.” Instead, he said, “Usually once a week you would get online and do an online chat. Not voice, but a chat.” He found the lectures from Ferris to be much better and very useful, but as far as the chat-only technique used by his community college, he said, “It takes a little getting used to.”

Like any student, Dave was conscious of the cost of college, including books. Because HVAC-ET at Ferris is one of only two HVAC baccalaureate degree programs offered nationally, Ferris faculty discovered that textbooks were not available for much of the material. Instead, faculty have authored course packs that contain pertinent information from several sources, including manufacturer’s literature and personal experience. Dave speaks of these course packs in positive terms:

The good thing was is that there wasn’t that many books to buy. I mean we know how expensive textbooks are, but a lot of the things [faculty] had put together in [their] own material, they would send us a whole stack of printed material, which made it a lot more reasonable, which was a pretty good experience.

Like Dave, Tom has kept his CDs and continues to use them from time to time. For him, they have become a resource for information to use with his students. Similar to Steve’s use of HVAC 451 to create a whole new business opportunity with his company, Tom is using portions of the HVAC-ET curriculum to better explain concepts to his associate degree students.
I think CDs are the way to go because the student can get out of school and he can refer back to those CDs for years….I thought that was excellent…that is very important. I’m the type person that when I go to a class, especially one that is important in my field, I keep all that data and I categorize it and put it in notebooks or crates. And that way I can refer back to it over and over and over as I have in the past. Since I have graduated, I’ve went on numerous occasions back to my containers where I have each program or each class in, and go back to it and refer back to something that I had a question on or somebody asked me something or maybe I wanted to freshen up on something….When you have the CDs, you can actually watch your lectures and continue on from there. That’s probably the biggest thing that I enjoyed in the beginning.

For Steve, the lecture CDs were a selling point for the program and helped him decide to attend Ferris.

After comparing the Ferris program to several others…and the way that the Ferris website had sample lectures…that really sold it for me….Ferris had done a lot of work in the area of HVAC, and the online tools really, really sold it.

After beginning the program, Steve found the CDs and a timeline from the faculty to be a good time management tool for him:

I liked it in just looking back because the first class we had gotten some CDs for the lectures so we able to actually listen to the recorded lectures prior to doing the work so it made it very structured from that perspective…You could go and do two or three lessons in advance…you knew what the time frame was that you had to complete the different assignments or lectures, and you were able to look at the
time involved into that in advance and plan your schedule accordingly.

Bill also spoke of the lecture disks, as well as the course management system. He said, “I remember my first set of lecture disks that I got,” and described the work as “pretty rigorous.” Referring to the course materials, he remembered that “a lot of things were supplied on CDs….There was a lot of material, a lot of references,” and thought overall that “it worked out well.”

**Theme Five: Well-prepared graduates**

This study is centered on the concept of CTE and its underpinnings as education for work (Rothwell & Gerity, 2008; Reese, 2002; Rojewski, 2002; Stone, 2002). It follows that a theme related to work would emerge from the data derived from a qualitative study of the graduates of a specific CTE program, and indeed it has. Every subject spoke of their experience on the job and how they perceived the HVAC-ET program related and contributed to their experience in the world of work.

Of note are three facts that differentiate the online subjects from the campus subjects relative to the world of work. First, for the campus subjects, their internships were significant features of their HVAC-ET experience. The internships led to full time employment, provided the connection between school and work, and helped the students mature. The online subjects did not serve internships. Though the internship was required of them, their HVAC-ET related job experiences allowed them to earn their internship credits through a proficiency-by-portfolio process. And since they had an average of 15.5 years of work experience, the internship would not have provided the same meaningful introduction to the world of work as it had for the campus subjects.

Second, where the campus subjects felt they entered the job market at the deep
end of the pool, the online graduates had already been in the “pool” for years, so while this was a significant experience for the campus subjects, it was not a factor for the online subjects. Third, the campus subjects had measured themselves against their coworkers who had graduated from other institutions, and often with a degree in mechanical engineering. The campus subjects had felt they were better prepared than their counterparts. That experience did not emerge with the online subjects as they were seasoned veterans with significant expertise even before the earned their HVAC-ET degree, and so there was no need for them to find a benchmark against which they could measure themselves.

Though all of the online subjects had previous experience in the industry, Tom, Dave, and Bill, who had all either already transitioned, or were about to transition into new careers as educators, needed their baccalaureate degree to either secure or retain the job. Connor, with over 20 years of HVAC experience, lost his position one month before graduation due to a corporate buyout and the subsequent restructure. While he will never know if he could have landed a new job without his HVAC-ET degree, he said it definitely helped. Nathan’s story is almost identical, except that Nathan lost his long-time corporate job before he started back to school at Ferris. Like Connor, he used the degree to land a new job, but with the expertise he had from his years in industry, will never know if the lack of the degree would have prevented him from finding employment. Tyler did not need to the degree to keep his job, but did need it to secure a promotion within the same company. For Greg, the degree was simply meant to provide a bachelor’s degree that would allow him to advance in a manufacturing setting totally unrelated to HVAC. Ultimately, fate intervened and the degree led him back to the HVAC industry.
As part owner of his company, Steve is the only online subject whose degree did not factor into his current position. His story is one of self fulfillment.

Because CTE and careers are so closely linked, the story of each subject follows, as told in their own words. The purpose of the extensive quotations is to provide a rich accounting of the various subjects’ stories. From these accounts, the essence of their experiences in the world of work as a result of their HVAC-ET experiences emerges. Finally, the value of the HVAC-ET degree emerges as a means to enhance the careers of its graduates.

I got my degree finished literally a month after I lost my job, and [the degree] was a big help in bringing me on to [my current employer] because I was able to basically say, “look I’ve got a bachelor’s degree, it’s in the mail from Ferris State.” That helped justify my income, my level of experience, and it was probably also, you’re not always justifying just your own salary and everything, you’re justifying their decision in hiring you by having that degree. I mean they’re able to put that on the little letter that kind of introduces you to everybody else and if they just said it was a two-year degree, they might be also questioning the guy that hired you. The fact was I got interviews I would have never gotten, because that was kind of the gatekeeper that I couldn’t get past before, as far as you must have a bachelor of science, an engineering background type of degree. And in the past, jobs I wouldn’t have gotten even a call for, I was now getting interview requests, at least a phone interview, so it was helpful in opening doors that would have been shut otherwise. Frankly, without the degree, I probably would have been in real trouble with this economy.
Nathan talks about his thought process when he got laid off before starting the HVAC-ET program at Ferris.

I’m getting laid off here and I really don’t have a four-year degree. I got a ton of experience, and that will get you a long ways, but just look at the environment now. I mean, you know I would say just having a bachelor’s degree is a minimum now days…. So anyway, in 2004, or at the end of 2003, got laid off and at that point it was kind of like well, clean sheet of paper here, so…I’m gonna go back to school on line here…and I started a HVAC business there, did mostly light commercial work and ah, while I was you know going to school.

When asked if the HVAC-ET degree helped him secure his new job, Nathan provided an assessment of his degree combined with the extensive experience he had previously attained in the field. Because of his past experience, he really does not know to what extent the degree played a role in the company’s decision to hire him, but he did think that it was likely a combination of the two.

I think so, I mean, it not something they said, “Oh, you gotta have this degree.”

But I think it’s a combination, I mean, there are some others within the organization that knew about that degree and some other people in the organization that have it. But it was generally a combination of experience and the degree I think, you know, I think that got me in the door.

Like Nathan, Dave was not sure how much his new degree factored into his new job, but the degree added a layer of credentials that he would have otherwise been lacking. Dave had worked for his local country government as an air conditioning technician, and taught part time at a local community college. The full time instructor let
Dave knew that he had plans to retire and recommended that Dave pursue a baccalaureate degree. With only industry credentials, Dave had to first complete an associate degree before beginning the HVAC-ET program at Ferris. Though the path to the full time instructor position was paved for him by his mentor, the job was not a given without the HVAC-ET degree. He said:

I knew that this is what I was preparing myself for, so the degree itself, if I didn’t have it I possible could have gotten the job with the associate degree, but really having this specific degree in HVAC really helped a lot.

The degree definitely played a role in Greg’s employment. In fact, his company found his resume on the Ferris Career Services website. Had he not been a student, the resume would not have been there and he would have never heard about the opportunity. For Tom, like Dave, the bachelor’s degree played a role in his new job as an HVACR instructor. Unlike Dave, Tom already had the position, and unlike Dave, Tom has no doubt about the role the degree played in him keeping it: “if I had not [earned the degree] I would have probably lost this job as an instructor.”

Steve was the lone online subject who was not promoted or hired by a new company with a higher level of responsibility. As a vice president and part owner of his company, there was no position to which he could be promoted, and so the degree was self-fulfillment for him, with a measure of credibility added among his peers.

Tyler moved up in responsibility in his company and likely could not have done so without the degree, despite the expertise he gained through years of experience. Corporate barriers and personal paradigms within his company prevented Tyler from being promoted to his target position without a baccalaureate degree. At his company, the
level of the degree was more important than what the degree was in, and the perception existed that anyone without a baccalaureate degree was not capable of working in elevated positions. Tyler spoke of his confidence in his own abilities and the corporate mentality that he was up against.

When you start looking at a service manager position or an account manager position or a new equipment sales engineer position, when you’re in a service technician role with the educational background that I had had prior to the four-year degree, I knew that I was capable of being able to perform in those jobs.

However, without actually having the four-year degree it made it difficult from a corporate perspective if you will, to be able to leverage myself into one of those roles. Because when you’re out in the field as a service technician, the general feeling amongst higher level employees in the company is that those technicians are only capable of being at a service technical level. Their mentality or educational background does not allow them to be able to work at a higher level, if you will. That’s no disrespect to the service technicians; it’s just the corporate mentality. They frown against moving technicians into higher level roles because past history has told them that it doesn’t always work out successfully.

So it was a challenge for me to be able to come from a service technician role and elevate myself into the roles that I’ve had since then….So to be able get the four-year degree, use that as a resume builder and also during the time of going through that program being able to convey that message to supervisors and other people in corporate roles, they knew where I was headed, they knew where I
wanted to go and it made it a lot easier for me to elevate myself out of that position….Without it I think it would have been a large struggle and I may not have gone to that point to be able to prove myself.

**Theme Six: HVAC-ET is not perfect**

Two main subthemes emerged when subjects were asked what they would change about the HVAC-ET program. Subjects noted that some of the materials they had received contained errors or were outdated. In general, the subjects expressed surprise at this, due to their perceived overall quality of the program. While they did not use this analogy, their words sounded similar to those of the owner of a fine automobile, expressing surprise and disappointment over a flaw in an otherwise high quality product. One subject went so far as to say that he felt Ferris was number one in the HVAC industry, and if they hoped to remain number one, they should update their materials.

The second subtheme to emerge related to the delay in communication associated with online learning. Subjects cited specific courses where feedback from their professor was delayed by up to a “month and a half, two months.” One subject expressed the feeling they were “drifting for several weeks at a time.” Even with normal communication lag expected when using electronic communication in the form of email, when faculty schedules did not align with student schedules, the students had no way to ask a question and get an instant response unless they happened to be in a live chat room. With full time jobs, subjects found themselves working on their courses during the nights and weekends, which were often the times when faculty were not at their computers.

Even when students were encouraged to share both the positive and negative aspects of their experiences, they seemed reluctant to say anything bad and would soft-
Connor was the most vocal when discussing issues with the program that he experience as he went through. Like the campus students, he shared his thoughts almost apologetically. One item that he thought caused stress among the students were “errors in the paperwork” that caused confusion. He explained, “On a given homework assignment, many of the same questions [were] being asked over and over again, by different sets of students.” Connor thought that many of those questions could have been prevented with clearer instructions, or by correcting errors on assignments that caused students to be “wasting time on silly stuff” rather than being “more focused on ‘how do I get this project complete?’” He talked about working with other students, spending unproductive time trying to figure out what was expected. “It was just like...all the students going, ‘hmmm, I don’t know, I got this out of it, you got that out of it?’” And then as if to apologize for pointing out the errors, Connor said, “I’m not trying to make it sound like there was thousands of them, but there are little jam ups here and there.”

Connor thought that even at its best, the inherent delay in communication encountered in the online setting caused frustration and lack of productivity for the students. Even with faculty “who respond quickly, it could still be a day, or if your schedule doesn’t allow it, it may be two days before you figure out what’s going on.” At its worst, Connor described a course where the students felt “kind of abandoned and were kind of drifting for several weeks at a time.” Needless to say, he felt that the course “wasn’t a good experience.” Again, as if to soften up his message, Connor quickly followed with, “But that was the only class.” Allowing some room for an excuse on the
part of the faculty, he began to say, “He might have had other things going on,” and then realized there was no excuse and trailed off with, “But ah, none the less…”

For Bill, delayed communication was also the issue:

The biggest downside to the program from my perspective as an online student is, in some classes it took a long time to get feedback. You would submit an assignment and a month and a half, two months would go by and there was no feedback about that. There was no grade or anything like that. And it made me very apprehensive. It’s like, man if I’m messing this stuff up I’m not going to be able to find out until it’s fresh too late.

Dave echoes the comments of both Connor and Bill regarding communication. The following quote shows the frustration that is generated by poor communication with online students:

I think it’s more of an online problem, is that you need to have pretty quick turnaround as far as on assignments and things like that. I mean there was a couple of classes that we had where the teachers didn’t. Just being able to turn an assignment in, come in a week later and look to see that they got it, and to see that you got some sort of a grade on it. But there was a few times through the process there was teachers that didn’t. You couldn’t get a hold of. To me that’s just, it, it really, you know, it’s a thousand miles away, and you can’t get a hold of somebody. It can be really frustrating.

After sharing that information, like Connor, Dave followed up by saying, “But it wasn’t bad,” as if to soften his message or apologize for offering a critique. When this occurred, the researcher would assure the subjects that any information was welcome,
both good and bad, and that they should feel comfortable and not “pull any punches.”

Tyler shared the concern about communication, saying, “The most difficult portion of the program when I went through it was communication directly back with the instructors.” He did not complain about excessively long delays. Rather, his issue was with the normal lag encountered when faculty schedules do not align with student schedules. Like some of the other subjects, Tyler shared his critique, spoke of difficulty of the communication lag, and then finished with a comment to lessen the impact of his message.

I spent the abundance of my time on the weekends doing the curriculum work. If I needed a question answered on a Saturday, it may be Wednesday or Thursday into the next week where I could get an answer back, and that was difficult because I’m trying to juggle a full time job and at the same time deal with the curriculum in the evenings or on the weekends.

The instructor’s schedule didn’t correspond with my schedule, so a lot of times it made it difficult because you may be ready to finish a task on Saturday and move on to something else but you can’t finish it for another week. The scheduling of that was kind of difficult. But we were able to manage through that.

Greg did not comment on communication issues, but did complain that general education courses were difficult for online students to take because of the limited offerings. He acknowledged that Ferris had been adding more as time went on, but for him, many of those courses came too late and he struggled to find the general education courses that he was required to take. Speaking of some of his classmates, he said:

They were having a tough time being able to take all the classes that were that
they needed to be able to finish. Especially when you’re trying to do it in California or Pittsburgh or some of the other places where these guys were coming from.

After singing the praises of the CDs and the convenience of grabbing one from his storage crates to view an old lecture, Tom complained about Ferris switching away from CDs and DVDs to streaming videos, and went so far as to say that he was kind of upset about the switch.

In the end, in the program, they started doing a lot of streaming instead of sending out CDs. Well I think CDs are the way to go. The reason I say that, the student can get out of school and he can refer back to those CDs for years....Whereas if you have to go an look on the web and find the website and if the web changes you can’t go back to it.

Tom pointed out that streaming is great, but that “everybody out here in the United States doesn’t have the best internet reception, and some people, in the rural areas, they just got land line internet, and that really doesn’t work too well.” Tom said that the CD lectures were “the biggest thing that I enjoyed in the beginning,” but when he was finishing up, Ferris was “doing away with it,” and he was “disappointed in that aspect.”

Tom did share the same thought as Connor relative to the content of some of the lectures, saying they “could be updated a little bit.” And like Connor and Dave, his comments show his loyalty to the school and his desire to offer constructive criticism without offending anyone. This verbatim comment provides an example of one of the limitations of this study. Since the researcher served as both the chair of the HVAC Department and the advisor to all online students during the time Tom was enrolled in the
HVAC-ET program, Tom and other subjects use the word “you” when they could be using the word “Ferris” in naming the program or the school. In the following comment, if Tom had been talking to a colleague at work, he would have replaced “you” with “Ferris” or “they.” The subjects’ choice of the word “you” indicates a connection with the researcher on a personal level, and may also indicate that they identify the researcher as possessing some form of control or ownership over the HVAC-ET program.

I felt Ferris was number one. It was a great school. And, ah for the number of years you all have been teaching the bachelors, um, some of the stuff is, there’s a couple little things that may need to be re-looked at to get a little of update on, but you want to stay on top and stay the number one, and right you are, so you know, just kinda, uh, with the program you could update a few things, and it would be great.

Like Connor, Dave and Tyler, Tom ends with somewhat of a disclaimer: “Those are a couple things that I seen, but it was no really negative against the school, just little minor things here and there that needed to be taken care of.”

Steve did not speak of problems with communication or any other problem for that matter. Instead, he offered a suggestion to add a course in project management to the HVAC-ET curriculum. As he said, “the program prepares you to definitely be an application engineer in the HVAC industry.” In his business, new hires are trained on the technical aspects of the industry with the goal of grooming them to be project managers. He shared is viewpoint by saying, “If there is a way to blend in introduction to project management or offer that as an option, I think that is probably worthwhile to students.”

Steve was the only online student to make such a suggestion, but he shares this view with
a number of the campus students.

Summary

Through the individual perspectives of each subject, it became clear that the HVAC-ET program provided a significant and meaningful experience in their lives. For both campus and online groups, the narrow focus of the curriculum and its strong alignment with the industry for which it prepares students provided career-enhancing opportunities and fostered very positive attitudes, strong personal meanings of pride, accomplishment, and in the case of the online subjects, validation of their expertise in the field. Further, an overall sense of loyalty to the HVAC Department was conveyed, along with a sense of gratitude for the educational opportunity, and in some cases, personal attention provided. For every subject but one, either a promotion was earned or a career was launched as a result of the degrees they had earned.

Within both groups, subjects felt the faculty and staff were professional, expert and personable. For the campus subjects, the facility that houses the HVAC-ET program was a significant source of pride. Most of the campus subjects described the Granger Center using superlatives and found it to be the ideal environment for learning about mechanical systems in buildings. For the online subjects, the lectures recorded on CDs, DVDs, and later streamed over the Internet paralleled the feelings the campus subjects felt for the Granger Center. The online subjects found the lectures to be of high value.

The campus students identified two areas of weakness in the program. The first was the lack of a learning objectives designed to develop a business acumen. The subjects found themselves better-prepared for the technical aspects of their jobs than their counterparts from other universities, but found themselves lacking in the business side of
the industry related to sales, bidding and project management. The second weakness identified by the campus students cited the lack of ABET accreditation as a factor that limits their ability to become professional engineers.

The online subjects identified two weaknesses as well. The first involved delayed feedback from the faculty, which was a source of frustration for them. The second involved stagnant educational content and errors contained course materials including electronic lectures and written material. Overall, both campus and online subjects felt the weaknesses were minor, but in the case of the online subjects, surprise was expressed over the flaws in what was otherwise perceived to be an excellent program of study.

Both groups cited social aspects of their experiences as positive attributes. For the campus students, the interaction with fellow students and faculty were cited as beneficial in making them feel a “part of the family.” For the online subjects, the relationships they developed with fellow students was cited as meaningful, while the trip they made to campus for summer laboratories was particularly meaningful, as it provided the opportunity to finally meet their classmates and faculty after a year of working together.

For both groups, general education had less meaning than the core curriculum. While all subjects could easily cite examples of direct application of their core learning objectives to their jobs, most had a difficult time relating their general education courses to work, and most had a difficult time remembering the general education courses they had taken. While some saw the general education courses as “road blocks” or courses they were “stuck with,” they also acknowledged that the courses were a necessary part of a university degree, and some cited personal interest and meaning in specific courses. Other subjects saw value in the general education courses in the broad-spectrum, though
no subjects spoke of general education as a part of their experience in the HVAC-ET program until asked specifically about it.
CHAPTER 5
DISCUSSION, RECOMMENDATIONS FOR FUTURE RESEARCH, CONCLUSIONS

Overall Summary

A phenomenological study seeks to discover and describe the essence of a phenomenon through the personal meanings of that experience from the subjects’ perspectives (Marshall & Rossman, 2006; Burke & Christensen, 2004; Bogdan & Biklen, 2003; Patton, 2002; Creswell, 1998). The phenomenologist expects these data to be diverse, scattered and complex (Marshall & Rossman, 2006). At the same time, though no two humans or human experiences are completely unique, the researcher expects to find some common ground among the differences in experiences. It is the commonality, the “essence” or “invariant structure” of the experiences that the researcher seeks out among the differences, or “variant structure” (Burke & Christensen, 2004).

In this study, though there was certainly a variety of experiences and perspectives, a number of common themes emerged that, when combined in a narrative format, describe the invariant structure of the HVAC-ET program from a phenomenological viewpoint.

Invariant structure of the HVAC-ET program

In the typical HVAC-ET experience, two critical alignments emerged. First, the program aligns sufficiently well with student needs and interests to be described as a “perfect fit” for them. Second, the curriculum aligns precisely with the design/applied engineering, controls, and energy sectors of the HVAC industry, as shown in Figure 3 (page 234). Because of these alignments, graduates perceive HVAC-ET as the premier
educational program in their field and exhibit feelings of great personal pride and a sense of accomplishment due to their affiliation with and graduation from it.

Campus graduates gained confidence in their skills and abilities through early career success and felt better prepared for their jobs than coworkers from other universities. Online graduates felt a new level of credibility as the skills and knowledge they had developed through extensive industry experience was validated through their HVAC-ET degree. Ample employment opportunities that awaited campus graduates, coupled with promotions and elevated positions for online graduates, fostered a strong sense of job security.

Subjects felt the robust, core academic curriculum was enhanced by a number of contributing factors. For both campus and online graduates, the most significant factor was a faculty comprised of experts who were experienced in a diversity of industry sectors and cared enough to devote personal attention whenever needed. For campus students, the design and function of the Granger Center provided an unparalleled venue for experiential learning, and online students considered the quality and organization of the electronic lectures and course materials to be great learning aids. Both campus and online graduates found interaction with faculty and fellow students to be an important social element of their overall experience. While online graduates had extensive previous experience, campus graduates with little prior knowledge of HVAC found both the industry-sponsored student organizations and the internship to be extremely valuable tools for building networking connections.

Weaknesses perceived by campus graduates were the lack of a contracting business class, and a program accreditation that would enable graduates to become
professional engineers. For online graduates, delayed feedback and poor communication were significant weaknesses, while outdated or inaccurate course materials were seen as minor weaknesses. Both groups were ambivalent about the general education portion of the degree, rendering it to be a non-essential element of the overall experience. A sense of gratitude was conveyed by the participants of this research, who as a group, were extremely positive about the HVAC-ET program, their experiences with it, and the preparation it provided them for their careers.

**Figure 3. Alignment of HVAC-ET with Students and Industry**

**Purpose of Study**

The purpose of this study was to investigate the phenomenon of industry-employed graduates of the Bachelor of Science in Heating, Ventilation and Air Conditioning Engineering Technology (HVAC-ET) at Ferris State University in Big
Rapids, Michigan. In particular, the researcher was interested in learning what the educational experience meant to the graduates and how they perceived they were prepared for work. And from their perspectives, what the essential elements of the program are and what changes they would make to improve it.

Existing quantitative data indicated a high level of program quality in terms of how well graduates and their employers perceived the graduates were prepared for work in specific technical areas. These data provide a measure of how well the HVAC-ET program prepares its students for employment but do not provide definitive results that lead to improvement. A goal of the research was learn how the HVAC-ET aligns with the industry for which it prepares its graduates, as judged from the point of view of its graduates. A secondary goal of the study was to establish a process by which other CTE programs may be evaluated.

**Research Questions**

**Research question one**

Research question one asked what the HVAC-ET program meant to its graduates on a personal level. The participants in this study all exhibited a strong positive attitude toward the HVAC-ET program. There was a sense of accomplishment, pride, gratitude and self-fulfillment.

The campus graduates felt a sense of pride, both in themselves and in the HVAC-ET program. They were proud of their personal accomplishment, not only in graduating with a baccalaureate degree, but in doing well in school. Best described as a “perfect fit,” the program sparked an interest that fostered a high level of achievement in students that had not always been high achievers. Participants who reported being poor high school
students, or college students who were aimlessly taking courses, found a focus in the HVAC-ET program that channeled their energy and motivated them to excel. This turnaround in performance or discovery of focus fostered a sense of pride in those who felt they were just poor students or who thought they would never graduate from college, let alone with a baccalaureate degree.

The online graduates also felt a sense of pride in accomplishment. For every one of them, the degree amounted to accomplishing a goal that had been long delayed for various reasons. With an average of just over 44 years of age, most of these participants had long worked in the HVACR industry with only an associate degree or no degree at all. With the associate degree as the terminal degree in HVACR (other than baccalaureate degrees from Ferris and Pennsylvania College of Technology), few of the online participants even knew of the HVAC-ET program. Those that did were prevented from enrolling until the program was offered online beginning in 2003. Like the campus graduates, the HVAC-ET program represented a perfect fit for the online graduates, albeit for different reasons than their campus counterparts. For all but one of the online graduates, the program represented a never-before offered opportunity to advance their education in the field they had been employed in for their entire careers. Achieving a baccalaureate degree at their age meant a great deal to these participants.

Both campus and online graduates are proud of graduating from the HVAC-ET program at Ferris State University. Though most of the online graduates live in states other than Michigan, they all had known Ferris as the premier source of HVACR education through trade journals and industry reputation. To hold a degree from a school with such a reputation is a sense of prestige to them. For the campus graduates, the
reputation of the HVAC program at Ferris was either handed down to them by family members, or was discovered as they progressed through the program and into their careers. Participants who graduated from the campus program reported being surprised at how many people knew of the Ferris program, and found their way paved by the reputation that preceded them. (This reputation acted as a double-edged sword, as campus graduates found that a lot was expected of them, finding their introduction to employment via the “deep end of the pool.”) Whether graduating from the campus or online program, participants perceived that they had earned a degree from the premier institution for HVAC in the country, and they took pride in that perception.

**Research question two**

Research question two asked how graduates perceive they were prepared for their careers. The campus graduates felt they were very well prepared for work, and found themselves with significant responsibilities in as little as six months out of school. Participants reported job duties that included substantial roles in design, energy auditing, sales and controls within their first year on the job. Their abilities inspired self-confidence and gained the confidence and respect of their colleagues and supervisors. Those who went to work for companies that had previously hired Ferris graduates found that their high performance was expected. Those who were the first Ferris graduate hired reported surprising their companies with their abilities and raising the level of respect for the HVAC-ET program within those companies.

Perhaps the term “ahead of the curve” best describes the campus graduates’ perception of their preparedness for work. As new and untested employees fresh out of college, the campus graduates found themselves working with other new employees,
many of whom were graduates of mechanical engineering schools. As discussed on page 6 and again in brief on page 177, the HVAC-ET program is essentially a subset of the mechanical engineering field. Needing a benchmark against which to measure their expertise and gage their performance, campus graduates found their mechanical engineering colleagues to be a likely and available frame of reference and found themselves better prepared to perform HVAC-related functions. Their mechanical engineering counterparts were equally prepared to learn other aspects of the job including new software programs and sales techniques.

Two key features of the program helped connect campus graduates with the industry they would be targeting for work and alerted them to the requirements of, and opportunities in, the world of work that was looming just over their horizons. First, membership and involvement in one or more of the three student organizations available to HVAC students provided multiple networking opportunities. Sponsoring associations and societies of the student organizations including The Air Conditioning Contractors of America (ACCA), The American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), and The Mechanical Service Contractors Association (MSCA) invite students to participate at the local and national level in their various conferences, conventions and expositions. Through travel to these events, the campus graduates were introduced to the breadth of the HVAC industry through personnel from various sectors of the industry including manufacturing, contracting, and engineering and came away with a new appreciation for the opportunities that were available to them throughout the United States. Conversations with industry personnel at these events gave the participants the chance to hear about the industry from those currently working in it. These
conversations reinforced the value of the curriculum to the participants as they discovered that what they were learning was relevant to their future career opportunities.

The internship served as the second key feature, connecting school to work for the participants while they were students. Where travels to conferences, conventions and expositions provided a glimpse into the real-world, the internship provided immersion. The internship required a minimum of 10 weeks of work in the industry related to the learning objectives of the HVAC-ET program. The internship took place between the participant’s junior and senior years of college. For some participants, the internship also provided the opportunity to travel to and live in a state other than their home state for the first time in their lives. As students, the participants were required to seek internship opportunities, make application for the job and follow whatever hiring procedures their potential employer required. For most of the campus graduates, the internship represented the first “full time” job they held within the HVAC industry. For all of them, it was the first time they were able to apply the knowledge they had learned in the HVAC-ET program to the world of work. The internship connected what they were learning in the classroom with the real-world, reinforced the relevance of the curriculum in their minds, and helped to build a level of self confidence in their abilities and knowledge. Exactly half of the campus graduates who participated in this study accepted full time employment with their internship employer following graduation.

For the online graduates, the term “prepared for work” had little meaning, as they had already been employed in the industry for 15.5 years on average. Instead, the HVAC-ET program provided validation for their experience, added credibility to their resumes, and broke through a ceiling that had prevented them from being promoted to an elevated
position.

Their education provided a deeper understand of concepts they either already knew or thought they already knew. Further, the program introduced them to sectors of the industry where they had no experience and added to their knowledge base and skill set. For the online graduates, the degree often meant a transition from a blue-collar job to a white-collar job. For example, three of the participants needed the degree to transition from the role of a service technician to that of an instructor of HVACR. In other cases, participants who had started with entry level jobs and moved up through the ranks over time, then lost what had become high-level jobs due to corporate restructuring. Though they had the experience and expertise, they found it difficult to be hired for jobs with similar compensation packages due to the lack of a baccalaureate degree, but were able to secure new jobs of similar responsibilities once they had earned their degree.

**Research question three**

Research question three asked what the essential (a) core-academic; (b) general education; and (c) non-academic elements were of a relevant HVAC-ET program.

*Core academics.* A stated goal of this research was to learn how the HVAC-ET aligns with the industry for which it prepares its graduates, as judged from the point of view of its graduates. Both the campus and the online graduates found the core-academic courses to be relevant preparation for jobs in the design/applied engineering, controls, and energy sectors of the HVAC industry. This is a significant finding, as these are the three sectors targeted by the core academic courses within the HVAC-ET curriculum (see
Table 2). A somewhat lengthy description of the individual core academic courses within HVAC-ET curriculum follows to provide the reader with some background and insight into the significance of this finding.

When the HVAC-ET program was developed in the early 1980s, industry stakeholders lamented the theoretical nature of the typical mechanical engineering program, and the resulting lack of practical engineering skills of newly hired graduates. In response to these concerns, the faculty started with the mechanical engineering discipline and borrowed only those engineering principles and applications necessary to pragmatically design mechanical (HVAC) systems for buildings.

Because proper HVAC system design is worthless without the application of automatic controls to operate the system in an efficient and effective manner, the curriculum was designed to incorporate a strong controls component. Based on the principle that students cannot learn controls until they learn the operation and application of systems, the program begins with an in-depth study of systems in HVAC 331: Secondary Equipment Selection and Design. The research subjects described this course as the “gateway” to the rest of the curriculum. While they found it to be challenging, they called it hard “in a good way” and proclaimed that they “learned a ton” in the course.

With 331 serving as a foundation, the first controls course, HVAC 312: HVAC Control Theory & Application, introduces students to control loop theory related to commercial and industrial comfort, process and safety applications and follows with an introduction to direct digital control (DDC), which utilizes the power of computer software to optimize system operation and efficiency.
Table 2

Crosslink: Industry Sectors and Core Academic Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Design/ Applied Engineering</th>
<th>Controls</th>
<th>Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>HVAC 331: Secondary Equipment Selection and Design</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HVAC 312: HVAC Control Theory &amp; Application</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>HVAC 342: HVAC Load Calculations and Energy Codes</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>HVAC 415: Digital Control Systems</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>HVAC 451: Energy Analysis and Audit</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>HVAC 462: Primary Equipment Selection &amp; Design</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>HVAC 499: Commercial HVAC System Design</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

HVAC 415: Digital Control Systems, the second and final controls course, provides application of theories learned in HVAC 312 as students learn to write the sequence of operation for a variety of common HVAC applications and then program systems located within the controls lab in the Granger Center. Many of the research subjects enjoyed the controls component of the program due to its hands-on nature, and several found employment in the controls industry as a result.

HVAC 331 serves as a foundation not only for the two controls courses, but also for the design component of the curriculum. The proper sizing of the heating and cooling equipment depends on the “loads” of a building. A heating load occurs during cold
months and measures the net energy that is lost to the cold outside environment. Conversely, a cooling load occurs during the warmer months, and measures the net energy gained from the warm outdoor environment, the sun, and from the people and equipment within the building. Air that enters and exits a building also contributes to the load. Students learn manual load calculation methods, and perform load calculations of actual buildings using proprietary industry software in HVAC 342: HVAC Load Calculations and Energy Codes. As the title indicates, this course also provides the application of codes and standards as they apply to HVAC system design. A number of both campus and online graduates cited using lessons learned in HVAC 342 on the job, and a number of online graduates described how they had performed load calculations prior to entering the HVAC-ET program, but either learned more about the process or discovered that they had previously been using inaccurate methodologies.

With HVAC 331 and HVAC 342, students are able to determine loads in each room of the building and then properly size and route ducting and piping systems to deliver the appropriate amount of fluids (air and water) as needed to each room. The final step in the design process calls for the selection of the “primary equipment,” which includes items such as chillers, boilers, cooling towers, and air handling units. These devices are available from a variety of manufacturers in a multitude of sizes and configurations to accommodate the needs of specific applications. In HVAC 462: Primary Equipment Selection & Design, students learn to use manufacturers’ literature and software to research and select the appropriate primary equipment. A number of both campus and online subjects work for manufacturing branch offices and perform this function as a service for their engineering and contracting customers.
As the capstone course, HVAC 499: Commercial HVAC System Design, incorporates all of the design components into a final project in which students are given architectural drawings of an existing building located in a specific city and are asked to design a complete HVAC system. More than half of the research participants cited this class as particularly meaningful because of its real-world feel, its comprehensiveness, and its demand on students to make and defend decisions involving several valid choices.

With the pervasive attention given to energy conservation during the time the program was designed in the 1980s, the curriculum was developed with energy efficiency at the core of all courses, and included two courses that focused on energy audit and analysis. Since that time, the second audit course was converted to the current capstone design course. In the remaining HVAC 451: Energy Analysis and Audit course, students conduct an in-depth audit of a functioning building located within a one-hour radius of campus. The goal of this course is to provide practical experience of the audit and analysis process, as well as the opportunity to present findings to the stakeholders of the building, such as the building owner, facility manager, or board of directors. A number of research participants reported performing exactly this type of work in their jobs, and two subjects had titles of energy engineers.

In summary, research question three represents a significant finding. The three sectors of the HVAC-ET core academic curriculum, including design/applied engineering, controls, and energy auditing and analysis emerged from the data as the three sectors of the industry for which the research participants felt well prepared. Indeed, the participants, particularly the campus participants, felt they were better prepared than their co-workers with mechanical engineering degrees. This finding indicates that the
HVAC-ET curriculum is exactly aligned with the sectors of industry for which it was
designed to prepare graduates.

*General education.* The general education portion of the HVAC-ET program did
not emerge as an essential element of the participants’ experience and education. Where
each participant could remember specific HVAC courses and even specific elements
within those courses, many struggled to remember the general education courses they had
taken. The overall attitude toward the general education courses would best be described
as ambivalent. While some subjects thought the general education courses were very
important and contributed to becoming a “well rounded person,” others saw them as
“road blocks” or courses they were “stuck with.”

It is important to note that this finding does not mean the participants found the
general education courses to have no value. At the same time, a theme did not emerge to
indicate the courses did add value. The mixed feelings of the participants may indicate
simply that the general education portion was not perceived as a significant component of
their education or experience with Ferris State University and the HVAC-ET program.

As CTE students, the participants tended to have a singular focus that included
only the HVAC portion of their degree. They know themselves as HVAC engineers and
identify with the HVAC industry, so it is perhaps no surprise that they identify so
strongly with the HVAC sector of their educational experience. This singular focus was
further evidenced through comments made by the participants relative to selecting the
HVAC-ET program due to its “narrow focus” and “concentration” on HVAC. Finally,
some of the subjects spoke of doing poorly in high school or of not being strong students.
It may be possible that their relative success and interest in the HVAC curriculum
provided a positive self-image that blurred the memory of other sectors of education that were not as interesting or did not produce the same positive self-image.

*Non-academic.* For both the campus and online graduates, the faculty emerged as an essential element of their education and experience in the HVAC-ET program. Participants cited excellent lectures, personal attention and a genuine interest in their success. Professors were described as “excellent,” “sharp,” and “very knowledgeable.” For the campus graduates, the fact that their professors knew them and knew them well was especially meaningful, as was the availability of the faculty and their willingness and even eagerness to work with students outside of class. For online graduates, the organizational skills of their professors were important. Since the students could not meet with their professors face to face, the organization of the course was a key element for effective time management. The layout and organization of the first course in particular was cited several times as an excellent and impressive example.

Not surprisingly, both campus and online graduates also cited social interaction with faculty and fellow classmates as meaningful. Campus graduates spoke of friendships they still have that formed on campus. For three of the campus subjects, friends were involved in their decision to attend Ferris, and for another, a friendship led to his current job. Campus graduates also described knowing their professor’s personalities, and even “hanging out” with them during extra-curricular activities.

Though the online students were separated by geography, they still managed to set up social networks with each other. Through the use of electronic communication tools such as email and chat, students collaborated on assignments and projects and came to know each other in the process. Inter-student phone calls were also used for verbal
communication, and in the case of two subjects, a close proximity in geography and a common bond as former soldiers led to a personal friendship that included visits to each other’s homes. Of particular meaning to the online graduates was the on-campus laboratory course held during the summer following their first year in school. This provided the opportunity to meet the classmates and faculty they had been working online with for nearly a year. More than half of the online graduates spoke positively of the summer lab and the opportunities to meet the faculty, fellow students, and perform hands-on functions in the labs.

For the campus students, social interactions with fellow students will occur as they do on campuses everywhere. The interaction with the faculty is an important theme to emerge, not because it is unique to this study or program, but because faculty have an element of control. Though beyond the scope of this research, a literature does exist that explores a so-called “teacher effect” that can contribute to higher student achievement (Moye, 2010; Lockwood & McCaffrey, 2008). The knowledge that students find meaning in their interaction with faculty should provide a motivator for faculty who are truly interested in the success of their students.

The social interaction discussed by the online graduates is also outside the scope of this study, but has been the subject of much research and is recognized as an important yet difficult component of online learning to achieve (Watson & Gemin, 2008; Beuchot & Bullen, 2005; Santhiveeran, 2005). Strategies to foster better inter-student communication and closer bonding between students should be explored, not only to increase student engagement, but to develop stronger bonds between students, and increase student retention and achievement.
Research question four

Research question four asked what changes, if any, could improve the HVAC-ET program from the perspectives of (a) pedagogy and (b) relevance. Campus graduates cited the lack of two elements in the HVAC-ET program. First, from the perspective of relevance, the lack of ABET-accreditation prevents graduates from becoming professional engineers. (See page 89 for more information on ABET.) For some of the participants, this represented a limitation in their current job. For others, earning a degree from an ABET-accredited program has become a goal, and one subject is actively working on achieving that goal. Another subject spoke about the lack of ABET accreditation, but then announced that he was not interested in doing the type of work performed by the professional engineers at his workplace.

For the faculty of the HVAC-ET program, ABET accreditation has been a topic of debate since nearly the founding of the program. Originally designed to be different from the traditional ABET-accredited engineering program that is most closely related to HVAC, i.e., mechanical engineering, the HVAC-ET program proclaims the difference in its name: “engineering technology” rather than “engineering.” This was a purposeful design, which featured the elimination of the multiple calculus courses required in a typical engineering program, as well as the traditional foundational engineering courses such as thermodynamics, fluid dynamics, mechanics, dynamics, statics and materials. Instead, the curriculum was designed with the HVAC-specific courses listed in the appendix on page 299. And rather than incorporate the first two years of a typical engineering program, the HVAC-ET program was designed with the associate degree in HVACR technology as a foundation, thus giving students the opportunity to learn
HVACR fundamentals through hands-on learning.

As discussed on page 89, a program must be EAC accredited under ABET in order for graduates to write the P.E. exam in the state of Michigan. While the HVAC-ET program could attain TAC accreditation with relative ease and with minor changes to the curriculum, no benefit would be gained for graduates. For EAC accreditation, major modifications would be required. Such modifications would eliminate many of the core-academic HVAC courses that make the program unique. Without these courses, the strength of the program and its alignment with industry would be diminished or lost.

The uniqueness of the HVAC-ET program is both its strength and its weakness. As the participants of this study established, the strength of the program is its preparation of students for, and its alignment with, the design/application engineering, controls, and energy sectors of the HVAC industry. As a CTE program, this is a measure of success. The uniqueness of the program is also a weakness. As discussed on page 32, with only one other baccalaureate degree known to exist in the United States, no national or normative assessment tools exist as benchmarks for HVAC-ET, thus the need for studies such as this. From the ABET perspective, the pragmatic nature of the program prevents the very graduates it produces from becoming professional engineers.

This represents a perplexing paradox for the faculty of the HVAC-ET program. Campus graduates spoke of their participation in the ASHRAE student competition, both in terms of the significance of the experience itself, and in the case of two subjects, of being a part of a winning team. This competition features teams from engineering schools located throughout the world, most of which are ABET-accredited.
Table 3 displays the Ferris student record in two of the three categories in this competition, and illustrates a 13-year record of top finishes. The paradox is this: Ferris students compete successfully against students in ABET-accredited programs while in school, yet are prevented from competing on the same level once they reach the workplace.

Though the participants of this study are aware of the conundrum, they nevertheless wish they could become a professional engineer. Ultimately, this was a theme that has emerged in this study for which there is no solution.

The second element cited as lacking in the HVAC-ET program by the campus participants amounts to the business side of the industry and represents a pedagogical suggestion. Participants felt they were poorly prepared for project management, estimating, sales, and similar job functions. This is an area that had been addressed by the faculty between the time the participants graduated and the time they interviewed for this study. A new course was added to the HVAC-ET program as a part of an overall curriculum improvement process in the fall of 2009. The course title and description follow:

HVAC 350: Contracting Issues in HVACR. The study of contracting issues as related to the HVACR industry. The course focuses on plans and specifications, estimating, budget issues, project management, economic cost analysis and codes and standards, all from the perspective of an HVACR professional. Lab exercises focus on application of contracting issues to a sample project (Ferris State University, 2010).
Table 3

*HVAC-ET Student Record in ASHRAE Design Competition*

<table>
<thead>
<tr>
<th>Year</th>
<th>System Selection</th>
<th>System Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>a</td>
<td>1</td>
</tr>
<tr>
<td>1999</td>
<td>a</td>
<td>2</td>
</tr>
<tr>
<td>2000</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2001</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2002</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2003</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>2004</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>2005</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>2007</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>2008</td>
<td>3</td>
<td>b</td>
</tr>
<tr>
<td>2009</td>
<td>2</td>
<td>b</td>
</tr>
<tr>
<td>2010</td>
<td>2</td>
<td>b</td>
</tr>
</tbody>
</table>

*Note.*  

- a Did not compete.  
- b Rule change prevented Ferris students from competing.

After several campus and a few online participants lamented the lack of business-related learning objectives in the curriculum, the researcher read the course description for HVAC 350 to them and asked for their feedback. Responses such as “perfect,” “that pretty much hits it,” and “well there you go, you’re ahead of the curve” confirmed that the new course meets the needs they had spoken of. From that perspective, this research confirms the need for the class and reinforces the rationale for creating it.
For the online graduates, both of the themes to emerge for improving the program were pedagogical. The first involved updating the materials, both on the lectures and written course content. With the overall quality of the HVAC-ET online program, surprise was expressed when dated or erroneous content was discovered in the materials. Connor had said, “Instead of being a continually improving program, it just seemed to kind of hold its place in time.” Though two of the participants to comment on the materials were from the original cohort and quite understood that glitches are expected during a launch, one of the participants was in the sixth cohort, by which time one might expect corrections to be made. Two of the subjects thought the professors could and should update the materials as they teach them, using the words “take care of it as you go and then you don’t have to worry about it.”

The high expectations of quality communicated by the participants of this study provide an indication of the level of effort that is required to create and maintain an online version of a high-quality CTE program. Conversely, the comments of one subject about “outtakes” in the videos may indicate that a different level of quality is expected between campus and online content. No campus participants commented that their professor had stumbled over a word in class, lost his train of thought, or made a mistake at the board. Yet some of the online participants thought the program should be “flawless” after three or four years online. Whether this expectation is reasonable or not, it is none-the-less an expectation. The challenge for faculty who develop online lectures is to arrive at a level of quality that is less polished than a professionally produced film, yet of sufficient quality to aid in the transfer of knowledge without distraction. For
The second theme to emerge from these data revolves around poor communication and delayed feedback. Though some delay in feedback is expected in online learning, participants expressed frustration even when their professor was prompt but not instant. When they were working on a project and had a question, participants said they had to wait until a response arrived. Because of their busy lives, it was difficult for them to complete work on time when their time for homework was available on the weekend and a response to a question did not arrive until mid-week when they had no time. This type of delay caused them to complete assignments one to several weeks later than they had planned due to circumstances beyond their control.

Participants also reported delays of several weeks, during which time they received no feedback whatsoever from their faculty, not even an acknowledgement that an assignment had been received. In these cases, the participants reported not only frustration but also stress due to not knowing if they were on the right track and concern over completing all of their work by the end of the semester.

There is a large and growing literature on issues with interactivity, communication, student satisfaction, and successes and failures of online asynchronous learning (Bray, 2007; Bolliger & Martindale, 2004; Burch, 2001; Valenta, Therriault, Dieter, & Mrtek, 2001). Though well beyond the scope of this study, it may be sufficient to report the general consensus that most students prefer face-to-face discussions to online discussions, even though the online discussions may be more convenient and
flexible (Wang & Woo, 2007). It seems that the online HVAC-ET students have the same issues with communication as online students in general.

Whatever level of interaction faculty might have planned during their HVAC-ET online courses, clearly the participants expected more. And while delays of several days caused frustration, they were not unexpected and the participants displayed a level of understanding. However, the delays of several weeks were clearly unacceptable to them, no matter what the reason. The area of communication represents the greatest opportunity for quality improvement in the online program. Faculty of this and any other online CTE program might take note: Prompt feedback is a critical component of a quality online program and a significant element of a meaningful learning experience.

**Practical Applications**

In a phenomenology, it is important to give full deference to the experiences of the subjects. In this study, a number of significant implications warrant consideration. Campus graduates spoke of the barrier created by the lack of ABET accreditation. Though they felt the HVAC-ET program was strong, the feeling of being held back is an implication that the leaders of the program should study closely. At the same time, it is interesting to note that the subjects were not aware of ABET while they were students. They became aware of it only after entering the world of work and discovering the difference between a professional engineer and an engineering technologist. This indicates that not enough education on the topic is provided while students are in school. It is the responsibility of the university to provide students with the best possible preparation for their jobs and careers. If the attainment of professional engineer status is a valued attribute for graduates, then the HVAC-ET program should explore every avenue
to seek a means by which the strength of the program can remain intact while providing
the accreditation that would allow graduates to become professional engineers. This
finding has implications not only for the faculty and leaders of the HVAC-ET program
and Ferris State University, but for other researchers who study CTE programs. Perhaps
there are desired outcomes of a specific CTE program of which they are not yet aware.

The repeated references to the Granger facility as an important asset to the
learning environment are another important implication for educational leaders and other
researchers to consider. The subjects felt this facility added to their educational
experience and enhanced their ability to comprehend and understand their studies through
the more tactile environment. Further, they often used the word “impressed” when
describing Granger and conveyed their feelings with an almost Disneyesque sense of
admiration. The architecture of the building factored into the decision to attend Ferris for
some of the subjects.

This seems to imply that thoughtful consideration should be given to the
architecture of learning facilities to explore means by which the facilities themselves
might not only house CTE programs, but also serve as a part of the learning environment.
While the innovations in the Granger center lend themselves to learning about the built
environment, it is possible that enhancements can be made to other CTE programs by
incorporating features related to the field of study into the facility or the surrounding
environment. Further, the sense of wonder exuded by the subjects in reference to Granger
indicates that the architecture of learning facilities can contribute significantly to the
overall educational experience of the students. A literature search to determine how the
architecture of academic structures impacts educational quality and experience was
beyond the scope of this study. While studies may have already been conducted, future CTE researchers may be interested to employ qualitative methodologies to discover if synergies exist between curricula, facilities and the learning environment.

From an evaluative perspective, the self-worth conveyed by the subjects due to skills, knowledge and abilities in their work carries strong implications for educational leaders. If workforce development is the goal of a CTE program, then graduates who feel valued in their work is a strong indicator of program success. From a phenomenological perspective, increased feelings of self-worth represents a significant means of understanding the experiences of the subjects and emerges as a part of the essence of that experience. This finding carries implications that expand and enhance CTE beyond the simple concept of workforce development. If good CTE programming instills increased feelings of self worth, it follows that employees may be more satisfied with their jobs and may be more productive. The development of a competent workforce is one thing. Individuals who define their self-worth through the pride they take in their work is quite another. This kind of win-win concept is another area that might be explored with future research in CTE utilizing qualitative methodologies.

The significance of the social interaction with both faculty and fellow students carries implications for educational leaders to consider as a factor in the quality of the education that students receive. This factor has obvious implications on class size, as the reduction in the potential for student/faculty interaction varies directly with class size. While larger class sizes result in higher academic production and reduced demand on financial resources, educational quality suffers when measured by the faculty to student interactions that emerged from this study as a part of the essence of the subjects’
experience. If faculty to student interaction is so important to students, whether on
campus or online, educational leaders must consider this carefully when course capacities
are under discussion.

In addition to providing information regarding the phenomenon of being a
graduate of the HVAC-ET program, participants were also asked to consider what, if any,
changes they would make to the program. The responses to the questions posed during
this study provide thoughtful insight for both the faculty of the HVAC-ET program and
for others who wish to consider foundational elements of a quality CTE program, or who
may wish to make improvements to an existing program.

With the long history of CTE as workforce development or education for jobs
(Rothwell & Gerity, 2008; Cohen, & Besharov, 2002; Sheppard, 1931) and federal
legislation to regulate that education (Stone, 2002; Mobley, 1964), this study reinforces
the importance of a curriculum that is aligned with the industry for which it prepares its
students and provides strong evidence that a unique CTE program can and does have a
role in the current educational system. The strong feelings of the participants that the
HVAC-ET program perfectly fit their needs, provided excellent preparation for their
careers, and fostered a strong sense of job security seem to indicate value in narrowly-
focused CTE curricula.

From the perspective of credibility, though the public perceives CTE as
something less than academic (Cohen & Besharov, 2002), the pride projected by the
participants of this study indicate just the opposite. Career success and the strong national
reputation of the HVAC-ET program instilled an attitude of superiority. This carries the
implication that quality CTE programs can and do measure up to academic programs. It
follows that efforts to improve the quality across the spectrum of CTE could improve its perception in the public eye. An important distinction must be pointed out: the HVAC-ET program is a baccalaureate-level degree. This is an anomaly within CTE, as the vast majority of programs exist at the secondary or associate degree postsecondary level. Perhaps this study makes an argument for elevating more CTE programs to the baccalaureate level.

Much work has been done to recognize the importance of integrating general education outcomes across all curricula including CTE (Humphreys, 2009; Meeder, 2008). The ambivalence of this study’s participants indicates that from the students’ perspective, that recognition is not clearly evident.

**Opportunities for Future Research**

This research focused solely on the perspective of the graduates of the Bachelor of Science in HVAC Engineering Technology from Ferris State University in Big Rapids, Michigan. As a qualitative study, a small number of subjects were interviewed using open-ended questions to obtain in-depth and rich information about their experiences as a student and a graduate. The results indicated that the program has a very strong position in the market via an exact alignment of the curriculum with the industry sectors of design/applied engineering, controls, and energy. No need for changes to the core academic curriculum was identified, though additions were recommended. For example, participants felt that a contracting business course would enhance their preparation for employment, and this recommendation confirmed the need for just such a course launched one academic year prior to this study.
The results of this study are valuable to all of the stakeholders of the HVAC-ET program. The rich narrative provides a much deeper understanding of program quality and relevance from perspective of perhaps its most critical stakeholders: the graduates working in the industry for which they were prepared. This study builds a foundation and provides a procedure for further research of specific CTE programming using a phenomenological methodology.

The results of this study represent a viewpoint of the HVAC-ET program from the perspective of its graduates. Several questions could be asked, such as: Do their employers perceive them and the HVAC-ET program in a similar manner? A study to interview the employers of HVAC-ET graduates would provide rich data against which the results of this study could be compared. Similarly, this study identified a difference in the perspectives of traditional campus graduates and non-traditional online graduates. The campus graduates felt they were prepared better than their coworkers who had graduated from mechanical engineering programs. While the online graduates felt they were well-prepared, they did not use such a comparison. Does this mean that the relatively inexperienced campus graduates hold a naïve perspective? Perhaps they are better prepared initially, but what happens after their first three years of employment? Do the mechanical engineering graduates catch up or even surpass the Ferris graduates over time? A similar study of mechanical engineering graduates (and their employers) would illuminate a different perception of their skill set in the workplace. The results of such a study may reinforce the recommendation made by campus graduates to accredit the HVAC-ET program under ABET in order to enable its graduates to become professional engineers.
Studies of HVAC-ET graduates five to 10 years and 10 to 20 years from graduation would provide a wealth of data from a longer viewpoint. How have they advanced in their careers? Did they remain in the HVAC industry? Has their education remained relevant? Does it still hold meaning for them? What value has general education held for them?

The results of this study are strong, though the literature suggests that evaluation in education is weak. Beyond the HVAC-ET program at Ferris State University, studies such as this could prove valuable for most any CTE program. Though this study was conducted as a part of a dissertation and required a significant amount of effort, the essence of the study could be replicated with much less formality and produce equally rich data. Such a study could be incorporated as a part of a cyclical self-study, such as the Academic Program Review utilized at Ferris State University, as discussed on page 12. Publication of the results of such studies would begin to strengthen the literature related to evaluation in education, and in CTE in particular.

The implications discussed under practical applications above suggest other areas that warrant further phenomenological study in the broader CTE field. How can the architecture of the academic facility enhance the learning of the student and contribute to the overall educational experience? What meaning do other CTE programs have for the graduates? What are the essential elements of other CTE programs from the perspective of the graduates? How does CTE contribute to the self-worth of graduates in the workforce? What are the essential elements of faculty to student interaction? How do faculty to student and student to student social interactions affect the overall educational experience of the graduate? The rich data provided from this narrow and deep qualitative
study paves the way for other research to follow. The questions above represent but a few of the topics that could be explored by future research.

Conclusions

A number of conclusions can be drawn from this research. First and foremost, the educational experiences of both the campus and online graduates generated feelings of pride, accomplishment and self fulfillment. Participants were proud not only of their personal accomplishment, but also of the program from which they graduated. Their perception of the HVAC-ET program as the premier HVAC education in the United States exemplifies the depth of their pride. The perceptions of both the campus and online students represent a broad spectrum of life experience, industry experience, and responsibility. The campus participants represent the relatively young and traditional student demographic. With an average age of roughly 24 at the time of graduation, and with virtually no industry experience, their exuberant assessment of their early career success is perhaps tempered by the lack of a test of time. Conversely, the level of responsibility they have assumed as soon as six months into their careers is certainly a testament to their preparation and skill set.

At the other end of the spectrum, the online participants represent a non-traditional student demographic. Averaging 20 years older than the campus graduates and with an average 15 years of industry experience, the online graduates had gained life skills and progressed through their careers. Some have children as old as the campus graduates and are essentially one generation older. As a group, these participants knew of Ferris and the reputation of the HVACR programs through articles in national trade magazines before they started in the program. They arrived with high expectations, so
their perception of the quality of the program and expressions of personal pride are significant statements.

Equally significant is the confirmation that the HVAC-ET program is relevant in terms of its alignment with the industry for which it prepares its graduates. The three sectors of the HVAC industry which emerged as those for which the graduates felt they were superbly prepared were the same three sectors targeted by the faculty in 1984 when the HVAC-ET program was first launched in its on-campus version. The level of quality and focus perceived by both campus and online graduates affirms and validates the relevance of the program, the focus of the curriculum, and the work of the faculty. This study resulted in positive feedback, but the results would have been equally valuable had they been negative.

As with anything, there is room for improvement. Through previous work with alumni and employers, faculty had identified the need for a contracting business class and added the new class to the curriculum in fall 2009. This study confirmed the need for that class and added a level of validity for its place in the curriculum. As with any curriculum, the participants reinforced the need for continuous improvement of content. Though the expectation for flawless materials may be a bit high, the message that improvements are needed came across loud and clear.

The desire of graduates to become professional engineers has been and continues to be an issue with no apparent solution. To be qualified, students must graduate from a program accredited by the Engineering Accreditation Commission (EAC) of ABET. Inclusion of courses required to align with EAC requirements would necessitate the removal of core-academic HVAC courses, which would weaken or destroy the narrow
focus of the program and render it similar to any number of engineering programs already available throughout the United States. Without additional years of school, there appears to be no solution that could combine both the strength of the narrowly focused HVAC-ET curriculum with the broad-spectrum, foundational engineering principles of an ABET EAC accredited program.

The most pressing need for improvement involves communication in online classes. For the faculty of the HVAC-ET program and for any reader who teaches online, the participants sent a strong signal that minimal delay is expected when waiting for online feedback. Despite the deficiencies identified, subjects were overwhelmingly positive about the HVAC-ET program, their experiences with it, and the employment they had achieved as a result of it.
REFERENCES


Bozick, R. & Macallum, K. (2002). Does participation in school-to-career limit students’ educational and career opportunities? Findings from the LAMP Longitudinal


Chickering, A. (2009). *Why are we here: To serve the market or to strengthen democracy?* [Presentation notes]. Big Rapids, MI: Ferris State University


Lewis, M.V. (1999). *An examination of the standards established by the accrediting commission of career schools and colleges of technology*. A report prepared for


Atlanta, GA: American Society of Heating, Refrigerating, and Air-Conditioning Engineers.


Peter D. Hart Research Associates. (2004). *Qualitative research for the association of American colleges and universities. Key findings from focus groups among college students and college-bound high school students.* Washington D.C. Author.


Welch, W., & Reineke, R. (2002). A study of advisory committees used by ATE projects and centers final report (part B). Kalamazoo, MI: The Evaluation Center,


Appendix A

HSIRB Approval Letter
Date: June 15, 2010

To: Richard Zinser, Principal Investigator  
   Michael Feutz, Student Investigator for dissertation  

From: Amy Naugle, Ph.D., Chair  

Re: HSIRB Project Number: 10-06-08

This letter will serve as confirmation that your research project titled "The Phenomenology of the Bachelor of Science in HVAC Engineering Technology for Ferris State University" has been approved under the expedited category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note that you may only conduct this research exactly in the form it was approved. You must seek specific board approval for any changes in this project. You must also seek reapproval if the project extends beyond the termination date noted below. In addition if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: June 15, 2011
Appendix B

Consent to Participate in Study
Western Michigan University
Department of Family and Consumer Sciences

Principal Investigator: Dr. Richard Zinscr
Student Investigator: Michael J. Feutz
Title of Study: The Phenomenology of the Bachelor of Science in HVAC Engineering Technology from Ferris State University

You have been invited to participate in a research project titled "The Phenomenology of the Bachelor of Science in HVAC Engineering Technology from Ferris State University." This project will serve as my (Michael J. Feutz) dissertation for the requirements of the Doctor of Philosophy in Educational Leadership (CTE Concentration). This consent document will explain the purpose of this research project and will go over all of the time commitments, the procedures used in the study, and the risks and benefits of participating in this research project. Please read this consent form carefully and completely and please ask any questions if you need more clarification.

What are we trying to find out in this study?
The purpose of this study is to gain a better understanding of how well the Bachelor of Science in HVAC Engineering Technology from Ferris State University prepares graduates for careers in the HVAC industry. In this case, I am interested in the experience of graduates of the bachelor's in HVAC Engineering Technology (HVAC-ET) as a means to learn more about how well the degree prepares students for their jobs in the industry. Rather than measuring student performance in school, I am more interested to learn how graduates were able to apply that learning on the job. This information will provide a more powerful assessment of the program and could lead to quality improvement.

Who can participate in this study?
I will be interviewing graduates of the HVAC-ET program from the past three years (2007, 2008, 2009) who have worked at least 12 consecutive months in the industry. For this study, research subjects will be asked to relive their educational experience. As such, it is important to recruit subjects who are not too far removed from their educational experience.

Where will this study take place?
Subjects for this study are located throughout the United States. Due to time and budget constraints, all interviews will be conducted by telephone. Though some subjects live near me in Michigan, I will conduct all of the interviews by phone to maintain consistency in protocol. If you consent to participate in this study, I will schedule the interview with you at a time and location that is convenient for you. A relaxed atmosphere will best allow you to respond thoughtfully and comprehensively, so I will ask that you seek a location that allows our conversation to be as free from interruptions and distractions as possible.
What is the time commitment for participating in this study?
The time it takes to read this document may be 10 to 15 minutes. A follow-up phone call to discuss the study and your willingness to participate may take up to 20 minutes. The actual interview will take one hour or less. A follow-up interview of a shorter duration may be necessary to clarify information or ask further questions. Once the interview has been transcribed, I will send an electronic copy to you via email, and ask you to review the transcript to ensure accuracy and to allow you to provide additional information or clarification if you choose. Depending on the amount of additional information you may add, the time commitment for this portion is difficult to determine. I anticipate your total participation to require no more than four hours in total over a span of up to ten weeks.

What will you be asked to do if you choose to participate in this study?
If you consent to participate in this study, I will email the interview questions to you ahead of time so that you have time to thoughtfully prepare. During the interview, I will ask you to speak freely in response to those questions. I will be interested only in your perspective during our conversation. All of the questions are open-ended. This allows you to respond in a manner that is most meaningful to you. I will also email written transcripts of our conversation to you and ask you to review them. You may wish to clarify a point or provide additional thoughts. A short follow-up interview may be necessary, with your consent.

What information is being measured during the study?
In this study, I seek your perception of the quality in the HVAC-ET program based on your experience in the workplace. Ferris State University conducts an Academic Program Review every five years. That study told us how graduates and employers rank various predetermined measures of quality, but it did not tell us why a good or bad ranking was selected, nor did it tell us how we could make improvements. In this study, I will be seeking your point of view to learn why the program did or did not serve your needs, and to learn how it can be improved.

What are the risks of participating in this study and how will these risks be minimized?
Known risks to you are limited to the inconvenience of your time and the potential for your responses to be made public through the dissertation dissemination process. All dissertations are published and made available to other researchers, so some of your responses may be quoted in the dissertation and subsequently published. However, your name and other identifying factors will be kept strictly confidential. If a name is needed in the dissertation to improve readability, a pseudonym will be used. Other identifying information will be masked. For example, a subject in New York City may be identified as “a graduate working in a large eastern city.” Interviews will not take place until you have signed this written consent.

What are the benefits of participating in this study?
As a participant in this study, you may find benefit in knowing that you have helped improve the quality of the HVAC-ET program. Your responses will also provide a chance for you to reflect on your own experience in the HVAC industry and may contribute to your own self-satisfaction.

Are there any costs associated with participating in this study? You have the option of mailing this consent form using your own stamp. If so, you will incur the cost of the stamp. Otherwise, I will supply you with a pre-stamped envelope. There will be no other costs to you for participating in this study unless you use a phone that charges you for minutes used. If that is the case, you may want to consider using a phone that can receive calls for no charge.

Is there any compensation for participating in this study? There is no compensation for participating in this study.

Who will have access to the information collected during this study? I, the researcher, am the only person who will have access to the transcripts of the phone interviews. As mentioned earlier, the dissertation will be published, though your identity will be kept confidential through the use of pseudonyms and masking of other identifying characteristics.

What if you want to stop participating in this study? You can choose to stop participating in the study at anytime for any reason. You will not suffer any prejudice or penalty by your decision to stop your participation. You will experience NO consequences if you choose to withdraw from this study.

The investigator can also decide to stop your participation in the study without your consent.

Should you have any questions prior to or during the study, you can contact the primary investigator, Dr. Richard Zinser at 269-387-3007 or richard.zinser@wmich.edu. You may also contact the Chair, Human Subjects Institutional Review Board at 269-387-8293 or the Vice President for Research at 269-387-8298 if questions arise during the course of the study.

This consent document has been approved for use for one year by the Human Subjects Institutional Review Board (HSIRB) as indicated by the stamped date and signature of the board chair in the upper right corner. Do not participate in this study if the stamped date is older than one year.
I have read this informed consent document. The risks and benefits have been explained to me. I agree to take part in this study.

Please Print Your Name

Participant's signature Date
Appendix C

Interview Protocol
Interview Script for HVAC-ET Graduate Subjects

Project: The Phenomenology of the Bachelor of Science in HVAC Engineering Technology from Ferris State University

Date: 
Place: 
Interviewer: 
Interviewee: 
Position of Interviewee: 

Thank you for consenting to participate in this study. I would like to record this interview so that I can be as accurate as possible for the study. At any point during the course of the interview, you may ask that I turn the tape recorder off.

Questions that the subjects will be asked include:

**Demographic questions (not audio recorded):**
To begin, I’d like to collect some demographic information about you.
1. What is your age?
2. What is your educational background?
3. Can you tell me the name of the company you work for, where it is located, and how your job title responsibilities have evolved since you joined the company?

**Interview questions (audio recording begins):**
From your perspective as a graduate of the HVAC-ET program at Ferris State:

1. I am interested in learning as much as possible about your experience, first as a student in the HVAC-ET program, and then as a graduate working in the industry. Please begin by telling me the story of your experience as a student going through the HVAC-ET program, what it was like for you and what it meant to you. It would be helpful if you started by describing how you came to be a student in the program, what it was like when you first arrived, and how you felt as you worked toward your degree.

2. Tell me about working in the industry as a graduate. Please begin by describing how you got your job, what it was like as a new hire and how you feel you have progressed up until today.

3. Let’s look at those experiences, what stands out as significant from your perspective?

Thank you for participating in this interview. May I contact you for follow-up interviews or to clarify some of your responses?
Appendix D

Email Correspondence/Telephone Script to Potential Participants
Recruitment Email Script to Potential Participants, First Contact

Dear _______

My name is Mike Feutz and I am inviting you to participate in a study of the graduates of the Bachelor of Science in Heating, Ventilation and Air Conditioning Engineering Technology (HVAC-ET) at Ferris State University in Big Rapids, Michigan, and their perception of their educational experience and their experience in the industry. This study is being conducted in partial fulfillment of a Ph.D. in Educational Leadership through Western Michigan University. I am the student investigator in this study (616-260-0452, feutzm@ferris.edu). The supervising professor is Dr. Richard Zinser (269 387-3007, richard.zinser@wmich.edu).

You are being invited to volunteer as a participant because you are a graduate of HVAC-ET at Ferris State University from the year 2007, 2008 or 2009. This study will be restricted to graduates from those years who have worked at least 12 consecutive months in the industry. If you choose to participate in this study, you will be asked to participate in a phone interview lasting no more than 60 minutes, at a time and location that is convenient for you. You will be asked for your thoughts and observations about your experience as a student of the HVAC-ET program and as an employee in the HVAC industry. Following the interview, a transcript of the interview will be sent to you by email, to provide the opportunity to verify the accuracy of the content, and to allow you to elaborate or clarify information if you feel it is necessary. If you choose to review the transcripts and provide further information, the process could take two hours or more. You may also be asked to participate in one or two follow-up phone conversations lasting less than ten minutes each, if clarification of your initial interview is necessary. Email may also be used to contact you throughout the study, however clarification of information will be done by telephone, unless you have a private email account that you are willing to use for this purpose. Overall, your participation will require approximately one and one-half hours of your time at a minimum, and up to approximately four hours of your time at a maximum, depending on your level of involvement in transcript review and verification, elaboration and clarification of information.

Your interview responses will be kept strictly confidential. This means that your name will not appear on any papers on which information is recorded. You will be identified using either pseudonyms or in generic terms (e.g., “As one graduated explained…”), and other identifying information will be masked (e.g., “a graduate in the Pacific Northwest…”).

If you decide you are interested in participating or learning more, please feel free to contact me by email at feutzm@ferris.edu and provide a phone number that you would like me to use. I will follow-up with a telephone call within two weeks to discuss in more detail this study. I will also provide you with a written consent form for your review prior to our phone conversation. This phone call should last no more than 20 minutes. If, after our conversation, you remain interested in participating, I will ask for your signature on the consent form. A follow-up time will then be scheduled for the interview. You will also receive the interview questions in advance so you can be prepared to respond to them, should you decide to participate.

If I have not heard from you within one week, I will follow-up with a brief second email to provide you another invitation to participate. If I do not hear from you following the second email, I will assume that you have declined to participate and will not contact you again.
If you have any questions, you may contact either me or Dr. Zinser, as indicated above. Thank you for considering possible participation in this study. The results of this study may be of interest to stakeholders of the HVAC-ET program, such as alumni, employers and faculty, and may be beneficial in assisting others as a process for better understanding the alignment of Career and Technical Education programs with the industry for which they prepare graduates.

Michael Feutz
Recruitment Email Script to Potential Participants, Second Contact

Dear __________:

Approximately one week ago, I sent an email to you inviting you to participate in a study of the graduates of the Bachelor of Science in Heating, Ventilation and Air Conditioning Engineering Technology (HVAC-ET) at Ferris State University in Big Rapids, Michigan.

I have not heard back from you, so I am following up to see if you received the first email and may be interested in participating in the study. If you are not interested, please reply with an email that contains “I am not interested” in the subject line. If you are interested in participating, please reply and provide a phone number that you would like me to use. I will follow-up with a telephone call within one week to discuss this study in more detail with you.

If I do not hear back from you, I will assume that you are not interested in participating, and I will not contact you again.

Thank you for considering participating in this study. I appreciate the time you took to read the information regarding the study.

Michael Feutz
Recruitment Telephone Script to Interested Participants Randomly Selected

Hello ____________,

Within the past two weeks, you contacted me with an interest in participating in a study of the graduates of the Bachelor of Science in Heating, Ventilation and Air Conditioning Engineering Technology (HVAC-ET) at Ferris State University in Big Rapids, Michigan.

I am calling to thank you for expressing an interest in participating in this study, and to see if you have any questions that I may answer for you, or if you would like to learn more about the study. I have also sent a consent form to you via email, and we may discuss that in detail as well.

Do you have any questions?

Are you interested in participating in the study?

(IF YES)

You may sign the consent form and return it to:
Mike Feutz
2665 Ashville NE
Grand Rapids, MI 49525

If you prefer, I would be happy to supply you with a pre-stamped and addressed envelope. Once I have received the signed consent form, the interview can begin.

I will be calling you to set up an interview time as soon as I receive the signed consent for.

Thank you. Your participation in this study is greatly appreciated. Please do not hesitate to contact me via phone at 616-260-0452 or email at feutzm@ferris.edu if you have any questions prior to the interview.

(IF NO)

Thank you for considering participating in this study. I appreciate the time you took to speak with me and read the information regarding the study.
Telephone Script to Interested Participants Not Randomly Selected

Hello __________,

Within the past two weeks, you contacted me with an interest in participating in a study of the graduates of the Bachelor of Science in Heating, Ventilation and Air Conditioning Engineering Technology (HVAC-ET) at Ferris State University in Big Rapids, Michigan.

I am calling to thank you for expressing an interest in participating in this study, and to let you know that more graduates volunteered to participate in the study than can be used. A random selection process was used to select the quantity of subjects needed. Those graduates were contacted by phone to discuss the study and answer their questions.

At this time, a sufficient number of subjects have consented to participate and no further subjects are needed. Thank you again for your interest and for taking the time to read the information regarding the study.
Telephone Script for Additional Subjects to Interested Participants Not Randomly Selected for Original Interviews

Hello __________.

I had contacted you earlier regarding a study of the graduates of the Bachelor of Science in Heating, Ventilation and Air Conditioning Engineering Technology (HVAC-ET) at Ferris State University in Big Rapids, Michigan, and let you know that a random selection process had not selected your name from the list of interested graduates.

I have conducted interviews of all current participants, and the initial data analysis indicates that interviews are needed with additional participants. I am calling to ask if you are still interested in participating in the study, and if so, to discuss the study and answer any questions you may have. I have also sent a consent form to you via email, and we may discuss that in detail as well.

Do you have any questions?

Are you interested in participating in the study?

(IF YES)

You may sign the consent form and return it to:
Mike Feutz
2665 Ashville NE
Grand Rapids, MI 49525

If you prefer, I would be happy to supply you with a pre-stamped and addressed envelope. Once I have received the signed consent form, the interview can begin.

I will be calling you to set up an interview time as soon as I receive the signed consent for.

Thank you. Your participation in this study is greatly appreciated. Please do not hesitate to contact me via phone at 616-260-0452 or email at feutzm@ferris.edu if you have any questions prior to the interview.

(IF NO)

Thank you for considering participating in this study. I appreciate the time you took to speak with me and read the information regarding the study.
Appendix E

HVAC Course Descriptions
HVAC 331: Secondary Equipment Selection and Design. A study of water and air systems used in commercial and industrial buildings. Course emphasizes system design, equipment and component selection and selected problems and solutions. Instrumentation, testing and balancing will be emphasized for optimum energy conservation and maximum comfort.

HVAC 312: HVAC Control Theory & Application. The study of control loop theory related to commercial and industrial comfort, process and safety applications. The course focuses on analog electronic and pneumatic control components and their systems used in new and existing installations. Lab exercises concentrate on control system operation and analysis.

HVAC 342: HVAC Load Calculations and Energy Codes. The layout and design of energy efficient combination systems (heating and cooling) found in commercial and industrial buildings. Complete heat loss and heat gain calculations will be performed both manually and through currently available computer software. Energy estimating methods will be studied and an analysis of an actual building conducted. State of the art equipment will be selected for maximum energy efficiency. Current federal, state and local codes and standards (ASHRAE) will be examined as they apply to HVAC systems.

HVAC 415: Digital Control Systems. The study of digital electronic control of HVAC mechanical systems to maximize their operating efficiency in commercial and industrial applications. The layout, programming and operation of the building management system will be emphasized.

HVAC 451: Energy Analysis and Audit. The survey of utility rate structures, billing
energy consumption and energy profiling of commercial and industrial buildings. On-site audit projects will report on recommendations to building envelopes, HVACR systems and control systems with regard to payback. Oral and written presentations are a requirement of this senior project course.

HVAC 462: Primary Equipment Selection & Design. The layout of state-of-the-art equipment and systems for commercial and industrial buildings. Emphasis will be placed upon the appropriate alternate energy sources with cost analysis and paybacks being performed.

HVAC 499: Commercial HVAC System Design. Given building architectural plans, appropriate software, codes and standards and owner’s requirements, students will select appropriate HVAC system, conduct economic analysis, design system and produce working drawings, specifications and control sequences for evaluation.