RUSS DEATON
Interim Executive Director

STATE OF TENNESSEE
HIGHER EDUCATION COMMISSION
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BILL HASLAM
Governor

MEMORANDUM

TO: John Morgan
Chancellor, Tennessee Board of Regents

FROM: Russ Deaton

SUBJECT: Approval of the Tennessee Technological University
Letter of Application to Plan the Vehicle Engineering BS Program

DATE: December 11, 2015

In accordance with THEC policies, colleges and universities are required to submit Letters of Application for authorization to proceed with developing proposals for new academic programs and units. The THEC financial projection form for the proposed program must accompany the letter of intent to plan. Upon THEC approval to proceed with developing proposals, institutions should do so in a manner consistent with THEC policies and criteria.

Programs must document relevance to institution's mission, provide enrollment, graduation and financial projections, describe the anticipated evaluation process, document employer and student demand, and certify that the proposed program will not duplicate existing offerings at other Tennessee public institutions. The proposal must ensure faculty sufficiency, existence of student support resources, and adequacy of library, space, equipment, and technology.

I approve Tennessee Technological University to plan the Bachelor of Science in Vehicle Engineering. It is understood that the proposed program will be in accord with the mission at TTU and will meet the *Master Plan for Tennessee Postsecondary Education 2015-25* degree completion and workforce development objectives, and will be implemented with existing funds.

The Letter of Application projects implementation of an approved program in August 2016. Please be advised that the Letter of Intent itself will be posted on the THEC website for public disclosure.

cc: Dr. Tristan Denley, TBR
Dr. Philip Oldham, TTU
Dr. Baham Ghorashi, TTU
Betty Dandridge Johnson, THEC

TENNESSEE BOARD OF REGENTS

Academic Proposal Form for All New Programs

COVER PAGE

This form is submitted with all proposals requiring Board approval to the TBR Vice Chancellor for Academic Affairs. The COVER PAGE may be submitted as a PDF. All other forms should be submitted as MSWord documents.

Please remember to submit only one proposal with related support documents per e-mail.

Sponsoring Institution(s): Tennessee Technological University

Proposal Statement: This letter of notification is to establish a new Bachelor of Science program in Vehicle Engineering at Tennessee Technological University to serve the needs of the growing automotive and related industries in the state. There are currently no educational programs of this type in the State of Tennessee.

Degree Designation [or] Type of Certificate:

B.S. in Vehicle Engineering

Formal Degree Abbreviation — **Title of Proposed Program to be established or impacted**

Proposed Degree [or] Certificate CIP & SOC Codes:

Concentrations: (if applicable)

Proposed CIP & SOC Codes: CIP Code: 15.0803 Automotive Engineering; SOC Code: 17-2141

Anticipated Delivery Site(s): Tennessee Technological University, Cookeville, TN

Proposed Implementation Date: Fall 2016

Cooperative/Collaborative Partners: None

For more information contact: Dr. Mohan D. Rao / 931-372-3270

Name — Telephone

Institutional Approval: _____ / 11/4/2015

Signature of President (required) Date

*The Cover Page documents the President's support and that the proposal has been reviewed and approved through the established institutional processes. Collaborative programs require the President's signature from **all** participating institutions.*

Letter of Application for All New Degrees Programs with/without Concentrations, Certificates, Duplications of Existing Community College Programs, Collaborative/Joint Programs

Refer to TBR Policy 2:01:01:00, TBR Guideline A-010, and THEC Policy A1:0 and A1:1 before developing a Letter of Application.

INSTRUCTIONS: Please respond to each question. If the question is not applicable, please use "NA" and include a brief explanation of why the question is not applicable to the proposed action. The form will expand to allow space as needed and must be submitted to the TBR Vice Chancellor for Academic Affairs and the Vice Chancellor for Community Colleges as designated in A-010.

SECTION I. INTRODUCTION

DATE OF SUBMISSION: November 5, 2015

INSTITUTION(S): Tennessee Technological University

TITLE OF PROGRAM: Bachelor of Science in Vehicle Engineering
CIP CODE: 15.0803-Automotive Engineering;
SOC Code: 17-2141-Mechanical Engineers

CONCENTRATIONS: NA
CIP and SOC CODES:

PROJECTED DATE FOR SUBMISSION OF IMPLEMENTATION PORTFOLIO: January 5, 2016

TARGET DATE FOR BOARD APPROVAL: May 2016

PROPOSED DATE OF PROGRAM IMPLEMENTATION: August 2016

A. PURPOSE: *(Goals and Objectives in keeping with Institutional Mission) (Specify: campus specific, regional, state-wide, national, International; Population: Traditional, Non-traditional [over 25], Military, Dual Enrollment [High School], Workforce, or other; Academic, Workforce development and/or Research Needs)*

This letter of application outlines the request for the creation of a new Bachelor of Science degree program in Vehicle Engineering (BSVE) at Tennessee Technological University (TTU). The proposed BSVE program at Tennessee Tech builds upon Tech's

long history of success with accredited undergraduate engineering programs. It will support our state's need for a vibrant automotive and associated supplier industries economy while growing the renewable and sustainable transportation and manufacturing sectors. The program will support the growth requirements for Nissan, Volkswagen and General Motors. Graduates of the program will benefit from the increased depth and breadth of the program, as well as emerging areas in embedded software, mathematical modeling, and electronic controls as the industry moves toward electric and autonomous vehicles.

Within TTU, this program will create new opportunities for collaboration with groups such as Baja SAE, SAE Formula, and it will sustain existing interdisciplinary projects between vehicle students, mechanical, mechatronics, electrical and computer engineering students. These synergistic efforts will lead to national recognition for TTU in the area of vehicle engineering.

TTU's Mission and the Complete College Tennessee Act of 2010

The proposed BSVE program aligns with the vision and mission of Tennessee Technological University (TTU) to provide academic, economic, and cultural leadership in the region and produce graduates from a broad range of academic disciplines prepared to compete in a technologically driven world. The strategic plan of TTU also known as *The Flight Plan* (https://www.tntech.edu/flightplan/focus-areas) is consistent with State of Tennessee's need for economic and human resources growth particularly in STEM areas. It calls for creating distinctive educational programs that improve undergraduate student experience, transform technology and invigorate faculty. The vision of the College of Engineering (CoE) at TTU aligned with *The Flight Plan* is to produce "Twenty-first Century Renaissance Engineers Revolutionizing Engineering to Solve Societal Problems." A Renaissance Engineer is an adaptive professional, is inquisitive and creative and makes significant contributions for the betterment of humanity. A Renaissance Engineer will not only seek jobs, but create jobs and drive innovation. For the past two and half years, the college has been implementing and investing in this shared strategic plan. The proposed BSVE program is consistent with our vision to produce skilled workforce for Tennessee and is imperative to the state's economic development.

"The Public Agenda for Tennessee Higher Education 2010-2015", statute T.C.A. §49-7-205(c) (1), part of the Complete College Tennessee Act of 2010, "presents the higher education community with the opportunity to develop a public policy agenda for the next five years that is shared by campus and system personnel, policymakers, CEOs of companies that hire graduates, and the many other constituents with a vested interest in the enterprise." Goals have been established to meet the following needs:

- Workforce and economic development
- Quality underpinning increased productivity, and

- Enhanced competitive research

The proposed BSVE program helps TTU achieve these goals in the following ways:

- It builds upon TTU's strengths in Engineering and Vehicle Design to address Tennessee's critical need for engineers, especially in high-demand areas tied to vehicle industries.

- It expands student access to rigorous and engaging baccalaureate education by offering a degree with an enhanced math and science foundation and experiential learning. TTU currently has six ABET accredited undergraduate engineering programs; the new BSVE will seek accreditation immediately upon graduating its first cohort of graduates.

- It fosters and promotes life-long learning and success in an ever-changing world by providing students with a degree that has focused depth and breadth than the current engineering options.

- It will expand TTU's ability to apply its expertise and collaborative approach to research in areas of interest to the State such as aerospace, materials, energy, and sustainable transportation.

- It will serve as a model for innovation and sustainability in areas related to vehicle engineering and sustainable transportation.

- This proposal also supports the CoE Strategic Plan of *Educating 21st Century Renaissance Engineer's* through expanded curriculum and opportunities that a) support innovation, creativity and entrepreneurship, and b) foster technical, professional and global leadership to all students.

B. INSTITUTIONAL PRIORITY *(Justify why this is a priority at this time and summarize the institution's current program development plans; institutional plans and meeting benchmarks to exit from post-approval monitoring, for any flagged programs; and resource commitments)*

The proposed BSVE program will be housed within the Mechanical Engineering (ME) Department in the CoE at Tennessee Tech. The CoE is the second largest undergraduate engineering college in Tennessee, and in the fall of 2014, total enrollment reached a historical high of 3046 students, second largest in Tennessee. The college offers bachelor's, master's and doctorate degrees in chemical engineering, civil engineering, computer engineering, computer science, electrical engineering, and mechanical engineering, as well as a bachelor's in engineering technology. The ME Department is the largest degree granting engineering program in the college with an undergraduate enrollment of over 800 students. Several specialized resources of the CoE will be also

be available to the BSVE program students and faculty, including the Clay N. Hixson Student Success Center, Center for Manufacturing Research (CMR) and Center for Energy Systems Research (CESR).

This new program will not only complement the existing accredited engineering programs, but also aligns with University's new initiatives--Tennessee Research Automotive Center (TRAC) and Innovation and Discovery Learning Institute (IDLI), also known as iMakerspace. Moreover, this proposal builds on the success of TTU's experience-based engineering programs such as the recently established DENSO Autonomous Vehicle Laboratory allowing students an opportunity to experiment in the areas of improving driving safety, intelligent interface with the vehicle, design of lightweight vehicles, efficient use of the vehicle power source, and design of new safety sensors, algorithms, and new materials to reduce the vehicle weight. We already have a set of vehicle related classes in Mechanical Engineering, Electrical Engineering, Computer Engineering and Computer Science departments that fit well within the proposed vehicle engineering curriculum.

The Higher Education Master Plan[1] calls for increased degree attainment and an annual growth rate of 3.5% (an additional 26,000 degrees by 2015) and calls for increased graduates in the Science-Technology-Engineering-Math (STEM) fields. This proposed degree certainly serves these needs. The Higher Education Master Plan also calls on institutions of higher education to adopt new approaches, and to try new instructional models.

In light of these facts, the Public Agenda requires that institutions adopt new approaches, try new instructional models, establish instructional partnerships with other institutions and with business and industry, and leverage the promise of instructional technology as never before. It may be from the basis of demonstrated resourcefulness, efficiency, productivity, and observance of distinct and differentiated institutional missions, that higher education will be able to argue for increased support, either from the state or from students, in the future.

This degree program adopts the intent of the Higher Education Master Plan in that it will combine the strengths existing programs at TTU to serve a growing need for more STEM-based graduates particularly related to the growing mobility industry in Tennessee. The program will be the first in the state to provide a degree program in vehicle engineering focusing on the ability to supply higher education opportunities to a large geographic area.

This degree program satisfies all the central themes of the Higher Education master Plan. First, the goal of workforce development is served through the addition of a STEM program that is needed in the state; this point to be justified in Section C, Program Need. Second, this program will increase degree production in a critical STEM area and allow

[1] 2010-2015 Higher Education Master Plan, http://www.tennessee.gov/thec/Divisions/PPR/planning/master_plan.html

the program to be offered at a university in the state that is well known for providing high quality technical education. Third, this fits well with TTU's planned development of a state-of-the art research and development center--TRAC near Lebanon's Nashville superspeedway--through shared resources, shared faculty, and shared administration to help grow and attract further capital investment to the State of Tennessee.

C. NEED: *(Identify the academic, workforce development, and/or research needs the program proposed in this letter of application will meet. Cite employment projections and supply/demand data appropriate to the discipline and degree level as justification using the Bureau of Labor Statistics (bls.gov), O*Net (onetonline.org) and the THEC supply/demand analyses (http://tennessee.gov/thec/Divisions/AcademicAffairs/academic_programs/THEC%20supply%0and%20demand%20Final.pdf), as appropriate, for the degree Or certificate field.*
A brief survey of the need and demand for the program should be conducted in order to inform development. Summarize the results.
Letters of support from industry stating that the proposed credential is recognized and would add value to their workforce should be included. Address sustainability of the program both in the short term (1-2 years) and longer term (5+ years) beyond the anticipated date of the first program graduates per THEC policy.

Educational Need:

Traditionally, the discipline of mechanical engineering has dominated automotive engineering with emphasis on engines and combustion, emission, design, dynamics and manufacturing. Today's cars are far from traditional. As the industry is transitioning toward more and more hybrid, electric and autonomous vehicles, the new automotive engineering is one of the most technologically compelling and interesting specialties available, and the growth and diversification of the industry is expected to drive more change in the global automotive market in the next 10 years than during the previous 50. There is a concentrated demand for automotive engineers with background in embedded hardware and software, mathematical modeling, simulation, sensors and electronic controls in addition to traditional topics of engines, vehicle ride and handling, noise and vibration, etc. With increased use of computer technology and the global focus of the industry, computer skills and foreign languages have become assets for students to obtain a greater range of employment options. And there is a need to understand lean manufacturing and green economy in the new curriculum.

Several states in the U.S. have successful, established automotive engineering degree programs at their universities, most notably Michigan, Michigan Tech, Ohio State, Purdue, Cornell, Kettering, Louisville, Virginia Tech, Clemson, Georgia Tech, Alabama and Mississippi State-most of these at the graduate level. Currently, there are no Baccalaureate of Science degree programs in automotive or vehicle engineering in any of the TBR or UT affiliated institutions in the State of Tennessee. Austin Peay State University branch center at Ft. Campbell, Kentucky only offers a B.S. Engineering

Technology program with a concentration in Automotive Technology, but this is not an engineering-level program and its graduates are not eligible for licensure as Engineers in Tennessee.

Workforce Development Need:

The automotive industry is a vital economic contributor to Tennessee. The state is home to three automotive original equipment manufacturers (OEMs); Nissan, General Motors, and Volkswagen and over 900 automotive suppliers. More than 120,000 Tennesseans are employed in the auto manufacturing industry that has an annual payroll of $6.5 billon. Tennessee is ranked number one by Business Facilities magazine for automotive manufacturing strength. Two recent studies by the Brookings Institution and the Center for Automotive Research firmly stated that the state's automotive sector required more focused emphasis on education, research, development and innovation to grow and attract further capital investment.

Tennessee Tech has a long and distinguished history of engineering education, research, and innovation. The CoE at Tennessee Tech is committed to meet the needs of a skilled automotive workforce for the state. Experts in automotive engineering are poised to develop innovations that will change society and address global transportation challenges. In order to make the most of this hyper-competitive and technologically intensive environment, engineers will need a clear understanding of how to work with virtual global teams, as well as strong backgrounds in both product development and production Curriculum and hands-on applications are at the heart of this initiative.

Research and Development Need:

As for research and development facilities, several neighboring states have university automotive research centers, such as the Center of Advanced Vehicle Technology at the University of Alabama, Mississippi State University's Center for Advanced Vehicular Systems, and International Center for Automotive Research (ICAR) at Clemson University (CU). Today, CU-ICAR has more than $200 million in partnership commitments that will directly fuel a knowledge-base critical to the automotive industry. Located in the heart of NASCAR and motorsports country, the 250-acre campus is strategically located between Charlotte, NC, and Atlanta, GA. In addition to the master's program, this is where Clemson University offers the nation's only PhD in automotive engineering.

Though Tennessee can boast of the ORNL Center for Transportation Analysis, their program in vehicle technologies is mainly focused on safety for heavy trucks. The proposed BSVE program complements TTU's planned TRAC for automotive research and development being developed at the existing Nashville Super Speedway. The currently inactive Nashville speedway consists of 1400 acres of land with paved and unpaved tracks and infrastructure built for motorsports is ideal for realizing Tennessee's vision to develop research and development, innovation and workforce education/training in the automotive and sector to complement similar efforts from other southern states.

Student Interest/Demand

According to industry expert, David Cole, director of the automotive transportation engineering program and dean of engineering at the University of Michigan, "There will be a big demand for automotive engineers. The main difficulty for the automotive industry over the next ten years will be finding the right engineer for the right discipline."[2]

The current demand for engineers who understand embedded software, mathematical modeling, and electronic controls is increasing in view of transition toward electric and autonomous vehicles. Moreover, the new breed of engineers will have to be ready to work with foreign automakers and suppliers. They'll have to deal with counterparts abroad, which will nearly eliminate time-honored methods of physical prototyping, thus thrusting them more deeply into virtual design.

They'll need to work in global collaborative environments, be strong in their engineering fundamentals, and be proficient in all manner of modeling and simulation.

As a premier technological university, Tennessee Tech University has strong student base interested in automotive related programs. Tennessee Technological University (TTU) has long been affiliated with the Baja SAE competition, having hosted the event 5 times and placed in the top 10 over 80% of the time since 1977. Student participation in Baja and SAE Formula competitions has demonstrated strong interest in vehicle related programs. The proposed BSVE will meet these student interests.

Dan Goodwin, executive engineer at Chrysler, remarks, "We're looking for the person who demonstrates solid training, leadership and communications skills and teamwork." Continuous learning is also a value Chrysler expects, notes Goodwin. Ford recruiters look for well-rounded candidates with excellent communication and analytical skills, and expertise in handling conflict, with extra points for those with an advanced degree.[2]

Labor Market Report:

A CAR study called "Beyond The Big Leave"[3] contends that in the next four to five years, the American economy will be short about ten million skilled workers, many of whom will be engineers. Over 12-15 years, that figure will balloon to about 30 million. At the same time, more than 13 million vehicles are being scrapped each year, while U.S. capacity is being reduced annually by four million units. Those figures, experts say, add up to a need for vehicles, as well as the engineers who design them.

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[2] http://www.graduatingengineer.com/resources/articles/20000515/Automotive-Engineering

[3] http://www.designnews.com/document.asp?doc_id=228490&dfpPParams=industry_auto,aid_228490&dfpLayout=article

According to Recruiter[4], the overall job outlook for Automotive Engineer careers has been positive since 2004. Vacancies for this career have increased by 8.01 percent nationwide in that time, with an average growth of 1.34 percent per year. One of Tenseness's neighboring states has had one of the highest vacancies and growth rate of 34%. Demand for Automotive Engineers is expected to go up, with an expected 18,700 new jobs filled by 2018. This represents an annual increase of 1.00 percent over the next few years.

The State of Tennessee Labor Market Report of January 2013 shows that ¼ of all jobs in the state are in the following areas: "Goods Producing" which includes Manufacturing (Durable and Non-Durable), Mining, Logging, and Construction. Add to that the areas of Professional, Scientific & Technical Services, and these areas represent a total of 519,000 current non-government jobs. The employment of professionals, scientific and technical personnel increased in Tennessee by 3,200 jobs from January 2012 to January 2013 even during these difficult economic times.

Career Cluster Guide, STEM Related Areas:

According to 2014 Labor Education Alignment Program (LEAP) annual report published by the TN department of Economic and Community Development, there is an increased need for STEM-related education throughout the state. The goal of Governor Haslam's Initiative; the Drive to 55, is to equip 55 percent of Tennesseans with a college degree or certificate by the year 2025. Through Tennessee Promise, high school students are offered two years of tuition-free community or technical college beginning with the Class of 2015. The proposed BSVE program will offer an excellent opportunity for the new students from the Tennessee Promise program to pursue careers in engineering and technology areas to realize Governor Haslam's vision.

Expansion of academic programs is necessary to serve the large geographic area of the state. The demand for STEM area degrees is expanding and academic institutions must expand offerings in this critical area to meet these needs. Overall the degree supports integration of a broad range of engineering skills which will support the demand for growth in the automotive sector from local and regional industries and businesses. This program will also bring to school an academic offering which is considered a "professional" degree field.

Sustainability and long term growth:

Business Facilities magazine named Tennessee the top state in its Automotive Manufacturing Strength ranking for 2014, for the fifth consecutive year. The automotive sector employs 111,000 workers at over 900 establishments and accounts for one in three manufacturing jobs in Tennessee. Since 2011, OEMs and suppliers in Tennessee have committed to over 22,000 new jobs. Among the latest successes is South Korean tire

[4] https://www.recruiter.com/careers/automotive-engineers/outlook/

manufacturer Hankook, which is building an $800 million facility in Clarksville that will employ 1,800 workers. It is the company's first U.S. production facility. In addition Volkswagen recently announced a major expansion of its Chattanooga plant, which opened in 2011 with an annual capacity of 150,000 vehicles and employs about 2,500 people . Their new investment is $900 million to add a second assembly line that will create 2,000 new jobs by 2016. Similar announcements of planned expansion in TN have been made by Nissan and other Tier 1 suppliers. In view of these, the academic institutions in TN including TBR affiliated institutions need to be ready to supply the much needed graduates to fill these future vacancies.

The educational opportunities offered in this degree are going through a period of increased demand which will extend well beyond the next decade. Tennessee has developed a master plan with a major emphasis for state universities that includes expanding STEM offerings, and graduates. One of the major directives from the state also calls for increased efficiency in developing and delivering degrees throughout the state – this program clearly satisfies these directives. Lastly the availability of engineers and other technical personnel is one of the most important statistics when new companies look to establish or relocate industries.

D. IMPACT:

Describe the articulation and transfer avenues projected for the proposed program in compliance with PC§ 49-7-202. Describe the anticipated effect the program will have on existing associated degree programs or concentrations within the institution as well as other institutions within the system.

The addition of a BSVE to the other degree programs in the College of Engineering would have a positive impact on the overall offerings of the College and is projected to lead to an overall increase in total number of Bachelor's degrees in Engineering and Technology awarded by the College. In particular, the inter-disciplinary nature of the course offerings is very-well suited to fill the demand in industry for engineers who have a "big picture" view of science and engineering, rather than being specialized in any one particular engineering discipline. This is particularly important in engineering management and project management type positions, which industry is always seeking new engineers to fill.

As a unique program offering, it is anticipated that many of the enrollees into the BSVE program will be new students to TTU. At the same time, it is also likely that there will be some transfer of students from existing engineering programs at TTU into the program, particularly those who might have an inclination toward employment in automotive and mobility industry. However, it is expected that this shift from current offerings will be more than offset by new students transferring into the program from outside TTU including other TBR universities and community colleges. Retaining these students in STEM disciplines would be a net plus to the University and the State. Furthermore,

increased fees from the increased student enrollment will allow further expansion of labs and specialized equipment which are needed for the long term sustainability of the program.

E. DIVERSITY STATEMENT:

Provide a statement in keeping with the TBR approved campus Diversity Plan of how the program will enhance diversity.

TTU aspires to be the institution that celebrates diversity by welcoming all students, faculty, administrators and staff as respected and valued participants in the University's educational mission. The University supports and encourages the promotion of diversity in its curricula, programs, faculty research, scholarship, and creative activities. Below is the TTU diversity statement:

In accordance with Tennessee Technological University's Mission and Strategic Goals, the University is as supportive of women as of men and as supportive of those in the minority as of those in the majority. The University provides educational opportunities to all eligible persons without regard to age, gender, ethnicity, race, religion, national origin, disability, or sexual orientation. The institution is committed to an inclusive and diverse campus that enriches the educational experience, promotes personal growth and a healthy society, prepares students for success in a global economy, and enhances America's economic competitiveness.

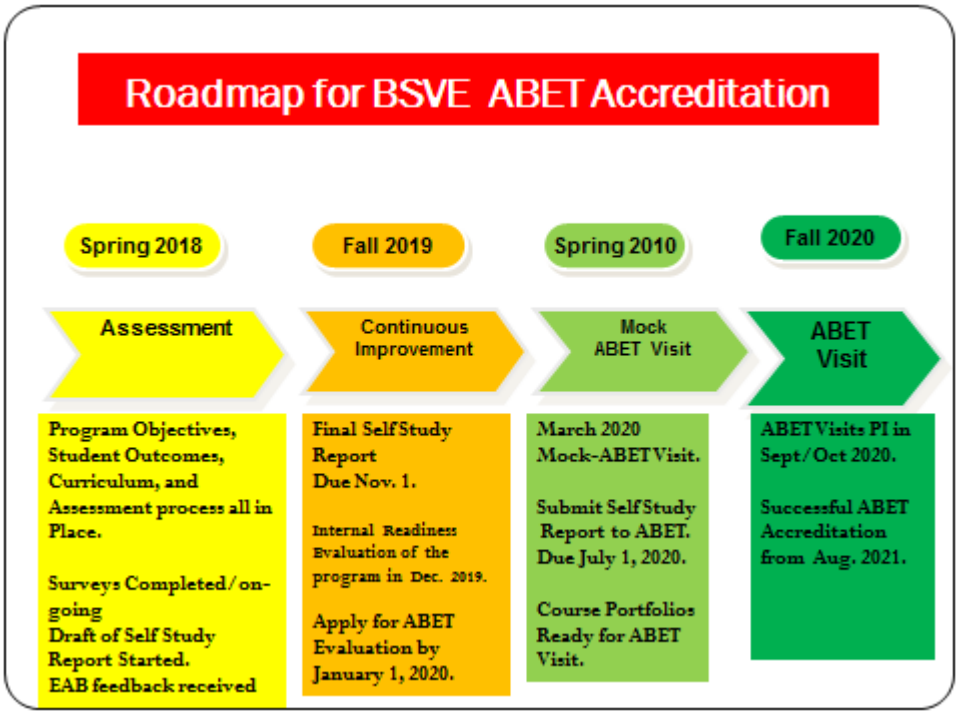
F. PLANS FOR ACCREDITATION:

*(Identify the source and **projected date** of Professional accreditation if applicable; if the proposed program requires a SACSCOC Substantive Change Review and, if so, describe the scope of the substantive change. Information on actions constituting substantive change can be found at the following website: http://www.sacscoc.org/substantivechange.asp . If there are no plans to seek specialized accreditation, please provide reasons.)*

TTU will apply for ABET accreditation of the proposed BSVE degree. The ABET Engineering Accreditation Commission (EAC) guidelines can be found at http://www.abet.org/eac-criteria-2015-2016/. The program is being developed with courses that meet the accreditation criteria requirements. In addition to curricular requirements, ABET accreditation requires the creation and participation of Institutional Review Boards (IRB) and meeting industry specific guidelines which are allied with ABET guidelines for particular areas.

The process of ABET accreditation is very rigorous. It involves continuous data collection for assessing student outcomes every year to show compliance with the accreditation criteria. For a new program such as this BSVE, an internal review needs to be conducted at three years into the program to provide feedback for the program and to prepare for the writing of program's self-study report. The time line of the process spans five years. At the end of the fourth year (when the program has graduates), a self-study

report is developed and submitted with a request for a general review. This occurs in the fifth year. Students who have graduated in the fourth year are grandfathered into accreditation period. After the initial accreditation, following reviews are conducted every six years. The following diagram depicts our proposed plan for ABET accreditation of the BSVE program.



G. IDENTIFY ANY LOW PRODUCING PROGRAMS AT YOUR INSTITUTION(S) BASED ON THEC ANNUAL PROGRAM PRODUCTIVITY REPORT(S):

Currently, there are no low producing programs in the college of engineering at TTU. All the engineering and engineering technology programs are at full capacity, in fact, some are oversubscribed.

H. LIST ALL NEWLY APPROVED AND ESTABLISHED PROGRAMS INCLUDING CERTIFICATES OFFERED THROUGH ANY PUBLIC INSTITUTION IN TENNESSEE INCLUDING THE TENNESSEE COLLEGES OF TECHNOLOGY AT THE SAME LEVEL (WITHIN THE SAME OR SIMILAR CIP [HTTP://NCES.ED.GOV/IPEDS/CIPCODE/SEARCHRESULTS.ASPX?Y=55&CA=2] AND SOC CLASSIFICATIONS [HTTP://WWW.BLS.GOV/OES/CURRENT/OES_STRU.HTM]). A CIP TO SOC AND SOC TO CIP CROSSWALK IS AVAILABLE AT HTTP://NCES.ED.GOV/IPEDS/CIPCODE/RESOURCES.ASPX?Y=55. THE THEC WEB-BASED INVENTORY AND PROGRAM PRODUCTIVITY ANALYSIS FOR STATE INSTITUTIONS ARE AVAILABLE AT:

HTTP://TENNESSEE.GOV/THEC/DIVISIONS/ACADEMICAFFAIRS/AA_MAIN.HTML.

A search for new or established BS programs in TN in the area of Vehicle or Automotive engineering with a CIP code of 15.0803 yields no results indicating no existing bachelor's level degree programs.
(**http://thec.ppr.tn.gov/APISearch/APISearch.aspx**).

I. IDENTIFY ANY LOW PRODUCING PROGRAMS IN THE SAME OR SIMILAR CIP/SOC CODES IN ANY PUBLIC INSTITUTION IN TENNESSEE BASED ON THE CURRENT THEC LISTING OF PROGRAMS FAILING TO MEET ENROLLMENT OR GRADUATION BENCHMARKS AS POSTED ON THE THEC WEBSITE BASED ON THEC ANNUAL PROGRAM PRODUCTIVITY REPORT(S) AT THE TIME OF SUBMISSION OF THE LETTER OF APPLICATION:

None or not applicable

SECTION II: ARTICULATIONS, COLLABORATIONS AND DUPLICATIONS INCLUDING INTERDISCIPLINARY PROPOSALS

A. *If a similar program to the one proposed already exists at other institution(s) in the state, describe any opportunities for collaboration with other institutions that have been or will be pursued.*

B. *For any proposed articulated or collaborative program(s):*

   a. *Which institution(s) will have a degree-granting authority?*
   b. *Which institution(s) will have the authority for faculty hiring, course assignment, systematic evaluation, and reappointment decisions?*
   c. *What agreements exist to ensure that faculty from all participating institutions will be involved in decisions about the curriculum, admissions standards, exit requirements?*
   d. *Which institution(s) will be responsible for academic and student-support services, e.g., registration, advising, library, academic assistance, financial aid, etc.?*
   e. *What agreements exist to ensure that the academic calendars of the participating institutions have been aligned as needed?*
   f. *In addition to the information provided by each participating institution regarding Financial Projections, please address the following items:*
      - *How will tuition rates be determined if they differ among the institutions?*

- *Has a formal agreement been developed regarding cost-sharing policies? If yes, please include it as part of the Letter of Application. If no, please summarize the current understanding between all parties and the plans for developing a formal agreement.*
- *What arrangements, if any, have been made for exchange of money between participating institutions?*
- *Provide Financial Projections (using the THEC Financial Projection form) for each institution involved PLUS an aggregate form representing all financial projections for proposed programs involving multiple institutions.*
- *If one institution wishes to discontinue the program, what agreements exist for terminating the offering?*
- *Specify any other issues and how they are proposed to be addressed.*

At this point, Tennessee Technological University will be solely responsible for developing and offering the proposed BSVE program.

B. If the proposed program is currently available through the Academic Common Market (ACM) (http://www.sreb.org/page/1304/academic_common_market.html), explain why the need for the requested program/course development cannot be better met through collaboration or in the case of universities, the ACM.

The proposed new program in BSVE does not exist in any of the Universities affiliated with ACM. In addition, this is a resident program designed to serve the residents of the State of TN to assist in its economic development including and job creation in the emerging automotive sector of the state.

C. If a 100% online program is being proposed: ***N/A***

1. If the institution(s) is (are) authorized to offer the same program as a ground program,
will the existing program be maintained in addition to on-line delivery?
Review the State Authorization Reciprocity Agreement (http://www.wiche.edu/sara) for additional requirements if the program will be advertised as open to residents outside of Tennessee.

2. Specify whether
[ ] ROCC (Regents Online Campus Collaborative) credit*
*[ ] ROCE (Regents Online Continuing Education & Workforce Development)*noncredit*
[ ] Other Institutional Collaborative or Industry-Institutional Partnerships
Length of Agreement:

Open-ended or limited (provide start and end dates)

3. *Check all institutions and organizations that will participate in the collaborative:*
   Universities: ( ) APSU ( ) ETSU ( ) MTSU ( ) TSU ( ) TTU ( ) UOM
   Community Colleges: ( ) CLSCC ( ) COSCC ( ) CSTCC ( ) DSCC ( ) JSCC
   ( ) MSCC ( ) NSCC ( ) NSTCC ( ) PSTCC ( ) RSCC
   ( ) STCC ( ) VSCC ( ) WSCC
4. *List any other support agencies including clinical affiliations, government, health and Business that will participate and provide evidence in portfolio per THEC 1.1.20K:*
5. *List any international collaborations which will be pursued and provide documentation of interest by the international partner institution(s), if available.*

***For Doctoral Programs*, provide letters from presidents of Tennessee institutions offering same or similar CIP doctoral programs within the same broad geographic service area certifying that the doctoral program will not be perceived as duplicative.**

***For Technical Certificates*, provide documentation of notification to Tennessee Technology Centers within the service area.**

Not Applicable for all of the above.

SECTION III: PROGRAM STRUCTURE

A. *Residency requirements (in keeping with SACSCOC requirements):*

To meet the residence requirements, a student must complete at least 25 percent of the credit for the degree requirements (32 credits) including a minimum of 24 of the last 30 semester hours of 3000 and 4000 level requirements at Tennessee Technological University.

B. Macromajors or Academic Foci:

ACADEMIC FOCI	Check all applicable
Arts	
Business	
Education	
Health Sciences	
Humanities	
Social Sciences	
STEM	X
Applied Science and Technology	
General Education	

C. **CURRICULUM:** *The proposed program requires completion of* ***128*** *Semester Credit Hours (SCH) distributed as follows (IF more than 120 SCH provide justification per THEC 1.0.60A):*

The 128 credit hours required for this degree is the same as other engineering degree programs in the college of engineering at TTU. It consists of 32 credits of Math and Basic Science courses as required by ABET and 24 credits of General Education Courses. These satisfy the minimum 41 credits of General Education requirements stipulated by TBR.[5] The proposed curriculum for the BSVE program is shown in the following pages and Tables. This curriculum was created by a group of 15 faculty members from Mechanical, and Electrical and Computer Engineering (ECE) working closely for a period of over one month. This curriculum has been discussed and supported by the curriculum committees and faculty of both ME and ECE departments and also presented and discussed as an information item at the CoE and TTU undergraduate curriculum committees. A formal approval by these committees will take place when the implementation portfolio is developed after this LoA is approved.

We believe this is a forward-looking curriculum that has a good mix of existing and new courses as well as a right balance between theory and practicum. An important feature of this curriculum is the introduction of vehicle engineering "threads" courses starting from the first semester of the program. We plan to introduce the various aspects of vehicle analysis, design, manufacture and testing to each cohort of students from the very beginning via a hybrid Baja type vehicle. In other words, students' will be learning by doing from day one so that they are "job ready" by the time they graduate from the program.

A summary of the curriculum along with new courses to be created is shown in Table 3.

1. General Education (Undergraduate only):

Rubric/Number	Course Title	SCH

TTU's general education requirements follow a program established by the Tennessee Board of Regents. It consists of forty-one (41) semester hours for baccalaureate degrees. Lower-division means freshman and sophomore courses. The courses comprising the general education curriculum are contained within the following subject categories:

Baccalaureate Degrees

Communication *9 hours**

[5] General Education Requirements and Degree Requirements : 2:01:00:00

Humanities and/or Fine Arts 9 hours
(At least one course must be in literature.)
Social/Behavioral Sciences 6 hours
*History 6 hours***
Natural Sciences 8 hours
Mathematics 3 hours
Total 41 hours

**Six hours of English Composition and three hours in English oral presentational communication are required.*

***Students who plan to transfer to Tennessee Board of Regents (TBR) universities should take six hours of United States History (three hours of Tennessee History may substitute). Students who plan to transfer to University of Tennessee System universities or to out-of-state or private universities should check requirements and take the appropriate courses.*

2. Major Field Core (courses required of ALL students in a program)

Rubric/Number	Course Title	SCH

Please see attached Tables

3. Concentrations(s): (Identify and list courses for each concentration separately; undergraduate concentrations must be at least 15 SCH; graduate concentrations at least 12 SCH.)

Rubric/Number	Course Title	SCH
N/A		

4. Electives: (May be guided or general electives; Include descriptions, prerequisites, or restrictions that may apply.)

Rubric/Number	Course Title	SCH

Please see Table 1 and 2.

5. Other credits (If applicable, describe requirements for thesis, dissertation, clinical experience, internship, portfolio or other capstone experience.)

Rubric/Number	Course Title	SCH
None		

6. Number of NEW courses (include newly developed yet never taught courses):
_____ with ____ SCH

Please see Table 3.

7. Number of SCH anticipated from transfer, articulation, PLA and other sources per THEC 1.06.0) (specify source): _____

   Varies.

8. For Universities only: Indicate all Tennessee Transfer Pathways (TTP) acceptable for entry into the proposed program per THEC 1.0.60:

TTP	Yes	No
Accounting		
Agriculture-AGBUS		
Agriculture-Animal Science		
Agriculture-Plant and Soil Science		
Art (Studio)		
Biology		
Business Administration		
Chemistry		
Civil Engineering		
Computer Science		
Criminal Justice		
Economics-Business		
Economics-Liberal Arts		
Electrical Engineering	X	
English		
Exercise Science		
Foreign Language		
Geography		
History		
Information Systems		
Kinesiology		
Mathematics		
Mass Communication		
Mechanical Engineering	X	
Music		
Physics		
Political Science		
Pre-Health (Pre-Dental, Vet, Med, OPT, Pharm)		
PreK-12		
Pre-Nursing		
Pre-Occupational Therapy		
Pre-Physical Therapy		
Psychology		
Social Work		

Sociology		
Speech Communication		
Theatre Arts		

Although the courses designated by Tennessee Board of Regents (TBR) institutions to fulfill the requirements of the general education subject categories vary, transfer of the courses is assured through the following means:

Upon completion of an A.A. or A.S. degree, the requirements of the lower-division general education core will be complete and accepted by a TBR university in the transfer process.

If an A.A. or A.S. is not obtained, transfer of general education courses will be based upon fulfillment of complete subject categories. (Example: If all eight hours in the category of Natural Sciences are complete, then this "block" of the general education core is complete.) When a subject category is incomplete, course-by-course evaluation will be conducted. The provision of block fulfillment pertains also to students who transfer among TBR universities.

Institutional/departmental requirements of the grade of "C" will be honored. Even if credit is granted for a course, any specific requirements for the grade of "C" by the receiving institution will be enforced. It is important that students and advisors be aware of any major requirements that must be fulfilled under lower-division general education. A complete listing of the courses fulfilling general education requirements for all system institutions is available on the TBR website (https://www.tbr.edu/academics/transfer-and-articulation) under Transfer and Articulation Information.

Proposed BSVE Curriculum: 128 credit hours plus ENGR 1020 (1)

1. General Education Requirement: 24 credits

- English, Speech Communication s and Literature (12)
  - ENGL 1010 (3); ENGL 1020 (3); SPCH 2410 or PC 2500 (3); Lit (3)
- Humanities and Fine Arts (6)
  - HUFA1 (3); HUFA2 (3)
- Social and Behavioral Sciences (6)
  - SBS1 (3); SBS2 (3)

2. Math and Basic Science Requirement: 29 credits (ABET requires 32)

- Calc I, Calc II, Calc III, Linear Algebra, Diff Eqn (18)
  - MATH 1910(4); MATH 1920 (4); MATH 2010 (3); MATH 2110 (4); MATH 2120 (3)
- Physics I and II, Chemistry I (11)
  - PHYS 2110 (4); PHYS 2119 (3); CHEM 1110 (4)
- Need 3 more Math and Basic Science credits
  - Use ME 3001 (3) ME Analysis (Numerical Analysis)

3. Remaining: 75 (72 credits + 3 credits to satisfy ABET Math and Basic Science requirement)

ME/ECE Engineering Core Courses (48 credits)	
ME (includes Civil Engg.) Core (24)	**ECE (includes Computer Sc.) Core (24)**
CEE 2110 Statics (3) **ME 2330 Dynamics (3)** **CEE 3110 Mechanics of Materials (3)** **ME 3001 ME Analysis (3)** **ME 3210 Thermodynamics I (3)** **ME 3710 Heat Transfer (3)** **ME 3720 Fluid Mechanics (3)** **ME 3010 Materials and Manufacturing (3)**	**CSC 2100/2101 Intro to Problem Solving & Computer Programming (4)** **ECE 2010 Electrical Circuits I (3)** **ECE 2011 EE Lab I (1)** **ECE 2020 Electrical Circuits II (3)** **ECE 3300 Electronics I (3)** **ECE 3010 Signals & Systems (3)** **ECE 2110 Intro. to Digital Systems (3)** **ECE 3130 Microprocessor Systems (4)**

Vehicle Engineering Core (8) (New Courses)
VE 3400 Introduction to Automotive Systems (2) **VE 3500 Sensors, Transducers and Instrumentation (2)** **VE 4400 Systems Integration (2)** **VE 4500 Reliability and Quality Engineering (2)**
Hybrid Baja Threads Experience (6 credits), New Courses **Two-Semester Senior Capstone Project (4 credits), New Courses**
The students in Vehicle Engineering will be exposed to a vehicle from day one. In the first semester of their freshman year, a special section of ENGR 1020 will introduce vehicle-related issues as well as an overview of the BSVE curriculum. In addition, a hybrid Baja vehicle will provide hands-on experience each semester of the freshman, sophomore and junior years through "Threads in Vehicle Engineering," seminar/lab courses. Each "Threads" course is 1 cr. hour. In the senior year, the students take a two-semester capstone design sequence. **Freshman: VE 1100 (1) + VE 1200 (1)** **Sophomore: VE 2100 (1)+ VE 2200 (1)** **Junior: VE 3100 (1) + VE 3200 (1)** **Senior: VE 4100 Capstone Design Experience I (2) + VE 4200 Capstone Design Experience II (2)**

Clusters or Technical Elective Sets (9 credits)	
At the end of the first semester of the junior year, students will choose a cluster of elective courses. The vehicle electronics clusters require that a student take a Cluster Elective in the second semester of the junior year.	
Vehicle Mechanics Clusters • **Option 1: Choose any one cluster (3 courses, 9 credits)** • **Option 2: Choose one course from each cluster, 9 credits)**	**Vehicle Electronics Clusters** **Choose any one cluster (3 courses, 9 credits)**
Cluster 1: Vehicle Mechanics & Performance VE 4XXX Vehicle Dynamics (3) VE 4XXX Vehicle Noise, Vibration and Harshness (NVH) (3) ME 4810 Automated Control Systems (3) **Cluster2: Vehicle Manufacturing & Design** VE 4XXX Automotive Manufacturing and Design (3) ME 4450 Design for Manufacturability (3) VE 4XXX Electric and Hybrid Vehicle Design (3) **Cluster 3: Engines, Energy** ME 3220 Thermodynamics II (3) ME 4630 Internal Combustion Engines (3) VE 4XXX Energy Storage: Batteries and Fuel Cells (3) **Cluster 4: Vehicle Modeling and Simulation** ME 4180 Finite Element Method (3) VE 4XXX CFD Modeling and Simulation (3) VE 4XXXX CAE Methods in Vehicle Modeling and Design (3)	**Cluster 1 – Electrical Propulsion Systems** ECE 3610 Intro to Power Systems (3) ECE 4630 Power Electronics (3) VE 4XXX Energy Storage: Batteries and Fuel Cells (3) **Cluster 2 – Controls/Autonomy** ECE 3210 Control Systems Analysis (3) ECE 4210 Control Systems Design (3) ECE 4140 Embedded Systems (3) **Cluster 3 – Communication and Connectivity** ECE 3510 Electromagnetic Fields I (3) VE 4XXX Automotive Communication Networks (3) VE 4XXX Electromagnetics for Automotive Systems (EMI/EMC) (3)

Table 1. Semester by Semester Plan for BSVE Degree (Vehicle Mechanics Clusters)

Freshman			
ENGL 1010	3	ENGL 1020	3
HUFA1	3	MATH 1920 Calculus II	4
MATH 1910 Calculus I	4	PHYS 2110 Cal-based Phys I	4
CHEM 1110	4	CSC 2100	3
VE 1100 Threads in VE I	1	CSC 2101	1
ENGR 1020*	1	VE 1200 Threads in VE II	1
	15+1		16
Sophomore			
ENGL 2130/2230/2330	3	SPCH 2410/PC 2500	3
MATH 2010 Matrix Algebra	3	MATH 2120 ODEs	3
MATH 2110 Calculus III	4	ME 2330 Dynamics	3
PHYS 2119 Cal-based Phys II	3	ECE 2010 Circuits I	3
CEE 2110 Statics	3	ECE 2011 EE Lab I	1
VE 2100 Threads in VE III	1	VE 2200 Threads in VE IV	1
		VE 3400 Intro to Automotive Systems	2
	17		16
Junior			
ME 3010 Materials and Manufacturing	3	ME 3710 Heat Transfer	3
		ME 3210 Thermodynamics I	3
ME 3001 ME Analysis	3	CEE 3110 Mechanics of Materials	3
ME 3720 Fluid Mechanics	3	ECE 3300 Electronics I	3
ECE 2020 Circuits II	3	ECE 3010 Signals and Systems	3
ECE 2110 Intro to Digital Systems	3	VE 3500 Sensors, Transducers and Instrumentation	2
VE 3100 Threads in VE V	1		
		VE 3200 Threads in VE VI	1
	16		18
Senior			
SBS1	3	SBS2	3
VE 4100 Capstone Design I	2	VE 4200 Capstone Design II	2
VE 4400 Systems Integration	2	VE 4500 Reliability and Quality Engineering	2
ECE 3130 Microprocessors	4		
Cluster Elective I	3	Cluster Elective II	3
HUFA2	3	Cluster Elective III	3
	17		13

* Not included in the 128 cr. hr VE curriculum.

Table 2. Semester by Semester Plan for BSVE Degree (Vehicle Electronics Clusters)

Freshman			
ENGL 1010	3	ENGL 1020	3
HUFA1	3	MATH 1920 Calculus II	4
MATH 1910 Calculus I	4	PHYS 2110 Cal-based Phys I	4
CHEM 1110	4	CSC 2100	3
VE 1100 Threads in VE I	1	CSC 2101	1
ENGR 1020*	1	VE 1200 Threads in VE II	1
	15+1		16
Sophomore			
ENGL 2130/2230/2330	3	SPCH 2410/PC 2500	3
MATH 2010 Matrix Algebra	3	MATH 2120 ODEs	3
MATH 2110 Calculus III	4	ME 2330 Dynamics	3
PHYS 2119 Cal-based Phys II	3	ECE 2010 Circuits I	3
CEE 2110 Statics	3	ECE 2011 EE Lab I	1
VE 2100 Threads in VE III	1	VE 2200 Threads in VE IV	1
		VE 3400 Intro to Automotive Systems	2
	17		16
Junior			
ME 3010 Materials and Manufacturing	3	CEE 3110 Mechanics of Materials	3
		ECE 3300 Electronics I	3
ME 3001 ME Analysis	3	ECE 3010 Signals and Systems	3
ME 3720 Fluid Mechanics	3	VE 3500 Sensors, Transducers and Instrumentation	2
ECE 2020 Circuits II	3		
ECE 2110 Intro to Digital Systems	3	VE 3200 Threads in VE VI	1
VE 3100 Threads in VE V	1	Cluster Elective I	3
	16		15
Senior			
SBS1	3	SBS2	3
ME 3210 Thermodynamics I	3	ME 3710 Heat Transfer	3
VE 4100 Capstone Design I	2	VE 4200 Capstone Design II	2
VE 4400 Systems Integration	2	VE 4500 Reliability and Quality Engineering	2
ECE 3130 Microprocessors	4		
Cluster Elective II	3	Cluster Elective III	3
		HUFA2	3
	17		16

* Not included in the 128 cr. hr VE curriculum.

New Courses to be Created:

1. VE 3400 Introduction to Automotive Systems (2)
2. VE 3500 Sensors, Transducers and Instrumentation (2)
3. VE 4400 Systems Integration (2)
4. VE 4500 Reliability and Quality Engineering (2)
5. VE 1100 Threads in Vehicle Engineering I (1)
6. VE 1200 Threads in Vehicle Engineering II (1)
7. VE 2100 Threads in Vehicle Engineering III (1)
8. VE 2200 Threads in Vehicle Engineering IV (1)
9. VE 3100 Threads in Vehicle Engineering V (1)
10. VE 3200 Threads in Vehicle Engineering VI (1)
11. VE 4100 Capstone Design Experience I (2)
12. VE 4200 Capstone Design Experience II (2)
13. VE 4XXX Vehicle Dynamics (3)
14. VE 4XXX Vehicle Noise, Vibration and Harshness (NVH) (3)
15. VE 4XXX Automotive Manufacturing and Design (3)
16. VE 4XXX CFD Modeling and Simulation (3)
17. VE 4XXX CAE Methods in Vehicle Modeling and Design
18. VE 4XXX Electric and Hybrid-Electric Powertrain Design (3)
19. VE 4XXX Energy Storage: Batteries and Fuel Cells (3)
20. VE 4XXX Automotive Communication Networks (3)
21. VE 4XXX Electromagnetics for Automotive Systems (3)

Description of New Courses:

1. VE 1100 Threads in Vehicle Engineering I (1)
2. VE 1200 Threads i99n Vehicle Engineering II (1)
3. VE 2100 Threads in Vehicle Engineering III (1)
4. VE 2200 Threads in Vehicle Engineering IV (1)
5. VE 3100 Threads in Vehicle Engineering V (1)
6. VE 3200 Threads in Vehicle Engineering VI (1)
7. VE 4100 Capstone Design Experience I (2)
8. VE 4200 Capstone Design Experience II (2)

The above courses are designed to provide hands-on integrated experience to students during each semester using a hybrid Baja vehicle. There will be a combination of lectures, seminars and lab work on theory introduced in other courses. Students will be exposed to all aspects of solid modeling, design, fabrication, measurement, testing, operation and refinement and optimization of the vehicle throughout the four years of the curriculum.

9. VE 3400 Introduction to Automotive Systems (2)

   Introduction to vehicle as a complex system, interactions of the subsystems in terms of its performance. Overview of propulsion systems, suspensions and steering systems, tire road interface, structural behavior and crash worthiness, materials and manufacturing, driver/occupants vehicle interactions, and onboard electronics.

10. VE 3500 Sensors, Transducers and Instrumentation (2)

    The objective of this course is to provide students with a functional understanding of various sensors used in vehicles including, oxygen, tire pressure, emission, temperature, blind spot monitoring, etc. The course focuses on principle of measurements, theory of instruments and sensors for measuring typical physical quantities in mechanical and electrical systems. Topics such as calibration, measurement uncertainty and noise are also covered.

11. VE 4400 Systems Integration (2)

    Methods and tools for package studies, ergonomic and design practices used in the automobile industry. Engine compartment packaging issues. Perception of interior spaciousness and visibility issues. Functional, geometric, production and IT integration. Managing and optimizing performance trade-offs from the combination of systems designed for individual functions.

12. VE 4500 Reliability and Quality Engineering (2)

    Basic engineering and statistics principles as well as advanced tools focusing on design of experiment, statistical process control and reliability engineering are presented. Theoretical and practical methods to improve the capability of systems to perform their designated functionalities, to predict the probability of their functioning without failures in certain environments for desired periods, to assess their maintainability, availability and safety based on sampled data, and to make decisions on corrective and mitigation.

13. VE 4XXX Vehicle Dynamics (3)

    This course will develop the models and techniques needed to predict the performance of a vehicle during driving, braking, ride, and steering maneuvers. Topics to be covered include: acceleration and braking performance, drive train performance. Matlab will be used as a computational tool for implementation of the models. Governing equations of motion are developed and solved for both steady and transient conditions.

14. VE 4XXX Vehicle Noise, Vibration and Harshness (NVH) (3)

    The objective of this course is to provide the student with training in the fundamental concepts of noise, vibration, and harshness (NVH) analysis and measurement, as well as

the principles of vibration and noise controls. The principles of NVH and sound quality are introduced and reinforced through hands-on laboratory sessions.

15. VE 4XXX Automotive Manufacturing and Design (3)

    This course presents an overview of vehicle manufacturing from an OEM perspective. Issues such as supplier integration, flexible manufacturing, and quality engineering methods and their applications to manufacturing are presented. Emphasis is placed on opportunities and challenges presented with automotive manufacturing in a global environment, integrated processes, product development, flexible and agile manufacturing, supplier integration. Design for manufacturing, computer aided manufacturing, rapid tooling technologies, technology integration, and virtual assembly are also discussed.

16. VE 4XXX CFD Modeling and Simulation (3)

    This course provides an introduction to the scientific principles and practical engineering applications of CFD. An overview of fundamental mathematical equations governing the fluid flow and heat transfer phenomena is presented along with practical use of commercial CFD codes for automotive applications.

17. VE 4XXX CAE Methods in Vehicle Modeling and Design (3)

    This course is designed to introduce to students the CAE techniques applied in the automotive industry, their role and limitations. Students will be introduced to the latest interactive modelling and simulation techniques and commercial software with the capability for automotive structural analysis and virtual product development.

18. VE 4XXX Electric and Hybrid-Electric Powertrain Design (3)

    The course focuses on electric and hybrid-electric powertrains components and architectures. Special emphasis is given to the use of such tools for component characterization, safely and efficiently interfacing electric machines and their controllers within the hybrid powertrain, accommodating accessory loads in hybrid powertrains and conducting system diagnostics.

19. VE 4XXX Energy Storage: Batteries and Fuel Cells (3)

    This course will focus on the fundamentals of battery and energy storage. Battery and fuel cell operations, characteristics, associated electronics including battery charging and monitoring. Battery related thermodynamics and ion and electron transport mechanisms will be discussed. Students will gain knowledge about battery electrode preparation, lithium based battery technologies and next generation batteries. Electrical modeling of

battery and development of state-of-charge and state-of-health algorithms for prediction of battery life will be covered as well.

20. VE 4XXX Automotive Communication Networks (3)

    Wired and wireless networks, network protocols, in-vehicle networks, vehicle-to-vehicle communication, vehicle-to-infrastructure communication, privacy and security, safety implications.

21. VE 4XXX - Electromagnetics for Automotive Systems

    Path loss and fading in automotive wireless communication systems, antennas, electromagnetic compatibility, interference sources, interference mitigation techniques.

AMERICAN HISTORY Requirement: All undergraduate students are exempt from this requirement if they have completed from one unit in American history at the secondary school level or six hours of American history in previous college. International students who have not completed one unit in American history at the secondary school level or six hours of American history in previous college work must enroll in American history in the first semester in residence and continue in consecutive semesters until they have earned six hours of American history (History 2010 and 2020), if exempted from ESL 1010 and 1020. International students who are required to take ESL 1010 and 1020 must enroll in American history upon completion of the ESL courses and continue in consecutive semesters until they have earned six hours in American history (History 2010 and 2020).

SECTION IV: STUDENT ENROLLMENT PROJECTIONS

Estimate the unduplicated annual full-time, part-time and FTE enrollments and number of graduates for the first five years of program operation. Include anticipated international enrollment if used as a primary recruiting tool. If the proposed program involves more than one institution, provide aggregated as well as disaggregated data for all institutions.

Complete a minimum of 3 years projection for certificates and associate degrees, 5 years projection for undergraduate and master's degrees and 7 years for doctoral degrees.

The numbers in the table below represent that the program will have a starting class of 25 students and at the end of five years the program is expected to grow to about 100 students. At this time, we do not anticipate any part-time or international students enrolled in the program. However, we are open to admitting these students in the future as the program matures and we are able to offer evening or distance classes. The growth will also depend on the availability of resources, advertising, and realization of the need for STEM students to fill future state job needs.

Table 3: Student Enrollment Projections

Year	Full-Time Headcount	Part-time Headcount	International Headcount Anticipated	Total Year Headcount	FTE*	Graduates
1	25	0	0	25	26.6	0
2	48	0	0	48	52.6	0
3	69	0	0	69	75.8	0
4	88	0	0	88	94.8	6
5	100	0	0	100	100	14

A. *Explain the basic assumptions including attrition rate used in estimating the size of the proposed program by benchmark against other comparable programs in the discipline*

and institution to establish a baseline for your projected enrollments. Assumptions should be related to the evidence of need and to other supportive data.

B. *Describe the recruitment plan for both domestic and international enrollment if anticipated. Please note: Programs may not be advertised prior to final approval through the THEC commission meeting per the THEC Policy 1.0.60.B*

Method Used to Support Enrollment Numbers:

The calculations shown above are based on total of credits each semester in the curriculum flow shown earlier divided by FTE of 15 credits for each semester to obtain FTEs. The total number of credits shown in the curriculum are 32, 34, 33 and 30 credits respectively during Freshman, Sophomore, Junior and Senior years.

The following assumptions are made: Retention rate=92% after each year, 4- year Graduation rate= 24%, and 5-year graduation rate =45%. These are the current graduation rate of engineering students at TTU as published by the Institutional Research, https://www.tntech.edu/ir/retention.

The program enrollment estimates listed in the Table 3 above are based on several studies. First, the current freshman students in the college of engineering at TTU were surveyed to ascertain an interest in a BS program in vehicle/automotive engineering. A short survey of consisting of two simple questions as shown in Figure 1 below was conducted. Out of approximately 530 freshman students who entered the CoE in the Fall of 2015, 96 students responded to the survey. It is seen from the figure below that about half the students who responded have expressed an interest in the program. It is reasonable to assume that we would have had about 45 students enrolled if the program had been existed at TTU in the Fall of 2015.

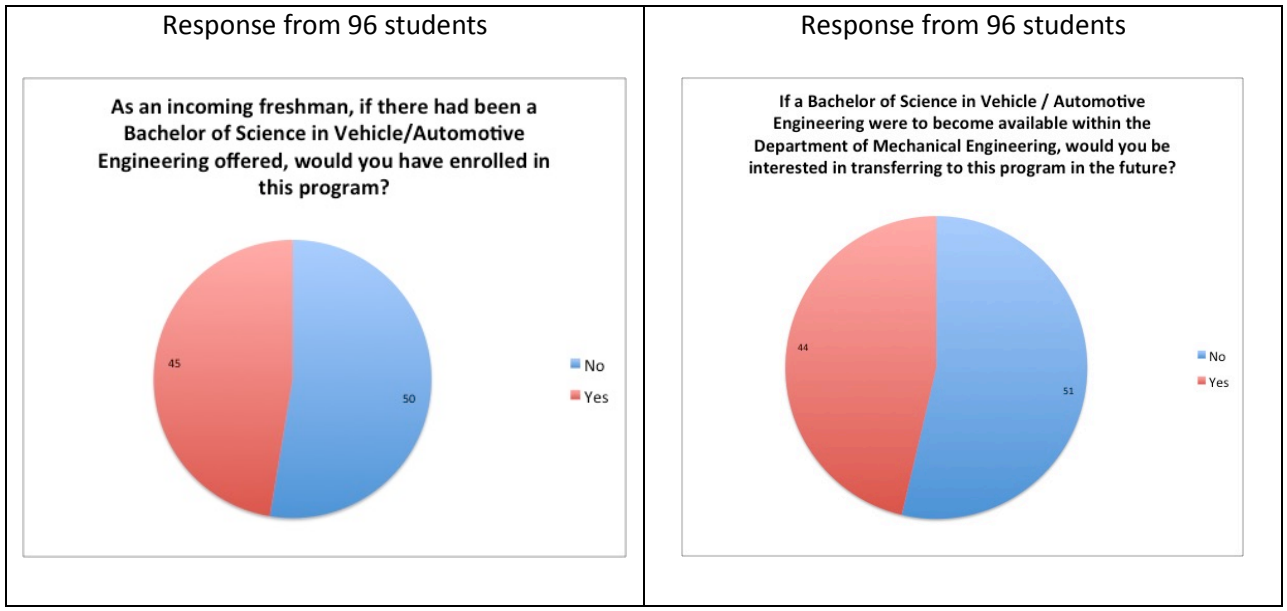


Figure 1. Results of Survey of Freshman Students in the College of Engineering at TTU.

Second, we examined the enrollment numbers at the newly established BS in Mechatronics Engineering at MTSU. The Mechatronics degree at MTSU is similar to the proposed BSVE in the sense that it is a very applied degree established through strong backings from industry in TN. MTSU had an initial projected enrollment of 12 students in 2013 growing to about 50 in 2017 in their letter of application proposal to TBR. However, as of 2015, their enrollment in the program has exceeded 240 students! This clears demonstrates a strong demand for degrees with direct industrial application similar to the proposed BSVE. In this respect, the projected enrollment for the BSVE could prove to be conservative.

Thirdly, it is reasonable to examine the general B.S.E. programs in other states that have been developed in the last 10 years. A 2012 ASEE paper conducted a survey of General Engineering programs in the nation.[6] This paper identified the following programs developed in the last 10 years. James Madison University and Marshall University have been added to this list since they are so new as to not be listed in the paper.

Following is a list of programs established in the last ten years and the year established (overall there are 24 B.S.E. programs accredited):

George Fox University	2003
Southern Utah University	2003
Robert Morris University	2004

[6] A Survey of General Engineering, Robert Grondlin, Arizona State University, ASEE paper AC 2012-4721

University of Southern Indiana	2004
Franklin W. Olin College of Engineering	2005
Andrews University	2006
Colorado State University, Pueblo	2007
East Carolina University	2007
Elizabethtown College	2007
Arizona State University Polytechnic	2008
Marshall University	2008
James Madison University	2011

From examining these programs and their growth and jobs reports, it is reasonable to project possible outcomes for the proposed BSVE program. The largest of the new B.S.E. programs listed above is the Arizona State University Polytechnic program which currently has 541 students. This program has the general engineering, electrical systems, mechanical systems, and robotics systems concentrations.[7] One of the smallest programs is the Marshall University program with only 20 students in the B.S.E. program. The newest program James Madison University, which was started in 2011, currently has 44 majors and is growing. Given the unique design of this degree, it is not unreasonable to expect growth to exceed at least 100 students or more at the end of five years.

Recruitment Plan:

The plan for recruiting students to the BSVE program will follow the same well-established current practice for recruiting students including minority students to other programs in the college of Engineering at TTU. These include several community outreach and high school outreach activities conducted throughout the year by the office of admissions, office of diversity affairs. The CoE Clay N. Hixson Student Success Center offers outreach opportunities to local high school students some of which are described at https://www.tntech.edu/engineering/cnh-ssc/outreach/

Although the TTU admissions office handles all freshman admissions, the CoE will be proactive in recruiting the best students to the proposed BSVE program. We seek to recruit a diverse student body that reflects community diversity and addresses the state's need to increase access to higher education for historically underrepresented and economically disadvantaged students.

[7] https://webapp4.asu.edu/programs/t5/programs/Keyword/Technology$0020and$0020Innovation$0020BSE/undergrad/false?init=false&nopassive=true

We will follow a multipronged approach in our recruiting some of which are:

- Develop brochures and a website for advertising the new program.
- Send mass emails and materials to students in local high school schools and colleges. Provide information that will help students in their decision-making process and then refer them to the website.
- Determine a "network" of connections within the local high schools and community colleges with particular emphasis on underrepresented populations.
- Identify students that are the best "fit' to this program and develop "pipelines" with colleagues at these institutions for new student referrals.
- Contact targeted students via telephone.
- Host an evening or weekend orientation to call prospective students.
- Advertise the program during freshman orientation and TTU community day in October.
- Advertise the program during the homecoming football, sporting and other college fair events.
- Use Facebook and other social media to advertise the program.

SECTION V: RESOURCES

A. Provide the most recent accreditation report/audits for any existing offerings within the same division/department/college which speaks to need or resource allocations.

Most recent Accreditation Results:

Engineering: The most recent accreditation of the five engineering programs (CHE, CE, EE, CmpE, ME) at TTU by the Engineering Accreditation Commission of ABET was in 2014-15. As a result of this visit, all programs received the maximum six year reaccreditation periods. Four of the five received completely "clean" audits (no deficiencies, weaknesses, or concerns), while Chemical Engineering had two "Concerns" regarding the adequacy of Faculty and Facilities. "Concerns", as per ABET, do not require and corrective action other than monitoring.

Computer Science: The last accreditation (2015) of the BSCS program by the Computing Accreditation Commission of ABET indicated two Concerns: Number of Faculty and Adequacy of Resources. Corrective actions are being taken by the program & University to address these issues.

Engineering Technology: The last accreditation (2012) of the BSET program by the Association of Technology, Management, and Applied Engineering (ATMAE) found no items out-of-compliance or in partial compliance, and full accreditation was given.

B. List any requirement for needed resources to support along with any industry contributions

Since TTU already has well established engineering programs with associated infrastructure including classrooms and laboratories, new resources to support the proposed BSVE program are tied to recruiting new faculty and purchasing new equipment to support vehicle related laboratory courses. As described earlier, the college

of engineering currently has oversubscribed degree programs and there is a strong need for additional faculty, support staff and space to catch up with the recent growth in undergraduate student enrollment. The new faculty and other resources requested below for the proposed BSVE will help alleviate some of the issues with high student-to-faculty ratio in ME and ECE departments. The proposed BSVE curriculum calls for the development of twenty (22) new courses, many of them are in the emerging areas and are interdisciplinary in nature. The successful implementation of the proposed program hinges on recruiting high faculty who can deliver the instructional experience to students. We propose to recruit a mix of four new tenure-track and lecturers with industrial experience in the various technical areas of need as mentioned in section D below.

As mentioned earlier, this program will be housed within the ME Department, hence most of ME facilities, classrooms, faculty and staff will be available in addition to some ECE resources. We expect to start with an initial enrollment of about 25 new students in the first year of the program and grow to about 100 students in five years. We expect to obtain contributions (financial and other) from industry for the TRAC initiative as it is developed and the availability of those resources to support the undergraduate degree program is unclear at this point. It is anticipated that those contributions will mostly benefit research and graduate programs. Hence it is important to make this BSVE self-sufficient from resource point of view. Please see attached letters of support (attached at the end) from several industries indicating strong support for the proposed program.

C. Cite the THEC annual degree productivity data where funds may be redirected from closed low-producing programs (THEC A1:1.2OP) of relevant.

Not Applicable as there are no closed low-producing programs in the college of engineering.

D. Faculty: Describe the strengths of the existing faculty in credentials and available FTE (state number of full- and part-time faculty). Estimate additional FTE (specify number of full-time and part-time faculty) needed to support the program. If faculty are drawn from multiple departments or are committed to teach in multiple programs, identify which faculty and the percentage of their time dedicated to each program.

Four new full-time faculty members (two tenure-track and two lecturers) in the areas of Vehicle Dynamics, Vehicle Systems Integration; Vehicle Computer Simulation, Vehicle Manufacturing, Reliability; Vehicle Electronics and Controls; Communications and autonomy. These positions will complement existing strengths in ME and ECE in the areas of Batteries, Noise and Vibration, Materials, Hybrid Vehicles, and Computational Fluid Dynamics. It is anticipated that the new positions will be recruited over a period of 1-4 years as described in the financial projections. In addition, support for one laboratory engineer along with two graduate students is requested to support the hands-on laboratory courses in the curriculum. The laboratory engineer along with graduate assistants will support the hybrid vehicle thread courses mentioned in the curriculum. The following

Table 4 describes the strengths relevant to vehicle engineering of existing faculty members in both ME and ECE departments; most already have an FTE of one in their respective departments. The students from BSVE taking existing courses will create additional FTE "teaching" of approximately .25 each for the two departments that will be offset by the four new faculty who will be required to teach one course in ME or ECE in addition to teaching and supporting the BSVE program. The additional faculty and support staff needed to support the program is shown in Table 5.

Table 4. Strengths of Existing Faculty Related to the Program

Name	Degree	Area of Expertise	Department
Alouani, Ali	PhD	Intelligent Autonomous Vehicles	ECE
Anton, Steve	PhD	Controls, Energy Harvesting, Vibrations	ME
Austen, Jeffery	PhD	Communication Systems, Signal Processing	ECE
Bhattacharya, Indranil	PhD	Batteries, Electric Vehicles	ECE
Canfield, Steve	PhD	Mechatronics, Dynamics of Vehicle Systems	ME
Chaoui, Hicham	PhD	Control Systems	ECE
Elkeelany, Omar	PhD	Embedded System Design	ECE
Hasan, Syed Rafay	PhD	Electronics, Embedded System Security	ECE
Johnson, Glen	PhD	Internal Combustion Engines	ME
Johnson, Wayne	PhD	Automotive Electronics Packaging, Manufacturing and Reliability	ECE
Languri, Ehsan	PhD	Energy, Thermal Management of Electric Vehicle	ME
Lee, ChuBum	PhD	Sensors, Transducers and Measurements	ME
Mahajan, Satish	PhD	Sensors, Electromagnetic Compatibility, V2G	ECE
Mahmoud, Mohamed	PhD	Network Security, Microcontrollers	ECE
Motevalli, Vahid	PhD	Hybrid Vehucles, Safety	ME
Ojo, Joseph	PhD	Power Electronics and Motor Drives, Modeling and Nonlinear Control, Battery	ECE
Rao, Mohan	PhD	Vehicle Noise, Vibration and Sound Quality	ME
Shirvanian, Alireza	PhD	Fuels Cells, Batteries	ME
Wilson, Chris	PhD	Modeling, Simulation, FEM	ME
Wilson, Dale	PhD	Baja SAE, Design	ME
Zhu, John	PhD	Materials	

Table 5. Additional Full-time Personnel to Support the Proposed program

Academic Year	Position	Degree	FTE	Expertise/Background
Year 1	Lecturer	MS	1.0	Automotive Design, Testing, Manufacturing
Year 1	Technical Staff	BS or Equivalent	1.0	Automotive Technician Experience
Year 2	Graduate Student Aide	BS	1.0	Mechanical Engineering
Year 2	Assistant Professor	PhD	1.0	Mechanical Engineering, Vehicle Mechanics, Manufacturing
Year 3	Assistant Professor	PhD	1.0	Electrical Engineering, Vehicle Electronics, Propulsion
Year 3	Graduate Student Aides	BS	2.0	Mechanical and Electrical Engineering
Year 4	Lecturer	MS	1.0	Automotive Electronics, Controls, Embedded Systems

E. Administrative/organizational structure and personnel

The proposed degree will be offered as a separate program in the ME department within the college of engineering. The ME department currently has a chair, associate chair and 19 full-time teaching faculty members. The administrative staff consists of five full-time personnel including three administrative associates, one master machinist and one laboratory engineer. The new laboratory engineer will have 50% appointments in each ME and ECE departments. The four new faculty requested will be shared equally (2 each) between the ME and ECE departments as well. During the first two to three years, the ME chair working with ECE chair will be responsible for administering the program including initial curriculum development, course scheduling and other logistical activities. One of the new faculty members in ME will eventually be appointed as the coordinator/director of the program in charge of curriculum, continuous improvement and accreditation as the program evolves. It is envisioned that in the future, as the TRAC initiative develops, all academic programs associated with TRAC including the BSVE and other graduate and research programs will be administered by one department/unit headed by the director of TRAC.

F. Clerical and Support Personnel, available and needed

The existing clerical and support personnel in both ME (3) and ECE (3) will handle supporting the additional students in the first five years. There will be a need for one additional clerical person as the program grows and integrated with the TRAC initiatives and graduate programs.

G. Describe existing library and information technology resources to be available to support the projected program.

Library:

The Angelo & Jennette Volpe Library building at TTU has 105,172 ft.^{2} of assignable space containing a total of over 2,020,000 items of materials in various formats. There are approximately 275,000 books and e-books (over 20,000 are in the engineering discipline); 91,000 bound periodical volumes (over 1,200 titles in engineering); 53,730 volumes of U.S. Government publication; and 62,000 pieces of various types of microforms. The Library Archive has approximately 3,615 ft.^{3} of space dedicated to University and regional papers, photographs, and artifacts. The map collection contains over 42,000 maps. The Library provides access to over 100 electronic resources, mostly databases, containing abstracts, articles, reports, and more. Access is available to over 12 engineering databases, including Knovel™, which connects users to over 4,000 engineering and science reference works and 95,000 interactive tables, graphs, and equations.

In fall 2011, the Volpe Library remodeled the main floor into a Learning Commons, which provides more technology for students, more student group study areas, other learning spaces, and a variety of seating and tables. The building is open over 95 hours per week during the fall and spring semesters.

The Volpe Library uses Millennium™, an integrated automation system from Innovative Interfaces, Inc., as its online catalog. In addition, the Library has an electronic search tool, called EagleSearch, which will search for any cataloged item (books, journals, databases, etc.) in and outside the library. These systems allow access to the Library's holdings and electronic resources from on- and off-campus. The Library is a member of the Southeastern Library Network (SOLINET). SOLINET is a regional network of the Online Computer Library Center (OCLC), a worldwide network. Through the interlibrary loan program, students and faculty have easy access to the holdings of most of the libraries in the United States and Canada, as well as a few libraries in other countries. This system (WorldCat) includes a record of over 2 billion library holdings for 72,000 libraries in 170 countries. Items requested through interlibrary loan are usually processed within two days. For faculty, the Library also offers an interlibrary loan service called 'Get It Now', which processes electronic articles and reports within an average of 20 minutes from the time of request. There is no charge for any of the interlibrary loan services. Tennessee Tech has partnered with several libraries that augment the library resources on campus. Students and faculty have access to the libraries of the University of Tennessee at Knoxville and all of the libraries of the Tennessee Board of Regents system. TTU also has a reciprocal borrowing program for faculty with Vanderbilt University, located in Nashville.

Information technology Service:

Information Technology Services (ITS) provides computer resources, services, and support for instruction, research, and administration at Tennessee Technological University. Information Technology Services is divided into four sections: Academic & Client Technologies (ACT), Administrative Systems Support, Network Services and Operations and Systems Support. A campus-wide Ethernet local area network (LAN), which uses fiber optic media, makes computing services available across campus. Wide-area networking is also available, allowing users access to the Internet.

The ACT supports the use of available technologies to enhance and support instruction and research. ACT also supports University Computer Labs across campus by providing trained workers, documentation, and training classes. ACT also provides first-level support for faculty, staff, and students across campus, including system analysis, new purchase consultation, and software site licenses. The Systems Support group consists of a manager and four analysts. Members provide internal support for the university servers. They install and maintain the operating system and its application software. They also identify and resolve system-related hardware and software problems. Members are responsible for performance monitoring and tuning, configuration, resource use, account authorization and security monitoring. Overall, the services provided by the TTU Library and ITS and Library are judged to be sufficient for the purposes of the BSVE program.

H. Describe Student Advisement Support. If the proposed program is part of a collaboration or articulation agreement, how will student advising be coordinated by all participating institutions to facilitate progression and completion across all participating institutions.

Since the BSVE program is proposed to housed within the ME department, the student advising procedure that is currently used in the ME department will be followed. In the ME Department, advising of students and providing career guidance is considered to be an important part of the role and responsibility of being a faculty member. While departmental staff members assist with the gathering of information and preparation of advising materials, the approval of course selection forms, substitution forms, course adds/drops, and senior electives requires the signature of a faculty member. Students meet with their advisors at least once a semester, as advisors must approval courses that the students wish to take the next term.

The advising of new freshman begins in the summer prior to the student's entrance term with participation in a SOAR session (Student Orientation, Advising, and Registration). Offered multiple times during the summer, the SOAR sessions enable students and parents to come to campus for a day-and-a-half to meet with their advisors and register for classes, as well as a number of other related activities and events.

The advising at SOAR and throughout the rest of their freshmen year is done by four dedicated advisors at the college level who serve as Freshmen Advisors for all engineering majors. These advisors have in-depth knowledge of issues related to freshmen advising, including such things as General Education requirements, AP & ACT course credit, and mathematics course requirements. Upon reaching their sophomore

year, each student is then assigned (based on the initial of their last name) a permanent faculty advisor for their remaining years in the undergraduate program.

At the college level, student advising is seen as an important area to student retention and success, key elements of the College of Engineering's Strategic Plan. As part of the College's commitment in this area, the "Clay N. Hixon Student Success Center" was created in the 2012-2013 academic year to. The Center currently has a full-time Director, four advisor positions, a staff support person, and several student ambassadors to "provide support, encouragement and resources to help our students as they work toward reaching milestones on the way to becoming 21st Century Renaissance Engineers".

Student advising is also a very important priority to the University as well. Evidence of this commitment can be seen in the University's new "Flight Plan", which sets out the institution's priorities and actions for the next few years. In this plan, "Improve Student Advising" appears as a top item in the plan's Focus Area 1-Enhance Quality of Undergraduate Student Experience.

I. Describe existing and anticipated instructional facilities & instructional equipment to support the proposed program.

Several classroom spaces directly controlled by the ME Department are available for instructional purposes. Available classroom space for instruction is 4399 square feet. As the undergraduate enrollment has increased, finding space to teach all the classes is becoming more of a problem, necessitating that ME department seek classrooms belonging to other departments. This is done using the classroom-scheduling software called "EMS" (Event Management Software) to assist in finding and scheduling available classrooms on a campus-wide basis. Overall, classroom space and quality is adequate for current enrollment, but will be problematic if the program continues to grow as it has the past several years.

The department also maintains a number of dedicated laboratory facilities to support the proposed program. A list of these is given in the Table 4 below. A listing of major equipment items purchased since 2008 in support of these laboratories is indicated in Table 5.

Table 4. Instructional Laboratory Space

Room	Description	Sq. Ft.
BRWN 119	Classroom/Lab- Measurements and Dynamic Modeling & Controls	500
BRWN 108	Laboratory – Measurements	763
BRWN 109	Laboratory – Energy Systems	769
BRWN 118	Laboratory – Senior Design	1067
BRWN 124	Laboratory – Mechatronics	769

BRWN 207	ME/ECE/CoE Computing Lab	764
CLEM 102	Laboratory - Energy Systems/Fluids	1575

In addition to the above, the following laboratories and facilities under the control of ECE department are also available to the proposed BSVE program.

- Embedded Systems Design Lab, Brown Hall 411
- Wireless Network Systems Lab, Clement Hall 400
- Electric Machines & Power Electronics Lab, Brown Hall 412
- Smart Grid Lab, Clement Hall 103
- Instrumentation & Sensor Lab, Brown Hall 409
- Advanced Systems & Robotics Lab, Brown Hall 408B
- Control Systems Lab, Brown Hall 410
- DENSO Power & Energy Lab, Prescott Hall 441
- DENSO Capstone Design Lab, Brown Hall 408
- Electronics Shop, Brown Hall 414B
- IT Shop, Brown Hall 414A
- Machine Shop, Prescott Hall 120B

The following is a list of major equipment items purchased over the last 5 years for upgrade and support of ME Department instructional and computing lab facilities.

Table 5. List of Equipment

PROVIDER	DESCRIPTION
Magtrol	HD Hysteresis Dynamometer
FLIR Systems	Thermal Imager
Edibon	Basic Hydraulics Bench
Turbine Technologies	Steam Turbine Power System
Atlas Corp	Dual variable-speed air compression/storage system
Edibon	Pipe flow friction apparatus
Edibon	Series and parallel pumping apparatus
AeroLab	Wind tunnel
PlasmaCam	Plasma table
CoE Project Truck	CoE Shop and Project Truck-ME Share
Newport Corp	Ed. Experiments in Laser Optics Kit
Polytec	Laser Vibrometer

The College of Engineering (CoE) has a wide variety of computing facilities available to serve both undergraduate & graduate students, faculty & staff. In particular, the CoE computer infrastructure includes the "MoLE-SI" (Mobile Learning Environment and Systems Infrastructure) wireless facility, and the CAE (Computer Aided Engineering) labs. These are available to all students in the College on an at-large basis. In addition to the College-wide labs, each CoE department typically has its own computing lab facilities accessible to their majors, often hosting specialized software particular to that major. Finally, there are also general-purpose computing labs maintained by ITS that CoE and other students have access to such as the Cornerstone labs in Clement Hall, the Volpe library, the TTU wireless network, and the Residence Hall wireless network (ResNet).

Overall, the instructional facilities and equipment available to students and faculty in the proposed program is judged to be adequate with the addition of new resources requested.

SECTION VI: FINANCIAL PROJECTIONS

A. *Use the THEC Financial Projections Form (FP) to provide revenues and expenditures for the proposed program. If the proposed program involved more than one institution, provide a separate excel FP Form for each institution as well as an aggregate for the combined financial projections.* ***Submit as an Appendix the THEC Financial Projection Form.***

B. If reallocation is used, provide a rationale and source for reallocation of budgeted funds. Cite THEC annual degree productivity data where funds may be redirected from closed/ low producing programs (A1:1.2OP), if relevant.

C. List for each institution involved:

1. *All active Letters of Application*
2. *Approved programs not meeting benchmarks*
3. *Low producing programs at all levels*
4. *Programs terminated within the last 12 months*

Tennessee Technological University

FINANCIAL PROJECTIONS-BSVE Degree Program

Assumptions:						
1	Estimated benefits rate for faculty & Staff:	30%				
3	Estimated average faculty & staff raise per year:	2%				
4	Tuition & Fees Estimate (16 crhr) - Year 1	$9,133				
5	Engineering Student Course Fee (SCF)	$60/credit				
8.	Estimated Tuition & Fees Increase per Year	4%				
I. EXPENDITURES						
A. One-time Expenditures		Year 1	Year 2	Year 3	Year 4	Year 5
	[a] New/Renovated Space-East Stadium Lab	$ 20,000	$ 20,000	$ -	$ -	$ -
	[b] Equipment	$ 50,000	$ 90,000	$ 110,000	$ 80,000	$ 50,000
	Library	$ -	$ -	$ -	$ -	$ -
	Consultants	$ -	$ -	$ -	$ -	$ -
	Other (ABET Accreditation Fees)	$ -	$ -	$ -	$ -	$ 12,000
Total One-time Expenditures		$ 70,000	$ 110,000	$ 110,000	$ 80,000	$ 62,000
	a Renovation of East Stadium Lab for Hybrid Baja to be done in two stages; b- See separate equipment list for details					
B. Recurring Expenditures						
Personnel						
Faculty		Year 1	Year 2	Year 3	Year 4	Year 5
	Salary, Lecturer, full-time	$ 60,000	$ 61,200	$ 62,424	$ 63,672	$ 64,946
	Salary, Assistant Professor full-time		$ 90,000	$ 91,800	$ 93,636	$ 95,509
	Salary, Assistant Professor full-time	-	-	$ 91,800	$ 93,636	$ 95,509
	Salary, Lecturer, full-time	-	-	-	$ 63,672	$ 64,945
	Salary, BSVE Coordinator (faculty suppl)	$ 15,000	$ 15,300	$ 15,606	$ 15,918	$ 16,236
	Total Faculty Salary	$ 75,000	$ 166,500	$ 261,630	$ 330,535	$ 337,145
	Benefits	$ 22,500	$ 49,950	$ 78,489	$ 99,160	$ 101,144
Total Faculty		$ 97,500	$ 216,450	$ 340,119	$ 429,695	$ 438,289
Support Staff		Year 1	Year 2	Year 3	Year 4	Year 5
Technician Staff for Hybrid Baja Expereince, Full time						
	Annual Salary Rate	45,000	45,900	46,818	47,754	48,709
	Benefits	$ 13,500	$ 13,770	$ 14,045	$ 14,326	$ 14,613
Graduate Teaching Assistant						
	Stipend Rate	$ 9,600.00	$ 9,792.00	$ 9,987.84	$ 10,187.60	$ 10,391.35
	Tuition	10,400.0	10,816.0	11,248.6	11,698.6	12,166.5
	Number of Students	0	1	2	2	2
	Total for Graduate Aides	$ -	$ 20,608	$ 42,473	$ 43,772	$ 45,116
Total Support Staff Salary		$ 58,500	$ 80,278	$ 103,336	$ 105,853	$ 108,438
C. Operating		Year 1	Year 2	Year 3	Year 4	Year 5
	[c] Travel for faculty and staff development	$ 2,000	$ 3,000	$ 3,000	$ 4,000	$ 4,000
	Printing, Copying, Mailing	$ 500	$ 500	$ 500	$ 500	$ 500
	[d] Materials and Supplies	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000
Total Operating		$ 7,500	$ 8,500	$ 8,500	$ 9,500	$ 9,500
Notes:	[c] Travel from TTU to I-CAR and other places for faculty and staf development					
	[d] Miscelleanous instructional supplies and materials					
Total Recurring Expenses		$ 163,500	$ 305,228	$ 451,955	$ 545,048	$ 556,227
TOTAL EXPENDITURES (1-time & Recurring)		$ 233,500	$ 415,228	$ 561,955	$ 625,048	$ 618,227
II. REVENUES						
		Year 1	Year 2	Year 3	Year 4	Year 5
Students Enrolled in the BSVE Program:		25.0	48.0	69.0	88.0	100.0
	Tuition & Fees/Student	$ 9,133	$ 9,512	$ 9,907	$ 10,318	$ 10,746
	Engineering SCF ($60/credit/student)	$ 420	$ 840	$ 2,040	$ 1,260	$ 1,140
Total Tuition & Fees		$ 238,825	$ 496,897	$ 824,327	$ 1,018,855	$ 1,188,609
Fedreal Grants		-	-	-	-	-
Private Grants or Gifts		-	-	-	-	-
Other		-	-	-	-	-
Revenue Tuition and Fees		$ 238,825	$ 496,897	$ 824,327	$ 1,018,855	$ 1,188,609
TOTAL REVENUES		$ 238,825	$ 496,897	$ 824,327	$ 1,018,855	$ 1,188,609

List of Laboratory Equipment needed for the program:

1. Upgrade to existing engine and chassis dynamometers with new data acquisition and controls: $60,000.
2. The FCT Single Channel Fuel Cell Testing Station including unit for fuel cell/battery laboratory: $50,000.
3. Equipment upgrades to existing measurements, mechatronics and energy laboratories: $150,000.

    - Energy Lab: Smoke meters, Temperature Sensors, Airflow Measurement Systems, Speed Measuring Systems ($20k)
    - Measurement Lab: Strain gage kits, Pressure gages, load cell measuring systems($30k)
    - Engine Lab:, Engines test benches, Exhaust gas and emission handling system ($30k)
    - NVH Lab: Noise, Vibration and Harshness Software and hardware ($25k)
    - Mechatronics Lab: Sensors, microcontroller kits ($20k)
    - Dynamic Modeling and Control Lab: Simulation software, laptops ($25k)

4. Hybrid Baja Lab (30k)

5. <u>Vehicle Communications Lab ($15)</u>

    - Spectrum Analyzer $12,000
    - Biconical Antenna $1000
    - Log Periodic Antenna $1300
    - EMC Probe Set $400
    - Conical Log Spiral Antenna $300

6. <u>Autonomous Vehicle Lab ($75k)</u>

    - Real Time Mapping Lidar $8000
    - Ultrasonic sensors: MB8450 Car Detection Sensor, 2 10-Pack @ $1000=$2,000
    - Lukas 1080p Wi-Fi Front and Rear Dash Camera with GPS 4@$280=$1,100
    - IR Distance Sensors 20@$25= $500
    - Stepping Motor Control PISO-PS400 $1,400
    - High Speed Data Acquisition NI-PXI6255 $3K
    - 4 GHz Oscilloscope $40K
    - 4 High Speed computers $8K
    - 2 laptops $3K
    - Basic lab infrastructure: power supply, soldering station, etc. $8K

Letters of Support from the following are attached:

1. Hankook Tire Manufacturing, TN
2. Mahle Engine Components, Morristown, TN
3. Tom McKay, Independent Consultant, Formerly of Nissan and Visteon
4. Tennessee Automotive Manufacturers Association (TAMA), Nashville, TN
5. C&S Plastic, Fayetville, TN
6. Calsonic Kasei, Shelbyville, TN
7. Denso, Athens, TN

Hankook
driving emotion

October 16, 2015

Chancellor John Morgan
Tennessee Board of Regents
1415 Murfreesboro Pike
Nashville, TN 37217

Dear Chancellor Morgan:

I am writing in support of Tennessee Tech University's proposal to offer a new Vehicle Engineering undergraduate degree.

In January of 2015, Hankook Tire Manufacturing Tennessee began the three year process of hiring engineers. These engineers will be classified as manufacturing, mechanical, electrical, chemical, industrial and process engineers.

The degree being proposed by Tennessee Tech University will allow Hankook Tire access to graduates in the specialized fields of interest in vehicle engineering. As we ramp up and become established, Hankook Tire would be interested in students for internships and co-op positions while they complete their education requirements at TTU. Additionally, TTU graduates will be well suited for our entry level positions as process engineers and quality control engineers that develop, maintain, support and enhance industrial operations and systems. It is our intent to fulfill our engineering needs from the Tennessee region and Tennessee higher education facilities.

Sincerely,

KK Mangold

Kenneth K. Mangold
Human Resource Manager
Hankook Tire Manufacturing Tennessee, LP

MAHLE

Driven by performance

October 21, 2015

MAHLE Engine Components USA, Inc.
One Mahle Drive PO Box 748
Morristown, TN 37815
Phone +1 423 581-6603
Fax +1 423 587-5170
www.us.mahle.com

Tennessee Board of Regents
Chancellor John Morgan
1415 Murfreesboro Pike
Nashville, TN 37217

BSVE - Tennessee Tech University

Dear Chancellor John Morgan,

I am writing to express MAHLE's support for the implementaion of a Vehicle Engineering undergraduate degree (Master's and PhD to follow) at Tennessee Tech University. With Tennessee being host to many automotive companies, the addition of this program would only make sense.

MAHLE is a leading global development partner for the automotive industry. With more than 10,500 employees in 32 cities, MAHLE North America generated sales of $2,266 million in 2014. In Tennessee, we have facilities in Morristown and Murfreesboro producing pistons, camshafts and filteration products. As MAHLE grows, the need for advanced automation becomes critical to our operations. These automated processes require the best of the best engineers.

Tennessee Tech Univerisity is one of our premier recruiting schoools and Tennessee is a great place to do business. We want to continue to be here for many years to come.

Sincerely,

Tonya Shortt
Human Resources Recruiting and College Relations

Tom McKay
6295 Los Bancos Drive
El Paso, TX 79912

October 5, 2015

Tennessee Board of Regents
New Program Review
1415 Murfreesboro Road, Suite 350
Nashville, TN 37217-2833

To Whom It May Concern:

The purpose of this letter is to express my support of the new proposed Bachelor of Science in Vehicle Engineering major at Tennessee Tech. I have worked over 27 years in the automotive industry including more than 19 years at Nissan in Smyrna, TN and in Japan as well as 7 years at the Tier 1 supplier level. In my most recent position at Halla Visteon Climate Control I was responsible for 9 plants and over 2,500 team members across North and South America. I have hired many engineers for my teams over the years, but none had the the foundation as a new graduate that this degree program will provide.

The new proposed curriculum is excellent. It is broad and comprehensive including both mechanical and electrical engineering courses. The 4 year BAJA project is outstanding and will help future tech graduates enter the work force well prepared including hands on experience with vehicles and experience working in teams which are critical for their future success. There is a strong need for qualified vehicle engineers and this program meets a growing need in industry.

Thank you for your consideration. If I can answer any questions or provide further insight, please contact me at either or by phone at 1-915-208-0079.

Sincerely,

Tom McKay

CC: Joseph Rencis, Ph.D., Vahid Motevalli, Ph.D., Mohan Rao, Ph.D. Tennessee Tech University

Rick Youngblood, President
Tennessee Automotive Manufacturers Association
217 Fifth Avenue North, Suite 200
Nashville, TN 37219

October 30, 2015

Chancellor John Morgan
Tennessee Board of Regents
1415 Murfreesboro Pike
Nashville, Tennessee 37217

Dear Chancellor Morgan,

It is my pleasure to express support for the proposed degree programs being developed to support the Tennessee Research Automotive Center. Having served the automotive industry in Tennessee for more than 30 years, I am very appreciative of the work being done to promote a sustainable workforce within our state.

In addition to serving as the plant manager of Nissan's facility in Decherd, it is my pleasure to function as the President of the Tennessee Automotive Manufacturers Association (TAMA). My involvement with TAMA allows me the opportunity to work with many of the leaders within Tennessee's automotive sector, and the association's top objective is to understand and seek resolutions to the problems faced within the industry on a daily basis. Developing a skilled workforce for the future of the industry is a topic that continually rises to the forefront as one of the challenges that we all face every day.

Recently, TAMA, along with several automotive manufacturing associations from other Southeast states, participated in a study conducted by the Center for Automotive Research (CAR) to determine how our region can continue to excel within the industry. One quote that I will share from the results of that study highlights the feelings of the automotive manufacturing associations. "The availability and interest of qualified workers was overwhelmingly cited by the companies interviewed for this study as the region's greatest obstacle to attracting new investment. Deficiencies were reported not only in availability of sufficient quantities of applicants but also in the capabilities and qualifications of the region's labor pool."

In short, I wholeheartedly support the initiatives being undertaken, and strongly believe that this will help to build a sustainable future for the industry not only in the great state of Tennessee, but across the Southeast as well.

Sincerely,

Rick Youngblood
President, Tennessee Automotive Manufacturers Association

October 29, 2015

Chancellor John Morgan,

I have been involved in the southern automotive sector for over 30 years. I have witnessed the growth of the automotive industry move south and continue to see more and more involvement from the educational institutes such as TTU. The growth has been so significant that it has caught many of us by surprise and now everyone is trying to catch up with the demand.
The proposed BSVE program aligns the vision and mission of TTU to provide academic and cultural leadership in the region to produce graduates to assist with the immediate need of engineers in the automotive sector. These individuals will assist in many areas other than automotive but I am partial to the automotive side.
I had the pleasure of visiting TTU this year and was amazed at what was being offered to the future engineers at this fabulous campus.
We all know the need for top level engineers in the US, but hopefully we can keep them in the south.
I cannot express how much success this higher education plan would benefit the students at TTU along with assisting the entire southern automotive sector.

I would highly recommend the Bachelor of Science in Vehicle Engineering program and hope it is another great success story for everyone involved at Tennessee Technology University.

Sincerely,

Ed Carter
V.P. Product Development
C&S Plastics LLC
24 Franke Blvd.
Fayetteville, TN 37334
Work 931-438-8200 ext. 2302

CalsonicKansei

October 28, 2015

Tennessee Board of Regents
Chancellor John Morgan
1415 Murfreesboro Pike
Nashville, Tennessee 37217

RE: Bachelor of Science in Vehicle Engineering Program at Tennessee Technological University

To whom it may concern:

This letter is in support of Tennessee Technological University creating and offering a Vehicle Engineering undergraduate degree. Expansion of Vehicle Engineering programs at the university level is key to insuring a strong future workforce in our mid-state of area. The automotive and transportation industries are moving toward technology advancements at a rapid pace and this initiative is crucial for workforce development. Tennessee Tech has a foundation of successful undergraduate engineering programs that are filling the pipeline for many automotive suppliers and OEMs, which makes them an ideal university to focus on Vehicle Engineering. This program would be beneficial for many local automotive manufacturers, giving them the opportunity to obtain job ready talent at an entry level with training on cutting edge technology in the industry.

As a Tier 1 Supplier, the need for Engineers who have prior automotive hands on experience and knowledge is continuously growing. Especially, as the industry moves toward electric and autonomous vehicles, we will need this new skill set readily available in our engineering teams to keep us competitive. CKNA currently employs over 150 team members in engineering positions. Due to the demands of the market and the technology changes in our industry we expect to have a steady need for skilled engineers in the areas of vehicle safety, noise and vibration, sensors and electronics, embedded hardware and software, etc.

The Automotive Industry is becoming extremely competitive as technology advancements become more prevalent in passenger vehicles. It is imperative that we create a mechanism to fill the pipeline with qualified individuals who can step in and assume the engineering roles of the future. This program will provide access to a broader base of entry level employees with the required skills to come to work for CK and other automotive manufacturers.

Signed: Kimberly Williams

Kimberly Williams
Vice President of Modules Manufacturing & Quality
CalsonicKansei North America

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DENSO

DENSO MANUFACTURING ATHENS TENNESSEE, INC.
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October 30, 2015

Tennessee Board of Regents
Chancellor John Morgan
1415 Murfreesboro Pike
Nashville, Tennessee 37217

Dear Colleagues:

I am pleased to write this letter of support for the Tennessee Research Automotive Center (TRAC) at Tennessee Technology University (TTU). One of the crucial elements of the project is for TTU to create and offer a Vehicle Engineering undergraduate degree. This degree program will support the Automotive / Transportation industry in Tennessee and the South East with even more job ready engineering graduates for the future.

DENSO Corporation is a global automotive components manufacturer with 28 manufacturing facilities in North America that employee over 17,000 people. During our longstanding relationship with TTU College of Engineering, we have provided opportunities for student projects and access to full-time job positions in engineering when students complete their degree at TTU.

We at DENSO understand the need for a strong, diverse workforce full of well-trained and highly skilled candidates. It is often difficult to find quality engineers to fill out vacant positions. We are therefore excited to work with TTU on its Vehicle Engineering program: TRAC. By increasing the number and diversity of engineering graduates, the program will have a great impact on the local graduates and provide DENSO and other local industries with a larger pool of qualified candidates. Our engineers show our support for the program by serving on career panels and/or as speakers for the course or workshops.

Thank you for your consideration of Tennessee Technology University's TRAC program. I am pleased to support this program and its innovative approach to address DENSO's workforce need and those of other corporations.

Sincerely,

Hugh Cantrell
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