Applied Baccalaureate Degree Program
Mechatronics Engineering Technology and Automation

Program Proposal

COVER SHEET
NEW DEGREE PROGRAM PROPOSAL

Program Information

Institution Name: **Clover Park Technical College**

Degree: **Bachelor of Applied Science in Mechatronics Engineering Technology and Automation** CIP Code: 15.0406

Name(s) of the existing technical associate degree(s) that will serve as the foundation for this program:

Degree: Mechatronics AAS-T CIP Code: 15.0403 Year Began: **2014**

Degree: Mechatronics AAT CIP Code: 15.0403 Year Began: **2014**

Planned Implementation Date (i.e. Fall 2014): **Fall 2020**

Proposal Criteria: *Please respond to all eight (8) areas listed in proposal criteria FORM D.*
Page Limit: 30 pages

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Chief Academic Officer

1/31/22
Date

Table of Contents

Introduction

Mechatronics is the interdisciplinary approach to complex systems where electrical, mechanical, and computers are used in combination. Though the terminology is somewhat new to the region, it is well established in Europe and Asia, and it is an increasingly high-demand field with few training providers in our area. Automation is an application of mechatronics that is growing rapidly as any scan of the news headlines will tell you. Clover Park Technical College (CPTC) proposes implementing a BAS: Mechatronics Engineering Technology and Automation (BAS-META) degree to better prepare our mechatronics associate degree graduates for today's job market. Mechatronics associates graduates enjoy an excellent employment record in entry-level advanced manufacturing careers. The new degree would build upon our current AAS-T in mechatronics by adding additional engineering math and physics, as well as hands-on work with cutting edge industrial technology and practices such as IIOT, Digital Twins, Sustainable Manufacturing, and Data Analytics.

We believe that this degree will be unique to the state and therefore have no risk of saturating the market. Our proposal differs from other engineering technology degrees in the state in both approach and scope, as well as the content of the offerings.

The BAS-META degree has the potential to serve the workforce of virtually all local and regional industries. Mechatronic systems are everywhere and growing increasingly complex. The rapid adoption of automation solutions across a broad swath of industries from manufacturing to processing to distribution to foodservice, will act as an accelerator for the demand of mechatronics engineering positions. As these systems all have a complex interplay between what were separate engineering disciplines, the clear advantage of a multidisciplinary system approach is apparent. It is difficult to find a deployment of a purely mechanical or a purely electrical system. Mechatronics graduates possess a unique strength in the creation and use of such systems as they understand the interfaces between all these disciplines. It is imperative for the economic growth of our community and region that there is a qualified workforce to meet these forthcoming technological changes. BAS-META graduates will be prepared to fulfill these needs while driving innovation in our industry forward.

Our capacity to meet Criteria 1-8 is explained, in order, below.

Criteria 1: Curriculum Demonstrates Baccalaureate Level Rigor

Curriculum demonstrates baccalaureate level rigor.	Describe curriculum including (1) program learning outcomes (2) program evaluation criteria and process (3) course preparation needed by students transferring with technical associate degree (4) general education component (5) course work needed at junior and senior levels in the BAS.

The curriculum and program outcomes for the BAS-META degree has been developed under the guidance and in close cooperation between experts from both industry and academia. During the development work, surveys have been taken to gain an understanding of industry preference and need, conferences and training opportunities provided by automation and technology companies have provided an insight into the available technologies and their potentials, and close attention to the advisory board of CPTCs Mechatronics program thoughts and feedback has been instrumental in generating this document. The program is intended to be a daytime hybrid program. Within the hybrid spectrum, it will lie more on the side of in person than online due to the hands-on skills required. Most industries in our space operate three shifts or schedules such as four ten-hour days, thus allowing working individuals the opportunity to attend these classes two days a week.

Program Outcome Development

The program learning outcomes have been adapted from ABET engineering technologies outcomes and follow the pattern established by the requirements of the ABET ETAC “Criteria for Accrediting Engineering Technology Programs. They are also consistent with existing ABET ETAC-accredited baccalaureate-level engineering technology degrees.

Program Learning Outcomes:

1. Devise solutions to broadly-defined engineering problems in complex mechatronics systems through the application of knowledge, techniques, skills, and modern tools of mathematics, science, engineering, and technology.

2. Design systems, components, or processes meeting specified needs for broadly-defined engineering problems for mechatronics systems.

3. Compose written, oral, and graphical communication in broadly-defined technical and non-technical environments.

4. Evaluate appropriate technical literature for application in mechatronic systems.

5. Evaluate the results of standard tests, measurements, and experiments for the improvement of processes, efficiency, and sustainability in mechatronic systems.

6. Build effective technical teams both as a member, as well as a leader.

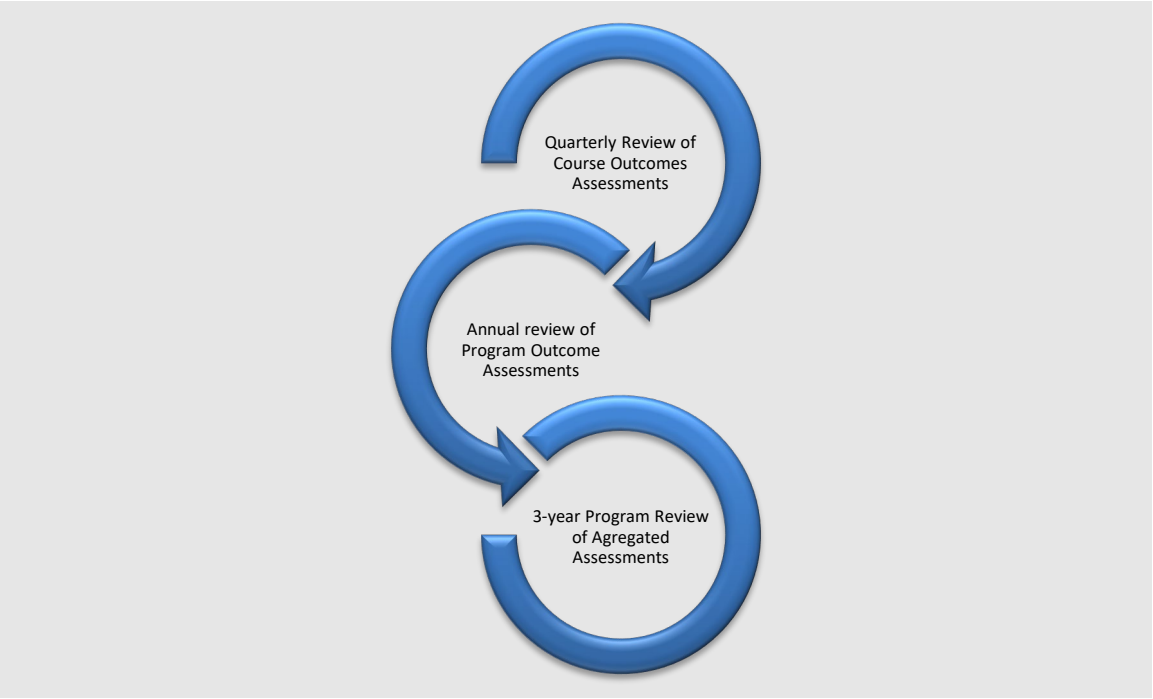
Program Evaluation Criteria and Process

All programs at Clover Park Technical College are formally reviewed on a three-year basis. The Dean of Instruction may choose to hold additional informal assessments, particularly as the program is in its infancy.

The BAS-META program will be evaluated on a quarterly, annual, and three-year cycle. A quarterly evaluation will be provided by the program's advisory board as well as faculty. The program's advisory board will be able to provide insight and professional opinions on current activities within the program as well as providing feedback on the directions the program intends to pursue. Annual evaluations are internal faculty assessments of students' ability to achieve program-level outcomes. Three-year evaluations are known as Program Reviews.

Per CPTC's Policy and Procedures Manual, a formal review of the BAS-META program for effectiveness will be conducted on a three-year basis. In addition to the formal program reviews, the Dean of Instruction may choose to employ other criteria and methods for assessing the entire program, drawing upon the input from a variety of stakeholders, including the following:

> *Program Advisory Committee*: The mechatronics program at CPTC has a healthy and diverse Advisory Committee comprised of industry experts who provide perspective, evaluation, and feedback on the program. With the addition of the BAS-META degree, we will look to add additional members to the board to better represent the diversity of stakeholders, including regional employers and alumni that request bachelor's degrees. This advisory committee currently holds meetings once every quarter of the year.
>
> *Student Assessments:* The program learning outcomes will be mapped to individual course learning outcomes, which will, in turn, be mapped to objective rubric-based assessments of student learning in the coursework. Evaluation of how well students are meeting course outcomes will be done on a quarterly basis and an aggregate of these assessments will be mapped up to the program learning outcomes on an annual basis to be reviewed by faculty and the advisory committee for potential curriculum changes. Program reviews will include a three-year report of these outcome assessments for administrative review.



Student Surveys: Upon graduating from or leaving the program, students will be surveyed as to what they perceived to be the strengths and weaknesses of all aspects of their experience, including classroom activities, pedagogical techniques, the relevance of specific courses, and other criteria, as appropriate.

Employers Survey: Mechatronics faculty at CPTC are active in the industry and gain information about current industry standards as well as the success of their students in the field. Faculty may decide to develop a formal survey for alumni employers to better track this type of information.

Faculty Evaluations: On a regular basis, the program faculty will meet as a team to discuss the program and its current curricula, and how they might be improved.

Course Evaluations: To provide specific feedback from the students' perspectives, surveys of student assessments on course and instructor effectiveness are distributed at the end of each quarter.

Wage Progression and Employment Status: The Mechatronics faculty at CPTC already tracks the status of the associate degree alumni and will continue to develop reporting processes for graduates of the BAS-META program that are consistent with CPTC best-practice.

CPTC's Mechatronics program has several external certifications cross-walked and paired with its offered courses. The external certifications provide third-party validation for the skillsets that students have acquired by completing a specific course. The Solidworks CSWA certification, for example, is a sought after and resume building certification.

The CPTC mechatronics program is currently exploring integrating Siemens SMSCP (Siemens Mechatronic Systems Certification Program) level 1 and 2 certifications into its curriculum. The Siemens SMSCP certifications are vendor-neutral mechatronics certifications offered in three levels from one of the largest automation and industrial solution providers in the world. Level 1 of the SMSCP certifies the student as an intelligent-machine operator, being able to interact with and operate the increasingly complex equipment in today's modern manufacturing environments. Level 2 certifies the student as a mechatronics technician, capable of troubleshooting, augmenting, and repairing complex systems. Level 3 of the SMSCP certifies the student as a creator and designer of complex mechatronic systems, an expert on systems. The intention is for students to be able to take their SMSCP level 1 certification as a mid-degree milestone and level 2 as one of their finishing milestones for the Mechatronics associate degree. The integration of SMSCP would be extended to include the BAS-META where the goal is to have students pass SMSCP level 3 certification as part of the conclusion of the program. SMSCP certifications would be offered and proctored twice a year for students to complete these certifications.

Two other strong certifications considered for the BAS-META are the Certified Motion Control Professional certification offered by MCMA (Motion Control & Motor Association) and Certified Vision Professional Program offered by AIA (Automated Imaging Association - Global Vision Systems Trade Association). AIA is the world's largest global vision and imaging trade group, organized specifically to advance global understanding and implementation of vision and imaging technologies like machine vision. The MCMA certification deals specifically with motion control and automation technologies. Both certifications are regarded in the industry.

The mechatronics program firmly relies on lean process principles when it comes to program improvement and development. Standardization, continuous improvement, and visualization allows the faculty to constantly be working on a new iteration of the program where all decisions are based upon objective data.

Course Preparation Needed by Students Transferring with Technical Associate Degree

In the development of the BAS-META, it has been the intention to be as open access and available as possible. Admission requirements are flexible to allow for broad participation without compromising the likelihood of success for future graduates.

Students will have three potential entry points for enrolling in the program. One entry point will be for students with a non-mechatronics associate degree. A second entry point will be for graduates of the Clover Park Technical College associate-level Mechatronics program. A third entry point will be for associate-level Mechatronics graduates of other colleges with established articulation agreements.

***Non-Mechatronics associate degree candidate*:** Candidates with an earned associate degree (or equivalent) from a regionally-accredited institution with a minimum of 90 quarter credits, of

which 20 credits are in the General Education Requirements listed below, will be eligible to enroll in the BAS-META however they must complete the BAS-META technical bridge before taking any upper-division coursework. Readiness to take MATH& 142 after the bridge is also required. It is recommended that students have some experience in a higher-level programing language before entry into the bridge, either through coursework, exposure via online courses/tutorials or practical experience with development platforms such as Arduino or Raspberry Pi.

The technical bridge consists of three five-credit intensive courses designed to bring the non-mechatronic students skillset up to a level where they will be able to succeed in the BAS-META program.

The BAS-META technical bridge consists of:

MEC 201 Systems Approach (5 credits) – The analysis and manipulation of complex systems from a top-down modular approach. Students learn how to divide a complex system into smaller modules and mapping them down to their single components, identifying sources of power, control signals, and conversions of energy along the way.

MEC 202 Total Mechatronics (5 credits) – A course that provides an expedited analysis of the core disciplines utilized in mechatronics. The course serves as a refresher or introduction to the most important principles utilized within the realm of mechatronics including AC/DC circuits, motors and drives, PLC programming, digital electronics and networks, hydraulics and pneumatics, and mechanical systems.

MEC 120 CAD (5 credits) - Introduces the use of parametric Computer-Aided Design (CAD) software to design parts working from engineering sketches and/or prototypes. CAD is an important tool for visualization and expression in the mechatronics field and is part of a vital skillset to be successful in the BAS-META program.

Mechatronics and automation have become a part of everyday operations for so many industries that it is important to offer an opportunity to a broad range of backgrounds including the foodservice and retail industry. The technical bridge will allow these traditionally non-mechatronic fields to cross-train and acquire vital skillsets to either transition or bring mechatronics into their current field. The technical bridge will be ready and offered for the first time during the summer of 2021. Graduates of the technical bridge will be eligible to enroll in the BAS-META program starting the fall of 2021.

Graduates of the CPTC associate-level Mechatronics program: AAS-T graduates of the CPTC mechatronics program will be eligible to enroll straight into the BAS-META program. The AAS-T mechatronics graduates will as a result of their degree have all necessary general education credits as well as the technical preset to be qualified for the BAS-META program. Graduates of the AAS-T in Mechatronics at CPTC will be eligible to enroll for the BAS-META program start fall quarter 2020.

***Graduates of other colleges with established articulation agreements*:** CPTC is currently in the process of exploring and developing articulation agreements with regional colleges. The ambition is to develop paths into the BAS-META program for all regional mechatronics program graduates.

General Education Component

To be admitted to the BAS-META program students must have a minimum of 23 general education credits from the distribution outlined below. Of these credits, three credits in COLL 102 may be waived for students transferring in with a GPA greater than 3.0. Students will acquire an additional 20 credits of general education courses during the junior level of the BAS-META program and an additional 27 credits of general education at the senior level. This is a total of 70 credits of required general education courses.

The general education credits will be distributed accordingly:

College Success – 3 credits

Consisting of COLL 102 College Success for All

Communications – 10 credits

Consisting of ENG &101 English Composition and ENG &235 Technical Writing

Quantitative – 20 credits

Consisting of MATH &141 Pre-Calculus I, MATH &142 Pre-Calculus II, MATH &151 Calculus I, and MATH &152 Calculus II

Humanities – 10 credits

Consisting of PHIL 310 Professional Ethics, and an additional 5 credits in any humanities subject

Social Science – 10 credits

Consisting of PSYC &100 General Psychology and PSYC 311 Industrial & Organizational Psychology

Natural Science – 12 credits

Consisting of PHYS& 221 Engineering Physics I and PHYS& 222 Engineering Physics II

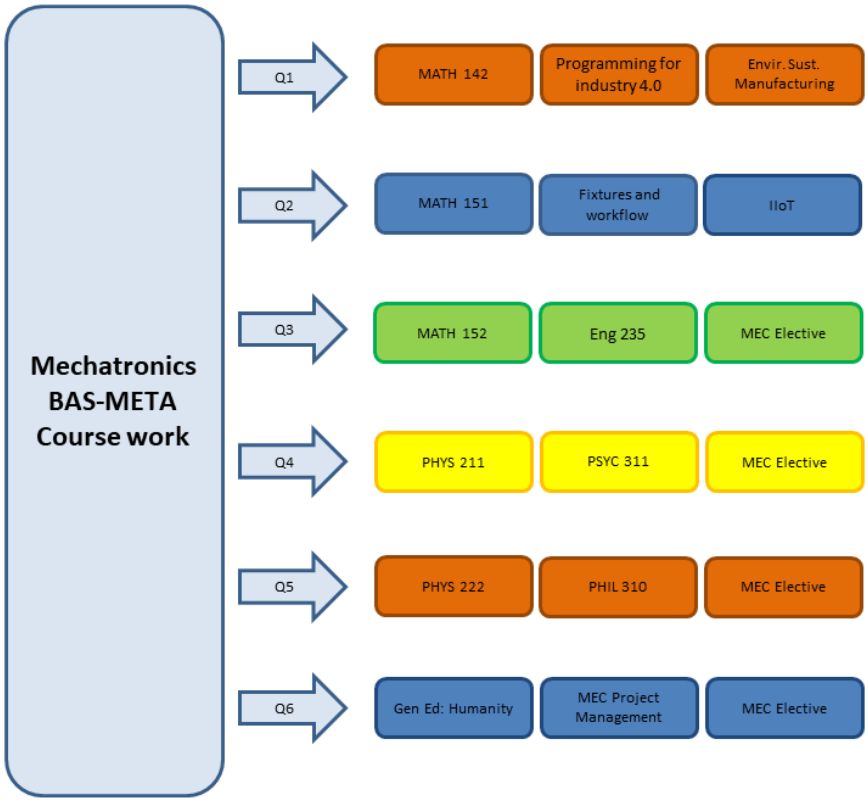
An additional 5 credits must be taken in either the humanities, social sciences, or natural sciences.

The general education requirements have been established according to the guidelines and standards established by the State of Washington and ABET ETAC in order to create a high quality and sustainable engineering technology program.

Course work needed at the junior and senior levels

Course work is designed around 15 credits per quarter, three quarters a year. Quarter loads will vary between ten to five credits credit split between mechatronics and general education, and the inverse of this ratio. The sixth and final quarter is centered on a capstone experience where the students are tasked with leading a project according to the course description provided later in this chapter.

Figure 1. Curriculum Structure



Students are required to take the following mechatronics courses:

MEC 300 The Industrial Internet of Things	**5 Cr.**
MEC 310 Environmentally Sustainable Manufacturing	**5 Cr.**
MEC 320 Fixtures and Workflow	**5 Cr.**

MEC 330 Programming for Industry 4.0	**5 Cr.**
MEC 450 Mechatronics Project Management Preparation and Planning	**2 Cr.**
MEC 490 Mechatronics Project Management	**5 Cr.**
Total MEC core upper division credits	**27 Cr.**

The above listed courses provide the core competencies identified as suitable for all mechatronics orientations.

Students will be required to choose at least four electives (20 credits) from the following:

MEC 361 Process Control	**5 Cr.**
MEC 362 Sensors and Actuators	**5 Cr.**
MEC 363 AI and Data Analytics	**5 Cr.**
MEC 381 Automation Evaluation and Implementation	**5 Cr.**
MEC 382 Machine Vision	**5 Cr.**
MEC 383 Dynamics of Machinery and Kinematics	**5 Cr.**
MEC 402 Robotic Integration	**5 Cr.**
MEC 403 Simulation, Emulation and Digital Twins	**5 Cr.**

The electives mentioned above are all courses providing students with skills needed by industry. It is the intention that students will be able to tailor the content and direction of their bachelor's degree to areas of industry that interest them the most.

Credit Budget

Students entering the BAS-META program will have earned at least 90 credit hours while earning their associate degree. The total credit load for the BAS-META degree is 94 credits plus any work needed in preparation. Thus, the BAS-META degree pathway will have a minimum of 184 credits. The credit budget is broken down as indicated in Figure 2.

Figure 2. Credit Budget

		Credits
Associate Degree		90
Preparation Tier	Technical and General Education as required	0-38
Junior Year		45
Senior Year		49
	Total	**184-222**

Note: the scope above includes 47 credits in upper-division mechatronics, 20 credits of lower-division general education and 20 credits of upper-division general education.

Criteria 2: Qualified Faculty

CRITERIA	STANDARD
Qualified faculty.	Provide a profile, including education credentials, of anticipated faculty (full-time, part-time, regular, continuing) that will support the program for each year (junior and senior). Include faculty needed to cover the technical course work, general education courses and electives. In addition, provide the total faculty FTE allocated to the program. Faculty and administrators responsible for technical courses must meet certification requirements for professional and technical administrators and instructors in the Washington Administrative Code.

Instructor Qualification

Clover Park Technical College recruits and employs well-qualified instructors. Instructors are encouraged to embrace lifelong learning and to maintain currency in their fields. Upper-division technical program instructors are required to have a Master's degree in a related discipline and at least three years' industry experience to teach as an instructor, whether adjunct or tenured, in a bachelor program. They also maintain a current Professional-Technical Faculty Certification.

General education instructors are required to have a Ph.D. (or ABD) in their field.

Faculty librarians contribute information literacy content in the context in both general education and technical courses and shall possess at least a master's degree in library science.

BAS-META faculty profiles and credentials can be found in Appendix C.

Student and Faculty Projections

We project a steady-state student load of 80 BAS-META students by the end of the fifth year (see Figure 3). This represents four cohorts of 20 students, with twice a year entry, teaching classes three quarters of the year. Our program total of 80 student projection is regarded as the maximum capacity. These numbers are not including a 10% attrition between junior and senior years.

Figure 3. Enrollment Projection and Instructor Requirement

	AY 20/21	AY 21/22	AY 22/23	AY 23/24	AY 24/25
Enrolled Students	22	53	71	80	80
BAS-META Teaching Faculty FTE	1	1.5	1.5	1.5	1.5
General Education Faculty FTE	1	1.5	1.5	1.5	1.5

The teaching faculty requirement for this new program is 3 full-time faculty split between technical and general education instructors.

For the first year, the program is offered, the technical teaching load will represent between 50% and 100% load for one instructor. CPTC currently employs one Tenure-Track instructor meeting the qualifications described above, who would be taking on the initial start-up of upper-division classes, with adjunct positions back-filling the lower division classes. For the second year of the program, and each year thereafter, the technical teaching load will represent 150% for one instructor, necessitating additional faculty. However, the time frame of program start-up will allow the needed cushion for other program faculty to obtain necessary credentials, or to hire additional qualified faculty.

Most of the General Education classes are already available for other BAS degrees on campus and have qualified faculty teaching them. BAS-META students will fill under-enrolled courses first, creating a cushion to hire new faculty as the program grows.

Criteria 3: Admission Process

CRITERIA	STANDARD
Selective admissions process, if used for the program, consistent with an open door institution.	Describe the selection and admission process. Explain effort that will be used to assure the program serves as diverse a population as possible. Include specific detail for selecting students for admittance when there are more applicants than available seats in the program.

Clover Park is committed to a first-come, first-served admission process consistent with an open-door institution. We will serve a diverse population by operating our recruiting and open admission process in our diverse local community and by encouraging diversity in our student body, faculty, and staff. The Associate Dean leads admissions to BAS programs for Student Success. This office is committed to serving BAS admission applications by providing prospective students with an admissions packet that includes application instructions and guidance. Once a student has applied for the BAS degree, the Associate Dean for Student Success has regular correspondence with the applicant. The acceptance letter outlines the next steps for each student and refers them to the program advisor and navigator for further assistance in navigating college processes.

Perspective students have three options for entry paths into the BAS-META program as described in Criteria 1:

- Clover Park Mechatronics AAS-T graduates.
- Non-mechatronics associate degree graduates and mechatronics associate degree graduates from institutions without articulation agreements.
- Mechatronics associate degree graduates from institutions with whom we have articulation agreements.

Graduates of the CPTC AAS-T Mechatronics program will be able to enroll on a first-come, first-served basis. To avoid lapses or interruptions for students who enrolled in the AAS-T program with the intention of continuing straight on to the BAS-META, a brief priority registration window will be given to students who will complete their AAS-T degree in the two quarters before entry to the BAS-META. After this priority registration period, the number of slots available to bridge or transfer students will be determined by the remaining seats in first quarter classes.

We believe in the importance of providing a solid path for many types of candidates, from those interested in expanding upon their skillset for mechatronic implementations in a traditionally “non-technical” field to those just looking at changing their career focus. Non-Mechatronics associate degree candidates and mechatronics associate degree graduates from colleges without articulation agreements who complete the technical bridge will be guaranteed admittance into the following fall program start. By completing and passing the accelerated

challenge of the technical bridge, the candidate has proven a commitment towards mechatronics that the BAS-META program will match. The number of available seats for the technical bridge will be determined by the mechatronics department's resources and capacity. Admission will be based upon a first-come, first-served basis for all candidates that fulfill the general education and associate degree requirements.

The admission process for graduates of other colleges with established articulation agreements will be determined by the articulation agreement itself.

As we have continued to gather information about interest from our current and former students, we have revised our enrollment projections upward. Eight former graduates have been in close contact with us about the development of the BAS-META and are all hoping to enroll, some in fall 2020, and some in spring 2021. Students approaching graduation in the next two quarters have a 75% interest in a fall 2020 start. Based on this new data and anticipating increased internal enrollments from students entering the AAS-T solely for entry to the BAS by spring 2022, table 1 provides a breakdown of our new projections by entry quarter.

Table 1. New Entry Enrollment Projections by Pipeline Source

New Entry Enrollments Projections by Pipeline Source					
Cohort Start Quarter	Former CPTC Students	Current CPTC Students	Bridge Students	Transfer Students	Total New Enrollments
Fall 2020	6	6			12
Spring 2021	2	8			10
Fall 2021		10	7		17
Spring 2022		12		2	14
Fall 2022 and beyond		12	8		20
Spring 2023 and beyond		12		8	20

Encouraging Diversity in the BAS-META Program

The CPTC mechatronics program is currently a majority non-white program (college demographics data has mechatronics students at 42% POC with 15% not reporting; our own internal student survey taken for the statement of need revealed 50% POC with 1% not reporting), and as the main feeder program for the BAS-META that diverse representation is

intended to carry over. The mechatronics department believes in openness and high visibility of its operations and activities in order to show that it is a program for everybody. All practices and procedures used in the mechatronics program will also be used for the BAS-META. The technical bridge entry point will hopefully increase the possibilities further for our community to participate in a fast-growing and rewarding field. While still requiring an associate degree, it is an entry point disregarding age and field of degree.

Credit may be awarded for military experience, as demonstrated through a student's military transcript, based upon guidelines from the CPTC's admissions office. Credit for prior learning and experiential competencies gained through work will be assessed on an individual basis, according to institutional guidelines described in CPTC's Policies and Procedures Manual.

CPTC strives to serve a diverse population by operating our recruiting and open admission process in our diverse local community and by encouraging diversity in our student body, faculty, and staff. We recruit a diverse population of applicants by maintaining an equity-minded approach to program outreach and recruitment efforts by maintaining a presence in the high schools for a variety of events, from career fairs to classroom visits. Additional outreach efforts include translation of college materials into Spanish, Spanish speaking college information nights, attending LGBTQ targets events, and partner with the Tacoma Housing Authority to recruit underserved populations. For our bachelor's programs, the college outreach team will continue to work with our community partners and recruit specifically for a bachelor's degree. Additional information on local demographics can be found in the Statement of Need, Criteria 2 (Appendix E).

Criteria 4: Student Services

CRITERIA	STANDARD
Appropriate student services plan.	Describe services that will be needed by the students admitted to the degree program and college plan for providing those services for baccalaureate level students. Include a description of financial aid services and academic advising for student admitted into the program.

Student Services at CPTC include the following services:

- Welcome Center
- Advising-Counseling
- Assessment Center
- Child Care Center
- Enrollment Services
- International Programs
- New Student Orientations
- Tutoring Center
- Outreach & Entry Services
- Student Aid & Scholarships
- Student Disabilities
- Student Life Programs
- Student Rights & Responsibilities
- Veterans Services
- Workforce Funding

The Vice President of Student Success is responsible for overseeing the services listed above.

Generally Available Services

Students in the BAS-META program will have access to all support, advising, and counseling services generally available to students at CPTC. Twice per month, during program information days, the staff of Advising, Enrollment Services, and Financial Aid stay until 6 pm to serve students. In addition, Advisors set up classroom visits twice per quarter. At these visits, Advisors remind students about upcoming deadlines for financial aid/enrollment, discuss education planning, troubleshoot individual questions, and connect students with internal and external resources as needed. Currently, general support/student services offices have the capacity to assist with program implementation. As enrollments grow, additional services or personnel will be considered. Some of these services include:

Welcome Center. The Entry Services team at CPTC meets with students one-on-one to help them navigate the steps to get started at the college. The team can provide information about:

- CPTC's entry steps
- Program costs and funding options
- Requirements for programs
- Registration Preparation

The Welcome Center has extended hours on the second and fourth Wednesday of each month to align with our Program Information Sessions and be available to those who cannot make it in during regular business hours.

Access and Disabilities Accommodations. CPTC is committed to providing reasonable accommodations for students of all abilities. Appropriate adjustments and assistive services or technologies will be provided to qualified students with disabilities during the recruitment, the application process, enrollment, registration, financial aid, course/module work, counseling, and program fulfillment. A Student Disability Specialist is on duty to be of assistance.

Enrollment Services. CPTC is dedicated to making the admissions experience as simple and intuitive as possible for new students. The registration process is available online (http://www.cptc.edu/register/). Credit evaluation, transfer review, and prior learning assessment are handled by the Credentials Evaluator and Student Completion Specialist in the Office of Enrollment Services.

Advising & Counseling Office (http://www.cptc.edu/advising) provides support and direction to help CPTC students meet their academic and career goals. CPTC assigns specific advisors to each program degree pathway who provide appointments and walk-in times to assist students and offers the following services: information regarding campus and community resources; academic advising and educational planning; career exploration resources and information; workshops on resumes; interviewing skills; job searching; and brief personal counseling on issues affecting a student's success.

Student Aid & Scholarships (http://www.cptc.edu/financial-aid) reviews applications for aid and considers students for grants, loans, work-study funding, and other awards as appropriate. Students can apply, get information, monitor their applications, and view their awards online through the Financial Aid Student Portal. Appointments to meet with professional financial aid counselors are also available Monday through Friday during business hours. The office has extended hours through 6 PM on the second and fourth Wednesday of each month to align with Program Information Sessions.

Childcare Services (http://www.cptc.edu/childcare) The Hayes Child Development Center provides services for children ages four weeks to five years with a discount rate for CPTC students and staff.

Library and Computer Labs (http://www.cptc.edu/library) are newly renovated. The library and information commons is a "one-stop" learning center dedicated to providing facilities and resources that support CPTC students, faculty, and staff. Its mission is to provide education leading to competencies that meet business and industry standards for the diverse workforce of today and tomorrow.

My Clover Connection (http://www.cptc.edu/mycc) is a one-stop utility for managing all functions of student accounts. These include: checking email, scheduling, paying fees, dropping class, changing PIN or contact information, and viewing/ order official transcripts.

Tutoring Services (http://www.cptc.edu/tutoring) are available to help in a variety of subjects such as basic math, writing, accounting, calculus, and statistics. CPTC's students also have access to eTutoring's free 24/7 online tutoring services in a variety of subject areas.

BAS Program-Specific Services

Program Advising

Program advising is the formal responsibility of the Student Services division and faculty counselors. This support office has designated specific program faculty counselors to provide advising services for BAS students. Faculty counselors work closely with program faculty to advise students on course choice, discuss student progress, direct students to needed resources and assist with other program-related retention issues or problems.

Navigator

The College has one full-time BAS Navigator/Manager who will specialize in guiding BAS students from application to graduation for four BAS programs and works under the direction of the Dean of Instruction. The BAS Navigator will provide supports for the four BAS programs at CPTC by assisting incoming BAS students with the following guidance: career pathway exploration; guiding students through the application process to include applying for funding and enrolling to the college; providing triage for students who present barriers to success; connect prospective and current students to financial aid, scholarship resources, and veteran funding resources; counseling and advising resources. Also, the navigator will assist with monitoring the progress of the students and communicating with faculty advisors as needed if student issues/academic progress issues.

Additional navigator duties include targeted outreach; marketing and recruitment; faculty support; collecting post-graduation data based on student surveys; and contacting alumni for specific employment and setting up student spotlight interviews for marketing purposes.

The BAS Navigator works closely with the Outreach and Entry Services Director to strategize the implementation practices to recruit a diverse student population with a specific focus on equity and access for underserved populations.

Academic Credit for Prior Learning

The management of the Prior Learning assessment will continue to be the responsibility of the Associate Dean of Enrollment Services, who reports directly to the Vice President of Student Services. Assessment of work submitted to gain credit for prior learning is the responsibility of qualified program faculty.

Lab and Classroom Facilities

The BAS-META program will be housed in the newly opened John W. Walstrum Center for Advanced Manufacturing and Technology (CAM-T). Opened in September 2019, this 63,000 sq.ft. The facility contains state-of-the-art classrooms and labs for mechatronics, non-destructive testing, machining, and fundamental manufacturing skills. The building operates as a collaborative learning environment where the student is encouraged to partner with students in

other programs to achieve greater outcomes in their projects. The building is centered on a large atrium space called the “Fifth Lab,” which gives the students a space between programs to collaborate. Additionally, students who become members of any of our program-related clubs will also have access to our digital collaboration lab, which contains design stations and 3D printers. Pictures of the facility and mechatronics lab are in available in Appendix B.

Criteria 5: Commitment to a High-Quality Program

CRITERIA	STANDARD
Commitment to build and sustain a high-quality program.	Provide a financial plan for the first five years of program operation. This plan should include (1) types of funds to be used to support the program; (2) projected program expenses; (3) appropriate facilities to be (4) equipment, technology, and instructional resources needed for the program; and (4) anticipated revenue. Document the college's ability to sustain the program over time.

Financial Plan

The following financial plan assumes the following:

- Student enrollment will be 16 FTE during AY 20/21 and gradually rise each subsequent year. Teaching will occur in three quarters, with the summer being reserved for the technical bridge outlined under Criteria 1.
- Starting in winter 2019, current mechatronics faculty will be contracted to start the development of instructional resources.
- By fall 2020, one half of one full-time faculty will be tasked to teach in the BAS-META program. By fall 2021, two full-time faculty (1.5 FTE upper-division, .5 FTE lower division) will be designated to teach in the BAS-META program.

Figures 4, 5, and 6 on the following pages show the financial plan for the first three full years of the BAS-META program operations.

College Commitment

The college is committed to funding the costs associated with the launch of the program by utilizing existing college resources and college reserves. This is further expanded upon under "Facilities, Equipment and Instructional Resources" below.

Facilities, Equipment and Instructional Resources

The BAS-META program is a hybrid (online and classroom) program that requires no additional facilities beyond existing CPTC classrooms and labs due to our new CAM-T (John W. Walstrum Center for Advanced Manufacturing and Technology) facility.

The program will require additional computing resources and equipment to expand the technical content to the baccalaureate level. Identified in as needs are items such as new servers, software, robots, and various other parts and equipment needed for this advanced instruction. A majority of this equipment is already on order as part of the equipment funds set aside for the new Center for Advanced Manufacturing building and the remaining equipment will be

purchased through Associates Degree program funds, due to program outcome overlap. Recently purchased and to-be purchased equipment is not reflected in the budget model presented later in this criteria for this reason. Figure 4 outlines equipment that will be utilized by the BAS-META program.

Figure 4. Equipment Acquired Outside Budget

Existent Equipment	Recently Purchased Equipment	Equipment Being Purchased In the Next 6 months.
3 X SMC mechatronics trainers: HAS, FAS, and IPC	2 X dedicated program servers	Omron 6 axis robots with integrated machine vision
2 X trainers for each: AC controls, hydraulics, pneumatics, and mechanical systems	CNC lathe	Parts for a second production simulator
4 X 6 axis robot arms: 2 Fanuc, 1 UR, 1 Mitsubishi	All new 3D design computers in classroom and computer lab	4 x UR-5 6 axis collaborative robots
Mechanical test frame	Parts for one production simulator	1 KUKA 6 axis robot with educational certification cart
Class sets of PLCs: Siemens 1200s, Clicks, and A-B Micrologix	High speed camera	1 KUKA 6 axis KR6-30 industrial robot
PCB production line		Class set of Siemens 1500 PLC kits
CNC mill, manual lathe, and heat treat furnace		Full TIA Portal software for 100 students

In addition to the start-up equipment costs, there are two major resource costs associated with this program. First, there will be annual licensing and equipment update costs. Second, there are annual consumables for parts used to build systems and projects. These are all built into the budget model below.

Library and Learning Resources

The CPTC Learning Resource Center provides a variety of print, audiovisual and online resources to students, faculty, and staff. The general collection of books, reference materials, magazines, and multi-media resources support CPTC's instructional programs.

The Learning Center's computer lab has a collection of electronic resources, including online reference databases, including ProQuest and Ebsco Host, electronic journals, computer applications, Internet access, and a variety of assistive technologies. CPTC's library is very hands-on; professional library staff is ready to help either in the building or online.

Our Program / Library faculty partnering starts with English 101 and 102. In these courses, students practice writing research papers. This exercise exposes them to information literacy and the process of finding and citing original sources. As the students proceed into their junior and senior year studies, they will have to compare, contrast, argue, and defend their findings in research papers. These assignments provide many opportunities within the program for

program faculty to partner with library faculty to ensure information literacy instruction is incorporated into the curriculum. (NWCCU Standard 2.C.6)

Remote access to online databases is available to students who are not on campus. In addition, Ask a Librarian is a free online reference and research help service available 24 hours a day 7 days a week. CPTC's own Reference Librarian is available to answer questions via email or phone.

The CPTC Learning Center and librarian support are in place to support any specialized research, data resource and/or subscription needs of BAS-META students and faculty. A budget already exists to support new resource requests in our library. We have budgeted additional monies for a total of $4,000 per year to acquire new library materials for this program. Faculty will work together with our qualified faculty librarian and library technicians to be sure our resources reflect the depth, breadth, and currency necessary to support a rigorous, upper-division program. (NWCCU Standard 2.E.1)

Data and feedback from library and program administration, faculty, and students will guide ongoing planning for library and information resources. (NWCCU Standard 2.E.2) CPTC will regularly and systematically evaluate the quality, adequacy, utilization, and security of library and information resources and services to ensure the rigor of the upper-division program and general education course work. (NWCCU Standard 2.E.4)

CPTC Aims to provide appropriate instruction and support for both students and faculty to ensure efficiency and effectiveness in obtaining, evaluating, and using library and information resources. Already in place are Library Skills Classes & Orientations upon request. Program faculty and librarians are prepared to present this instruction in-person and online. The Faculty Librarian is directly integrated into the College's curriculum documentation and approval process. Library resources and information literacy are documented considerations in the development of every course. (NWCCU Standard 2.E.3)

Our library participates in an Interlibrary Loan System to make more resources available to our students. As part of the Library Leadership Council's Reciprocal Borrowing Statement, CPTC students, staff and faculty may present valid identification to gain access to circulating materials from other participating Washington Association of Community and Technical Colleges (WACTC) libraries as an alternative to interlibrary loan. As of January 2017, thirty Washington State community and technical colleges in addition to CPTC, participate in this agreement.

Program Costs and Funding

Figure 5. Budget

I. PLANNED STUDENT ENROLLMENT

	FY 0		FY 1		FY 2		FY 3		FY 4		FY 5	
	FTE	Headcount	FTE	Headcount	FTE	Headcount	FTE	Headcount	FTE	Headcount	FTE	Headcount
A. New enrollments to institution	0	0	15	22	45	53	67	71	79	80	79	80
B. Enrollment from existing programs												
	0	0	15	22	45	53	67	71	79	80	79	80

II. REVENUE

	FY 0		FY 1		FY 2		FY 3		FY 4		FY 5	
	On-going	One-time	On-going	One-time	On-going	One-time	On-going	One-time	On-going	One-time	On-going	One-time
1. New Appropriated Funding Request	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2. Institution Funds	$27,469	$64,188	$28,293	$0	$29,142	$0	$30,016	$0	$0	$0	$0	$0
3. Federal (e.g. grant, appropriation)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4. New Tuition Revenues from Increased Enrollment	$0	$0	$97,369	$0	$292,106	$0	$434,914	$0	$512,809	$0	$512,809	$0
5. Student Fees	$0	$0	$3,960	$0	$9,540	$0	$12,780	$0	$14,400	$0	$14,400	$0
6. Other (e.g., Gifts, Program Revenue)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Revenue	$27,469	$64,188	$129,622	$0	$330,788	$0	$477,710	$0	$527,209	$0	$527,209	$0

Budget Note:

I.A. Enrollments are assumed to be full time; therefore FTE=headcount

II.5. Program equipment/Computer Technology Fees 11.4 TUITION = 45 CR (1 ANNUALIZED FTE)

III. EXPENDITURES

	FY 0		FY 1		FY 2		FY 3		FY 4		FY 5	
	On-going	One-time	On-going	One-time	On-going	One-time	On-going	One-time	On-going	One-time	On-going	One-time
A. Personnel Costs												
1. FTE (total for all personnel types)	0.33	0.25	1.33	0.00	1.83	0.00	1.83	0.00	1.83	0.00	1.83	0.00
2. Faculty		$17,917	$73,817	$0	$114,048	$0	$117,469	$0	$117,469	$0	$117,469	$0
3. Adjunct Faculty	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4. Grad Assts	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
5. Research Personnel	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
6. Directors Administrators	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
7. Administrative Support Personnel	$20,348	$0	$20,958	$0	$21,587	$0	$22,234	$0	$22,901	$0	$23,588	$0
8. Fringe Benefits	$7,122	$6,271	$6,271	$0	$47,472	$0	$48,896	$0	$49,130	$0	$49,370	$0
9. Other:	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Costs	$27,469	$24,188	$101,046	$0	$183,106	$0	$188,600	$0	$189,500	$0	$190,428	$0

Budget Notes:

III.A.2. Faculty salaries are increased by 3% each year

III.A.8. Fringe calculated as 35%

	FY 0		FY 1		FY 2		FY 3		FY 4		FY 5	
	On-going	One-time	On-going	One-time	On-going	One-time	On-going	One-time	On-going	One-time	On-going	One-time
B. Operating Expenditures												
1. Travel	$0	$40,000	$10,000	$0	$10,000	$0	$10,000	$0	$10,000	$0	$10,000	$0
2. Professional services	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
3. Other services	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4. Communications	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
5. Materials & supplies	$0	$0	$13,000	$0	$13,000	$0	$13,000	$0	$13,000	$0	$13,000	$0
6. Rentals	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
7. Materials & goods used for product sale (e.g. fabrication auto repair) Please reflect revenue in II.6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
8. Marketing materials and advertising	$0	$0	$2,000	$0	$2,000	$0	$2,000		$2,000	$0	$2,000	
9. Miscellaneous:	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Operating Expenses	$0	$40,000	$25,000	$0	$25,000	$0	$25,000	$0	$25,000	$0	$25,000	$0

Budget Note:

III.B.8. $0 of operating expense is provided for each new faculty line

	FY 0		FY 1		FY 2		FY 3		FY 4		FY 5	
	On-going	One-time	On-going	One-time	On-going	One-time	On-going	One-time	On-going	One-time	On-going	One-time
C. Capital Outlay												
1. Library Resources	$0	$0	$4,000	$0	$4,000	$0	$4,000	$0	$4,000	$0	$4,000	$0
2. Equipment	$0	$0	$20,000	$0	$20,000	$0	$20,000	$0	$20,000	$0	$20,000	$0
Total Capital Outlay	$0	$0	$24,000	$0	$24,000	$0	$24,000	$0	$24,000	$0	$24,000	$0
D. Capital Facilities Construction or Major Renovation												
	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
E. Indirect Costs (overhead)												
1. Utilities	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2. Maintenance & repairs	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
3. Other	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Indirect Costs	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
TOTAL EXPENDITURES	$27,469	$64,188	$150,046	$0	$232,106	$0	$237,600	$0	$238,500	$0	$239,428	$0
Net Income (Deficit)	$0	$0	($20,424)	$0	$98,682	$0	$240,110	$0	$288,709	$0	$287,781	$0

Criteria 6: Program Specific Accreditation

CRITERIA	STANDARD
Program specific accreditation.	Indicate whether the institution will seek specialized program accreditation. If so, describe plans for accreditation and identify appropriate accreditation body. Include a statement of college's plan to seek accreditation through NWCCU and/or current status of college's standing to offer applied baccalaureate degrees.

With SBCTC approval of the BAS-META Program, CPTC will immediately file a Major Substantive Change Proposal with the Northwest Commission on Colleges and Universities.

The BAS-META program Intends to seek accreditation with ABET under its Engineering Technology Accreditation Commission (ETAC). The crafting of the program outcomes as a whole, as well as general education course selection, technical course subjects, and descriptions, have been written with ABET ETAC criteria in mind.

ABET accreditation requires at least one graduate to complete the program before applying for review. As such, we will begin the application process of this accreditation after the second year the program is offered by submitting our readiness review by October 1st, 2022, followed closely by our request for evaluation. Work over the next six months will be done on our self-study report which will be due July 1st, 2023. An on-site visit will take place as scheduled between September and December of 2023. A period of feedback and responses occurs for several months after the visit. Decisions on awarding accreditation would then be made at the July 2024 ETAC meeting, followed by a formal notice of that decision by August 31st, 2024.

Criteria 7: Pathway Beyond Baccalaureate

CRITERIA	STANDARD
Pathway options beyond the baccalaureate degree.	Describe opportunities and articulation agreements for the place bound BAS graduate to continue their education onto a graduate (Master's) degree program. Detail specific discussions with public and private baccalaureate institutions (when applicable) regarding post-baccalaureate pathways for graduates.

As mentioned in our statement of need, the BAS-META would be only one of a handful of Mechatronics bachelor's degree programs in the nation. As such further pursuits in education may be limited by distance. Graduates may seek out a Master's in Engineering Technology online from Purdue University, or in person at CWU (Central Washington University) if they restart their program. With additional course work in the respective concentration, students may be admitted to mechanical, electrical, or software engineering masters programs.

One distinct pathway has presented itself in our development of this proposal: the Biological Systems Engineering Department's Masters and Ph.D. program at Washington State University. They have been searching for an in-state program to feed applicants, and have given valuable feedback on our proposal to prepare students for this pathway. Indeed, one of our outside evaluators, Dr. Manoj Karkee, is an associate professor in this graduate program. Dr. Karkee has also indicated that our students should be able to join interdisciplinary robotics Masters in Science degree in numerous departments around the country like Oregon State.

As Mechatronics is an emerging field, we will continually search for new potential pathways as they are created, and pursue relationships with those institutions.

Criteria 8: External Evaluation

CRITERIA	STANDARD
External expert evaluation of the program	The institution will select two external experts to review the program. External experts should come from a university level institution, i.e. departmental professor, academic dean or department head. The expert should be a practitioner/instructor from within the content area of the proposal. In a separate document, provide copies of external evaluators' report or letters. Summarize the institution's responses and subsequent modification to the proposal based on evaluator's recommendations. Attach a short bio of the evaluators.

External Evaluators and Their Qualifications

Kevin McFall, PhD Kennesaw State University	Manoj Karkee, PhD Washinton State University	Gail Norris, SITRAIN Director Siemens Industry, Inc.
• "This program is well-positioned to fill an increasing gap between industry demand and available academic programs." • "I am excited to see this program launched and am certain it will find traction both with students and employers."	• "I believe the program will be a successful undertaking for Clover Park Technical college ..." • "... the classes are well designed and appropriate"	• "This program provides deep knowledge in skills which are in the top 10 sought by industrial clients..." • "This is one of the programs most thoroughly aligned to industry and regional needs that I have had the pleasure to review. "

CPTC selected three external reviewers to examine our program from distinct perspectives. First, we wanted feedback from one of the few mechatronics bachelor's degrees in existence. For this, we enlisted Dr. Kevin McFall, acting chair of the Mechatronics Engineering at Kennesaw State University. Second, we wanted feedback from a potential postgraduate pathway institution. We recruited Dr. Manoj Karkee as Associate Professor of Biological Systems Engineering at Washington State University to fill this perspective. Finally, we wanted

input from an industry leader on the program proposal. Gail Norris, Director of SITRAIN at Siemens, was kind enough to provide input from a global leader in automation.

Full copies of the evaluations and evaluator bios can be found in Appendix D.

Responses and Modifications to Proposal Due to Evaluator's Recommendations

The input provided by our external reviewers has been invaluable and greatly appreciated. This final version of our program proposal reflects many changes to address their recommendations. In particular, we made changes to expand our program resources section to provide for a better picture of the college's allocation of resources to the program.

Response to Dr. Karkee's Recommendations

Dr. Karkee believes the program is "a highly desirable area for creating a degree that helps create a workforce needs of current and future industries". In general, he describes the course work as "well designed and appropriate." His recommendations include greater pre-baccalaureate preparation in computer programming. Though our students have adequate programming in their Associates through both titled classes and constant application of programming in other classes, we did not mandate this preparation in our transfer students. Karkee's suggestion to this was to look in the future to provide more basic programming electives which we will take under advisements as we go through our continuous improvement process. Additionally, a strong recommendation for experience with programming has been added to the transfer requirement. In response to his suggestion for more collaborative robotic systems, we are ordering five more co-bots (as they are called) to be received by March 5th, 2020, including four UR robots, as suggested in his evaluation.

From his unique perspective as a potential post-baccalaureate pathway, Dr. Karkee states that "In my graduate research and education program, I hired one Ph.D. student from a mechatronics program in Thailand, and found out the student possessed highly desirable background and skills for working on agricultural automation and robotics projects." About our program's preparation, he says, "I have and am convinced to hire more students in my graduate program with mechatronics degrees, which I believe is true for a large number of graduate programs in mechanical, electrical, agricultural and other engineering departments and multi-disciplinary robotics programs."

Response to Dr. McFall's Recommendations

Dr. McFall states that "This program is well-positioned to fill an increasing gap between industry demand and available academic programs." The coursework he finds to be "relevant for the field of industrial automation: process control, robotic integration, Industry 4.0, fixtures, and workflow, etc." In speaking of the general education requirements, he states:

> "I am particularly pleased with the choice of general education courses. They cover wide-ranging fields such as math, science, writing, humanities, social science, and more. What I find intriguing is how these courses, while solidly anchored in their individual disciplines, cover topics relevant to the major: technical writing, professional ethics, industrial and organizational psychology, etc. A common complaint from technical students is that their general education does not feel relevant for their careers. The choice of these courses should help dampen such complaints."

In recommendation, Dr. McFall suggested improvements in two areas: qualified faculty and resources. In response to his recommendation that we include a resume from our currently qualified faculty, we have included Carl Wenngren's resume as Appendix C. His recommendations under the equipment section included concerns around an anemic future order of program-specific items. We were unable to say for certain at the time of his remarks, but can now state that we will be spending a significant capital outlay on seven more robots and more advanced PLCs to address these concerns. His other questions surrounded scheduling and hiring decisions to make sure there is no shortfall in either instructional or equipment resources. Although we have prepared an in-depth analysis of resources for a quarter by quarter schedule, we considered this to be an internal document and as such did not share it with the evaluators. We take his words under serious advisement and are confident that we will be able to meet these challenges both adequately and efficiently.

Dr. McFall's statement from his unique position as chair of one of the few similar programs in the nation is worthy of calling out separately:

> "I believe this is a timely and relevant program. The field of Mechatronics, Robotics, and Automation is poised to touch nearly all aspects of manufacturing and business operations in the coming decades, with few programs in the country prepared to meet existing, let alone, future needs. I am excited to see this program launched and am certain it will find traction both with students and employers."

Response to Ms. Norris' Recommendations

Ms. Norris provides us with an industry perspective on our program. As the Director of SITRAIN, Siemens industrial training arm, she can provide unique insights into the needs of the industrial workforce. Additionally, as someone who has personally observed the current faculty deliver sample lessons on mechatronics subject matter, she is also well positioned to give input as to our rigor and qualifications.

In response to our rigor, Ms. Norris states, "Core/GE courses expand the mindset and provide ethical/moral parameters for decision making in technical areas, which becomes more critical as digitalization rolls out. Electives further enhance those technical needs of employers." Asked if faculty are qualified, she responds "From the observed participation in the SMSCP instructor certification class, yes." In her evaluation, she makes no significant recommendations for the proposal, just a thorough endorsement. Of the overall proposal she writes:

> "This is one of the programs most thoroughly aligned to industry and regional needs that I have had the pleasure to review. The faculty and school did a phenomenal stakeholder analysis to ensure their offer aligned with the needs of the students and employers, and I believe it will be successful at engaging both."

Appendix A – BAS-META Course Descriptions and Outcomes

Note: Course numbers are provisional stand-ins to serve as indications of the progression in the content and will likely be changed upon adoption by our curriculum committee.

Technical Courses:

MEC 300 The Industrial Internet of Things

Students will gain a broad perspective on IIoT technologies and industry 4.0 applications. An in-depth exploration will be made of the theory and application of large-scale networking of sensors in industry and the data collection and analysis work that results. Topics include remote field devices, smart sensors, RFID tracking, edge devices and cloud computing platforms. Focus will be spent on how to identify suitable applications, how to merge OT with IT, how to capture the data generated, and exploring a lean approach to data management.

MEC 310 Environmentally Sustainable Manufacturing

An examination of the lean management practices that lead to the reduction of waste, and the economic benefits of sustainable management perspectives focusing on the supply chain. Students will learn how to quantify the environmental impacts from raw material to product end of life, learn how to develop and implement responsible strategies and tools to achieve sustainable and efficient manufacturing processes. Includes examination of Life Cycle Assessment of products, manufacturing, and supply chains.

MEC 320 Fixtures and Workflow

The course takes a product focus approach to manufacturing, by examining the organization structures and Lean principles applied to the design and construction of complex manufacturing production systems. Students will learn how to analyze a product for its manufacturability. The course includes how to talk to designers and customers to bridge DFM and DFA inconsistencies, how to select manufacturing methods and create flow, how to develop metrics and determine economic and sustainable production.

MEC 330 Programming for Industry 4.0

The course focuses on programming for industrial hardware control. Students will work on seamless information and instruction flows between various industrial devices from the perspective of programming. Experience will be gained in programming in the most up-to-date environments used in Industry. Students will program in C++, C#, Python, and other languages in the application of a complex industrial system. The class will analyze the current state of the ever-changing ecosystem of programming environments and relate them to practical applications.

MEC 361 Process Control

Experience handling analog signals, PID controls and multiple process variables typically found in process control. Focus on controlling temperature, pressure, mixing and other common process variables through PLC's and SCADA. The course focuses on statistical methods as applied to keeping various industrial processes under statistical control. Students learn how to keep a process steady, do alterations to the process with predictable outcomes and how to bring the process back under control if it goes unstable.

MEC 362 Advanced Sensors and Actuators

Experience designing and building complex sensing and actuation devices, including communications, signal conditioning and programming. The purpose of this course is to provide experience in problem solving complex industrial challenges by choosing and applying different sensor and actuators. The course will introduce students to technical challenges that they will have to solve by robustly applying knowledge of materials, sensors, and actuators.

MEC 363 AI and Data Analytics

This course covers the theory and application of algorithms for machine learning and inference, from an AI perspective. Python and C based languages will be employed to process large data sets through both conventional and AI based systems. Students will practice drawing conclusions from given data and setup models for capturing data. This covers data mining, where the algorithms are used to automatically detect interesting information and relations in large industrial or scientific databases. Students will use large data sets for AI control of process variables, predictive maintenance, and production flow.

MEC 381 Automation Evaluation and Implementation

Examination of the business, safety, and social considerations involved in the decision to automate and the effective implementation thereof. Students will examine the choices involved from a managerial perspective.

MEC 382 Machine Vision

Practical experience on implementing vision systems in manufacturing processes. The course gives a general overview of machine vision and introduces the student to machine vision software and hardware. The course covers common topics like finding known models in images, depth perception, camera calibration and alignment, image stabilization, tracking of objects, photometry, boundary detections, environmental factors and point clouds, along with various sensing technologies.

MEC 383 Dynamics of Machinery and Kinematics

A mathematical exploration of the functions used to describe the motions and momentums of machine elements with an emphasis on the application of motion control. This course introduces students to the application of the principles of dynamics to mechanisms and machine elements.

Students learn how to visualize and analyze motions in machines, how to create new machines based upon desired kinematics.

MEC 402 Robotic Integration

Experience designing and integrating complex robotic manufacturing cells. Applying design for manufacturing techniques to system, cell, and tooling and fixture design. The course focuses on programming for industrial hardware control. Students will work on seamless information and instruction flows between various industrial devices from the perspective of programming.

MEC 403 Simulation, Emulation and Digital Twins

Design working simulations and Digital Twins of machinery for use in virtual commissioning, predictive maintenance and process optimization. The course introduces the students to the area of virtual process planning and to get hands on experience in some of the most relevant and needed areas of industry utilizing virtual process planning while preparing upcoming production. The students will learn how prepare products for production with virtual tools and how to conduct virtual process planning of a production cell consisting of various components such as machines, fixtures, robots, products.

MEC 450 Mechatronics Project Management Preparation and Planning.

Precursor to the Mechatronics Project Management course. Students will begin the planning and preparation for the management of a complex mechatronics project.

MEC 490 Mechatronics Project Management

Project Management of a team of Mechatronics students in the design and build of a complex mechatronics project.

General Education Courses:

ENGL& 101 English Composition I

Utilize the writing process to write clearly with consideration of audience, purpose, and tone, using standard grammar and punctuation conventions along with common discourse modes and patterns of organization. Read and process sources using independent and critical thinking skills, following established conventions for incorporating and documenting sources in writing.

ENGL& 235 Technical Writing

Focuses on technical writing skills and projects for industry and professions. Strong emphasis will be placed on principles of good writing and research techniques. Students will use appropriate technology and research to prepare letters, resumes, reports, proposals, newsletters, specifications, and other writing tasks typically required in a technical work setting. Discovery and knowledge of workplace ethics and guidelines as they pertain to writing will be

researched, discussed, and used to enhance research. Requires use of technology including, but not limited to, computers, printers, and scanners.

MATH& 141 Pre-calculus I

Covers linear, quadratic, polynomial, rational, absolute value, exponential, logarithmic, and inverse functions and equations; composite functions, linear and quadratic inequalities, graphs of functions, relations, and inequalities; and graphic transformations. Introduces limits, linear and quadratic curve fitting, and mathematical modeling, including exponential growth and decay. Graphing calculator required.

MATH& 142 Pre-calculus II, Functional Trigonometry

Covers circular, trigonometric, and inverse trigonometric functions and graphs; trigonometric and inverse trigonometric identities; trigonometric equations; vectors and elementary vector operations; De Moivre's theorem and equations with complex solutions; and polar and parametric equations and their graphs. Graphing calculator required.

MATH& 151 Calculus I

Covers algebraic and transcendental functions, continuity, limits (including indeterminate forms), derivatives and differentials of algebraic and transcendental functions (e.g., exponential, logarithmic, and trigonometric forms), applications of differential calculus, and an introduction to antiderivatives or indefinite integrals. Graphing calculator is required.

MATH& 152 Calculus II

Topics of calculus are presented geometrically, numerically, and symbolically. MATH& 152 topics include applications of integration, differentiation, and methods of integration, including improper integrals. Graphing calculator required.

PHIL 310^{DIV}: Professional Ethics

This course increases students' awareness of ethical dilemmas that might occur at work, to show how such ethical issues are subject to management analysis and decision-making action, and to provide students with the conceptual tools necessary to identify and develop an acceptable resolution to these dilemmas.

PHYS& 221 Engineering Physics I

The first quarter of a three-quarter sequence in calculus-based physics for science and engineering students. The course covers topics in mechanics, including kinematics of motion, force, work, energy, momentum, and kinematics & dynamics of rotation. Lab included.

PHYS& 222 Engineering Physics II

The second quarter of a three-quarter sequence in calculus-based physics for science and engineering students dealing with the topics of equilibrium of rigid bodies, properties of solids, gravity, fluid mechanics, heat, thermodynamics, waves, sound and light. Lab included.

PSYC& 100^{DIV} General Psychology

Surveys the knowledge and methods of the discipline of psychology. Presents a broad view of this subject and establishes the foundation for further study of the discipline. Emphasis will be placed on applying psychological knowledge to daily situations and on accessing and assessing information about behavior from a variety of sources. Skills in scientific reasoning and critical thinking will be developed.

PSYC 311^{DIV}: Industrial & Organizational Psychology

Examines how people behave and interact with each other at work with an emphasis on the way that this affects job performance. Topics covered in this course include the development of leadership skills; recruitment and retention; motivation and team building; managing change; and conflict resolution.

AAS-T Catalogue Descriptions and Requirements:

Mechatronics - Associate in Applied Science – T Degree

Mechatronics is a multidisciplinary approach combining mechanical engineering, electrical engineering, process control engineering, and software engineering into an integrated skill set for construction, repair, and optimization of complex industrial equipment. This makes it applicable to a wide range of growing industries including automation and robotics, advanced manufacturing, aerospace and transportation systems, process control, logistics and supply chain management, and agriculture.

Clover Park Technical College's AAT Mechatronics degree provides the skills needed to succeed in this exciting field. The program begins with courses that establish a solid base of technical skills and an understanding of the various disciplines that make up mechatronics as well as lean manufacturing and quality standards. Courses are taught with an eye toward linking disciplines together for larger mechatronic systems. Subsequent courses then build expertise in the foundational skills while increasingly integrating all skills into the design, construction, optimization, maintenance, and repair of full mechatronics systems.

Program Learning Outcomes

Upon successful completion of the Mechatronics degree, students will be able to:

- Employ safe practices while using fluid power, electrical, mechanical and control equipment.
- Analyze the transmission of power between electrical, mechanical and fluid power.

- Use digital and analogue controls on mechanical, electrical, fluid power, and hybrid systems.
- Construct complex machinery involving multiple forms of power and control.
- Troubleshoot mechatronic systems, including the complex interplay between different power and control variables.
- Validate new and emerging power, control, and communication technologies.
- Prioritize efficiency and environmental sustainability in mechatronic systems and processes.
- Prioritize social benefit from the perspective of mechatronic systems.

Completion Requirements

Prerequisite(s)

To enter the program, a student must be eligible to take college-level English and college-level psychology, or another social science or humanities course.

This program assumes that students will be able to enroll in, or will have passed, MATH& 141 by the start of the third quarter of the program. Any developmental coursework that a student may be required to take to achieve this may increase the program length and is not reflected in credit counts as shown below. Math sequences to meet this requirement must be planned with your advisor prior to program enrollment.

Students must be at least 17½ years of age at the start of the program.

Program Course List

Quarter 1 - Preparation

FSME 101	Workshop Safety	3
FSME 111	Quality Principles, Inspection and Test	5
FSME 112	Fabrication Fundamentals I	5
FSME 113	Fabrication Fundamentals II	5

Program Core

MEC 115	DC Circuits	5

MEC 116	AC Circuits	5
MEC 120	Computer Aided Design I	5
MEC 125	Hydraulics and Pneumatics	5
MEC 128	Applied Statics and Strengths of Materials	5
MEC 130	Electric Motors and Drives	5
MEC 132	Lean Manufacturing	5
MEC 135	Digital Electronics and Networks	5
MEC 140CL	Computer Programming and Logic	5
MEC 150	Mechanical Systems	5
MEC 160CL	Programmable Controls I	5
MEC 163	Industrial Survey	5
MEC 173	Applied Mechatronics	5
MEC 289CAP		5
	Or	
MEC 290CAP	Mechatronics Capstone Project	5
	Mechatronics Technical Electives	5
	AAS-T General Education Requirements	23

	Total Credit Hours:	**116**

Mechatronics Technical Electives: See list below

AAS-T General Education Requirements: see list below

Technical Electives:

- Students must take 10 or more credits from the following courses. Other related courses may be approved by faculty.

MEC 121	Computer Aided Design II	5
MEC 165	Robotics	5
MEC 170	Sensors and Actuators	5
MEC 200	Programmable Controls II	5
MEC 210	Metrology and Calibration	5
MEC 220	Maintenance Management	5
MEC 281	Independent Study I	2-5
MEC 282	Independent Study II	2
MEC 289CAP		5

General Degree Requirements

All AAS-T degrees must have a minimum of 20 credits of transferable general education. These credits replace the academic courses required for the AAT degree. Required credits include:

- 5 credits in communication: ENGL& 101 (or higher)
- 5 credits in quantitative reasoning: MATH& 141 (or higher)
- 5 credits in a social science or humanities course: PSYC& 100DIV, or other transferable social science or humanities course that meets the CPTC diversity requirement.
- 5 credits in a transferable Social Science, Humanities, or Science course

- 3 credits in COLL 102 *must be taken in first 2 quarters

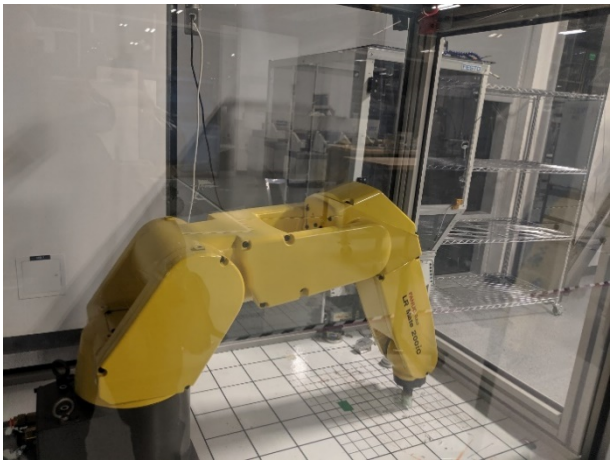
Students pursuing an AAT or AAS-T degree must complete all college degree requirements prior to graduation. This includes courses that meet the requirements for diversity, computer literacy, and the capstone project.

Appendix B – Pictures of Labs

1 Mechatronics lab

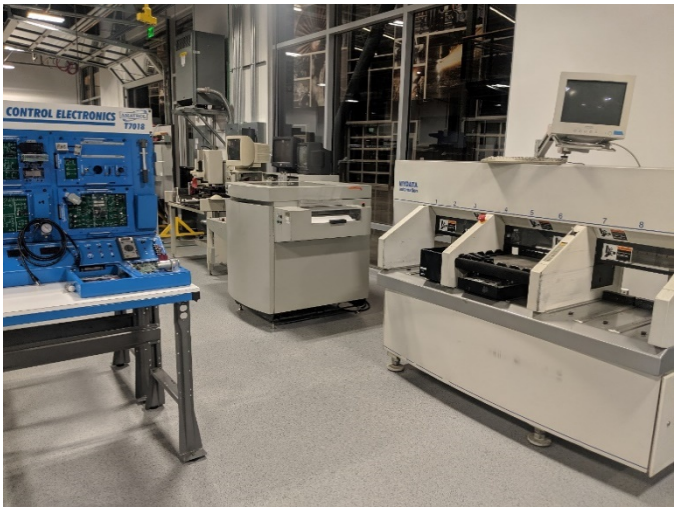
2 Fluid Power Zone

3 One of Our Robots



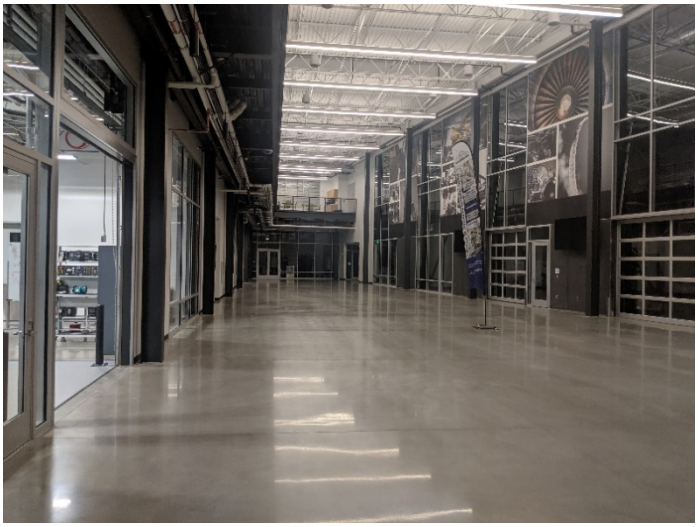
4 Automated Manufacturing Cell

5 Our PCB Pick and Place Line

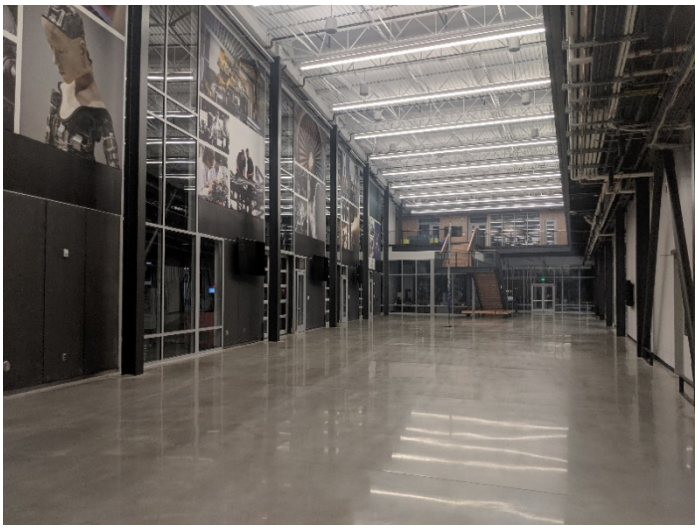


6 Our Automated Production Flow Simulators

7 The "Fifth Lab" from Outside Mechatronics



8 Whole Length of the "Fifth Lab"



9 Mechatronics Lab from Stairs in "Fifth Lab"

Appendix C – Qualified Program Faculty

BAS-META faculty

Faculty Name	Credentials	Status	Course(s)
Carl Wenngren	M.Sc Production Engineering Specialization: Production management Major: Mechanical Engineering Minor: Industrial engineering and management Chalmers University of Technology, Gothenburg, Sweden B.A. Degree in Mechanical Engineering Specialization: Production engineering Chalmers University of Technology, Gothenburg, Sweden	Full Time (Tenure Track)	MEC 300 The Industrial Internet of Things 5 Cr. MEC 310 Environmentally Sustainable Manufacturing 5 Cr. MEC 320 Fixtures and Workflow 5 Cr. MEC 330 Programming for Industry 4.0 5 Cr. MEC 361 Process Control.5 Cr. MEC 362 Sensors and Actuators 5 Cr. MEC 363 AI and Data Analytics 5 Cr. MEC 381 Automation Evaluation and Implementation 5 Cr. MEC 382 Machine Vision 5 Cr.

To Be Hired	Masters Required	Adjunct	MEC 383 Dynamics of Machinery and Kinematics 5 Cr. MEC 402 Robotic Integration 5 Cr. MEC 403 Simulation, Emulation and Digital Twins 5 Cr. MEC 450 Mechatronics Project Management Preparation and Planning 5 Cr. MEC 490 Mechatronics Project Management 5 Cr.
Erwin Swetnam	Juris Doctor Western State University College of Law Master of Business Administration Western Governors University BA, Political Science Idaho State University	Adjunct	PHIL 310 Professional Ethics
Dr. Joseph Donaldson	Ph.D., English Northern Illinois University	Adjunct	ENGL 310 Business Communications
Carolyn Van Beek	ABD Ph.D., Industrial& Organizational Psychology Grand Canyon University MA, Counseling Psychology Chapman University BS., Community Health Central Washington University	Adjunct	PSYC 311 Industrial& Organizational Psychology
Dr. Ali Ostadfar	Ph.D., Engineering Sciences Simon Fraser University M.Sc., Biomechanical Engineering Tehran Azad Science and Research University B,Sc., Mechanical Engineering Tehran Azad University	Adjunct	Phys&221 Engineering Physics I Phys&222 Engineering Physics II

Carl Wenngren – Clover Park Technical College

Carl Anders Edward Wenngren

Mechatronics Instructor
4500 Steilacoom Blvd SW
Lakewood, WA 98499
carl.wenngren@cptc.edu

Education:

2008-2010:
Masters Degree in Production Engineering
Specialization: Production management
Major subject: Mechanical Engineering
Minor subject: Industrial engineering and management
M.Sc Degree Thesis, " Improving a manual assembly area using layout change and standardization - A participative approach" at ABB Kabeldon Breakers and Switchers in Alingsås, Sweden
Chalmers University of Technology, Gothenburg, Sweden

2005-2008:
B.A. Degree in Mechanical Engineering
Main field of study: Mechanical engineering
Specialization: Production engineering
B.A Degree thesis, "Material and Quality, a study of metal bar cutting"
Chalmers University of Technology, Gothenburg, Sweden

2004-2005:
University Leadership Course, while serving in the Swedish Armed Forces.
Theory done at the university and in practice implemented as a commanding officer (CO) at my unit.
Cooperation between Lund University and Armored Regiment P7, Revingehed, Sweden

1996-2004:
Senior High-School, focus on math, engineering, and industrial arts
Ekbackeskolans Gymnasium, *Osby, Sweden (2000-2004)*
Bladins International School, *Malmö, Sweden (1998-2000)*
Lahore American School, *Lahore, Pakistan(1996-1998)*

Work experience:

2017-Present	Mechatronics Instructor CPTC
2012-2018	Owner/Engineer APIPCO Industries LLC
2012-2013	Manager of family forest estate, Co-founder APIPCO Industries LLC
2010-2011	Co-founder and head design engineer, Willwater LLC
2009	Machine Operator / Assembler, ABB Kabeldon, Sweden
2008-2009	Customer Service Representative, Net Revelations, including on site guidance, Gothenburg, Sweden

2007-2008	Consultant - Parts and Warehouse at Student Consulting, for numerous industrial companies, Gothenburg, Sweden
2007	Driver, Swedish Postal Service
2006	Paver, Gat- och kantsten AB
2004-2005	Swedish Armed Forces, Drafted NCO (2d LT); trained tank commander, Leopard 2 A4-A6 MBT
2003-2004	Assistant to the Secretary of Culture, County of Osby, Sweden
2000	Trainee Market Management, Volvo, Bulgaria

Other experiences & accomplishments:

- Siemens SMSCP Instructor Level 1 (June 2018)
- Trained Supplemental Instruction (SI) leader at Chalmers University of Technology, *(June 2006)*
- Officers Training, Swedish Armed Forces (drafted); discharged as None Commissioned Officer (Second Lieutenant), *(April 2005)*

Appendix D – External Evaluations

Dr. Kevin McFall – Kennesaw State University

College Name:	Clover Park Technical College	**BAS Degree Title:**	Bachelor of Applied Science in Mechatronics Engineering Technology and Automation
Reviewer Name/ Team Name:	Kevin McFall, Ph.D.	**Institutional or Professional Affiliation:**	Kennesaw State University
Professional License or Qualification, if any:	Interim Chair, Department of Mechatronics Engineering, Kennesaw State University	**Relationship to Program, if any:**	None
Please evaluate the following Specific Elements			
Concept and overview	Is the overall concept of the degree program relevant and appropriate to current employer demands as well as to accepted academic standards? Will the program lead to job placement?		
	I have no concerns that students completing the BAS-META program will have trouble finding jobs. This program is well-positioned to fill an increasing gap between industry demand and available academic programs.		
Degree Learning Outcomes	Do the degree learning outcomes demonstrate appropriate baccalaureate degree rigor?		
	Yes. They are anchored to the ABET Program Student Outcomes, which is the standard in accreditation for bachelor's programs in engineering and engineering technology.		
Curriculum Alignment	Does the curriculum align with the program's Statement of Needs Document?		
	Yes. The technical content of the curriculum match directly with the comprehensive data collected to gauge the need of local industry.		

Academic Relevance and Rigor	Do the core and elective courses align with employer needs and demands? Are the upper level courses, in particular, relevant to industry? Do the upper level courses demonstrate standard academic rigor for baccalaureate degrees?
	The program courses at all levels definitely cover topics relevant for the field of industrial automation: process control, robotic integration, Industry 4.0, fixtures and workflow, etc. This includes advanced topics such as artificial intelligence, data analytics, machine vision, digital twins, etc. which routinely appear at the graduate level if not advanced undergraduate.
General Education Requirements	Are the general educations requirements suitable for a baccalaureate level program? Do the general education courses meet breadth and depth requirements?
	I am particularly pleased by the choice of general education courses. They cover wide-ranging fields such as math, science, writing, humanities, social science, and more. What I find intriguing is how these courses, while solidly anchored in their individual disciplines, cover topics relevant for the major: technical writing, professional ethics, industrial and organizational psychology, etc. A common complaint from technical students is that their general education does not feel relevant for their careers. The choice of these courses should help dampen such complaints.
• Preparation for Graduate Program Acceptance	Do the degree concept, learning outcomes and curriculum prepare graduates to enter and undertake suitable graduate degree programs?
	By definition, bachelor's degrees in engineering technology offer limited advancement to graduate programs. However the proposal does a fine job of identifying several opportunities graduates of the BAS-META program have to pursue postgraduate studies.
Faculty	Do program faculty qualifications appear adequate to teach and continuously improve the curriculum?
	The presumption is this is the case. The proposal states simply that one faculty member exists with a Master's degree in a related discipline and at least three years of industry experience. However, no CV or other

	information about this person was supplied, making it impossible for me to judge the capabilities of this faculty member. Please correct me if I have missed this information.
Resources	Does the college demonstrate adequate resources to sustain and advance the program, including those necessary to support student and library services as well as facilities?
	The facilities, student support, and library services appear sufficient to support the proposed program. It would appear the new building offers adequate space into which the new program can expand. More questionable, however, are equipment and teaching resources. If I understand correctly according to Figure 4, the only new equipment that will be purchased is a 6-axis cobot and a server. It is unclear if the recently purchased equipment is needed to support existing activities or if it is to be dedicated entirely to the new program. In any case, the majority of equipment for the new program will be shared with existing activities. This assumes the existing equipment is highly underutilized and will be available for the new program; however, no information is provided to understand the level of use for existing (and recently purchased) equipment. Similarly on the faculty side, no indication is given as to how much bandwidth existing faculty have to develop new courses this academic year, and deliver 0.5 FTE of courses in the new program next year. Does the existing faculty member truly have half of their time currently free to take on this load? It is unclear how many faculty are planned to be hired for the new program and when. Figure 3 indicates 1.5 FTE faculty are required in the major, and 1.5 FTE faculty are required for general education (details for how these numbers are determined would be useful). However, the Financial Plan later specifies that 2 FTE faculty (1.5 upper division, 0.5 lower division) are required in the major. Using the larger number from the Financial Plan, the total general education and in-major faculty need is 3.5 FTE. It is unclear how much of this load can be absorbed with existing faculty, and how much will be covered with new hires. The $117,469 allocated for faculty in FY3 is certainly insufficient to support 3.5 FTE faculty members, therefore a significant portion of the teaching load must be absorbed by existing faculty. On the revenue side, I am unsure of the relationship between headcount and FTE in Figure 5. But if 16 full time students generate $64,107 in FY1, how can 48 students (the projected steady-state total enrollment) generate $580,728? Presumably there is something I am missing. While I am confident students will enroll in the program, and likely in larger numbers than predicted, it would appear forecasting the revenue and expenditures necessary to deliver the program could use some refinement.
Membership and Advisory Committee	Has the program received approval from an Advisory Committee? Has the program responded appropriately to it Advisory Committee's recommendations?
	Yes, the proposal includes comprehensive input from the Advisory Committee, and has done an excellent job building a curriculum incorporating their recommendations.

Overall assessment and recommendations	Please summarize your overall assessment of the program.
	I believe this is a timely and relevant program. The field of Mechatronics, Robotics, and Automation is poised to touch nearly all aspects of manufacturing and business operations in the coming decades, with few programs in the country prepared to meet existing, let alone, future need. I am excited to see this program launched and am certain it will find traction both with students and employers.

Reviewer Bio or Resume

Dr. McFall has been teaching in the largest undergraduate Mechatronics Engineering program in the country since 2012, one of only six ABET accredited programs nationwide. For the last two years, he has served as the acting Chair of Kennesaw State University's Department of Mechatronics Engineering. He is responsible for programs with over 500 students with majors or minors in mechatronics, coordinating connection with industrial partners and research activities. He has actively participated in multiple workshops over the past year exploring the Future of Mechatronics and Robotics Engineering Education where academic leaders have met to further define and refine the contents of programs addressing this emerging field. Additionally, he has served in the past as an external evaluator of proposed mechatronics programs throughout the country. More information can be found at http://facultyweb.kennesaw.edu/kmcfall/index.php.

Dr. Manoj Karkee – Washington State University

College Name:	Clover Park Technical College	**BAS Degree Title:**	Mechatronics Engineering Technology and Automation
Reviewer Name/ Team Name:	Manoj Karkee	**Institutional or Professional Affiliation:**	Washington State University
Professional License or Qualification, if any:		**Relationship to Program, if any:**	
Please evaluate the following Specific Elements			
Concept and overview	Is the overall concept of the degree program relevant and appropriate to current employer demands as well as to accepted academic standards? Will the program lead to job placement?		
	Comment As the world is moving rapidly into highly automated operations in not only industrial and manufacturing settings but also in medical, agricultural, construction and mining fields, demand of professionals with mechatronics background has been increasing rapidly. In fact, there has been similar degrees offered in other parts of the world for quite sometimes now and based on my limited understanding, those graduates seem to be in high demand. In my own graduate research and education program, I hired one PhD student from a mechatronics program in Thailand, and found out the student possessed highly desirable background and skills for working on agricultural automation and robotics projects. I believe the graduates from the proposed degree would not have difficulty for job placement.		
Degree Learning Outcomes	Do the degree learning outcomes demonstrate appropriate baccalaureate degree rigor?		
	Comment In general the rigorousness is enough. I understand that there are existing barriers, I suggest that in recent future, general course guidelines/requirement for a technical degree to be adjusted to add one more required class on computer programming.		

Curriculum Alignment	Does the curriculum align with the program's Statement of Needs Document?
	Comment As the graduates are heading to the industry or academic research heavily influenced by AI, IoT, big data, and machine vision systems, inclusion of those classes makes the program highly desirable for future workforce creation.
Academic Relevance and Rigor	Do the core and elective courses align with employer needs and demands? Are the upper level courses, in particular, relevant to industry? Do the upper level courses demonstrate standard academic rigor for baccalaureate degrees?
	Comment Yes, the classes are well designed and appropriate. One suggestion would be to include the fundamentals of control systems as a separate elective class or a part of process control class.
General Education Requirements	Are the general educations requirements suitable for a baccalaureate level program? Do the general education courses meet breadth and depth requirements?
	Comment The requirements are generally good and appropriate. As, statistics and programming skills are key to higher education, research and development, I suggest, in the future, to consider emphasizing statistics and computer programing a bit more.
f) Preparation for Graduate	Do the degree concept, learning outcomes and curriculum prepare graduates to enter and undertake suitable graduate degree programs?
	Comment

Program Acceptance	As I mentioned elsewhere, I have and am convinced to hire more students in my graduate program with mechatronics degrees, which I believe is true for a large number of graduate programs in Mechanical, Electrical, Agricultural and other engineering departments and multi-disciplinary robotic programs. I would believe, further enhancing graduates background on programing would be even more helpful.
Faculty	Do program faculty qualifications appear adequate to teach and continuously improve the curriculum?
	Comment The current faculty members are sufficiently qualified to start the program and there is a plan proposed to hire more faculty members to create a qualified team as the program grows in the next a few years. I would suggest hiring at least one faculty member with strong industry experience and at least one with strong academic experience on research, development and scholarly publications as the graduates may need to develop understanding and experience of both the fields to open up their horizon for future career.
Resources	Does the college demonstrate adequate resources to sustain and advance the program, including those necessary to support student and library services as well as facilities?
	Comment The college already has an associate technical degree in mechatronics with various laboratories that provides a foundation to build on. There are mechatronics, PCB and fluidpower labs, to list a few, that are highly relevant for the degree to be offered successfully. I would believe a newer robotic systems designed for human-robot collaboration (e.g. Universal Robots), would be a good addition to the program resources.
Membership and Advisory Committee	Has the program received approval from an Advisory Committee? Has the program responded appropriately to it Advisory Committee's recommendations?
	Comment

	Advisory committee feedback has been sought and incorporated when possible. My preliminary comments were considered seriously and were addressed convincingly.
Overall assessment and recommendations	Please summarize your overall assessment of the program.
	Comment In general, this is a highly desirable area for creating a degree that helps create a workforce needs of current and future industries that are moving towards highly automated/autonomous operations (e.g. Industry 4.0, Ag 4.0). The proposal provided good outline of the curriculum and ways applicants are attracted to the program. I believe the program will be a successful undertaking for Clover Park Technical college and hope it will grow into a 4 year undergraduate program to which high-school graduates could directly apply.

Reviewer Bio or Resume

Manoj Karkee, Ph.D.
Associate Professor, Biological Systems Engineering
Center for Precision & Automated Agricultural Systems
Washington State University, Prosser, WA 61801
Tel: (509) 786-9207, Fax: (509) 786-9321
Email: manoj.karkee@wsu.edu

RESEARCH INTERESTS AND EXPERTISE

- Sensing and control for automated, precision and autonomous agricultural systems
- Robotics and artificial intelligence for agricultural applications
- Agricultural systems modeling, simulation and control

EDUCATION

PhD, Agricultural Engineering and Human Computer Interactions, Iowa State University, 2009
M.E., Remote Sensing and GIS, Asian Institute of Technology, Thailand, 2005
B.E., Computer Engineering, Tribhuvan University, Nepal, 2002

PROFESSIONAL EXPERIENCE

- Associate Professor, Washington State University, 2016-present
- Assistant Professor, Washington State University, 2010-2016
- Assistant Scientist, Iowa State University, 2009-2010

TEACHING EXPERIENCE

- Machine Vision for Biological Systems (WSU) BSysE 530 – Five semesters
- Precision Agriculture Technologies (WSU Advanced Topic) BSysE 551; Fall 2014
- Data Structures and Algorithms for GIS (Advanced Topic) BSysE 552; Summer 2012
- Fluid Power Systems Engineering (ISU) AE 413, Fall 2009

HONORS AND AWARDS

Honorary Membership:

- Phi Kappa Phi Honor Society
- Tau Beta Pi, The Engineering Honor Society (TBP)
- Alpha Epsilon, Honor Society of Agricultural, Food, and Biological Engineers (AE)

Selected Awards:

- *Featured as Western Innovator,* **Capital Press,** 2019.
- *2019 Pioneer in AI and IoT,* **Connected World Magazine**, 2019.
- *Finalist, Early Career Excellence Award,* **WSU College of Agriculture, Human and Natural Resource Sciences,** 2017, 2018 and 2019.
- *Nominated for New Holland Young Researcher Award,* **American Society of Agricultural and Biological Engineers**, 2017.
- *Invited Participant, Next Generation Leaders Event,* **International Commission of Agricultural and Biosystems Engineering (CIGR),** 2015.
- *Certificate of Excellence in Reviewing,* ***Computers and Electronics in Agriculture,*** *2014.*
- *Outstanding Reviewers Award,* **American Soc of Ag and Biological Engineers,** 2013.
- *Honorable Mention Paper Award (In the recognition of authorship of a literature of exceptional merit),* **American Society of Agricultural and Biological Engineers**, 2011.
- *Research Excellence Award* (outstanding research performance among the 2009-2010 graduates), **Iowa State University,** 2009.
- *The AIT Alumni Association Prize* (outstanding academic performance among students in the School of Technologies), **Asian Institute of Technology,** Thailand, 2005.

INVITED SEMINARS/PRESENTATIONS

- Automation and Robotics in Agriculture, *Asian-Australian Conference on Precision Agriculture (Key-note Speech)*, Ludhiana, India, October 14-17, 2019.
- Automation and Robotics in Specialty Crops, *Cornell University*, USA, Sep 09, 2019.

- Automation and Robotics in Specialty Crops, *CPAAS Technology Day, Washington State University*, USA, August 22, 2019.
- Automation and Robotics in Agriculture: Global Perspective and Nepali Context, *Kings College, Kathmandu*, Nepal, July 2, 2019
- Writing Convincing Research Manuscripts, *China Agricultural University*, June 20, 2019
- Challenged and Opportunities in Agricultural Robotics, *China Agricultural University*, June 19, 2019
- Agricultural Robotics: Global Perspective and Local Context, *Annual Convention of Indian Society of Agricultural Engineers*, Jan 28-30, 2019.
- Agricultural Automation and Robotics - Challenges and Opportunities *(Key-note Speech)*, *Australasian Conference on Robotics and Automation,* Christchurch, New Zealand, Dec 3-6, 2018.
- UAVs and other Advanced Technology for Precision Pest Management, *Oregon State University Farm Fair*, Hermiston, Nov 30, 2018.
- Agricultural Automation and Robotics: Challenges and Opportunities in Small-Scale Farming, *Association of Nepalese Agricultural Professionals of Americas*, September 30, 2018;
- Recent Innovations in Automated Fresh Market Tree Fruit Harvesting, *6th IFAC Conference on Bio-Robotics,* Beijing, China, July 13-15, 2018.
- Agricultural Automation and Robotics - Global Perspective and Local Context, *Nepal Agricultural Engineering Society*, Kathmandu, Nepal, July 20, 2018.
- Agricultural Automation and Robotics - Global Perspective and Local Context, *Far Western University,* Kanchanpur, Nepal, July 18, 2018.
- Recent innovations in Automated Fresh Market Tree Fruit Harvesting, *China Agricultural University,* Beijing, China, July 10, 2018.
- Recent innovations in Automated Fresh Market Tree Fruit Harvesting, *North West Agriculture and Forestry University*, Yangling, China, July 9, 2018.
- Automated Fresh Market Tree Fruit Harvesting - Where Do We Stand? *Commonwealth Scientific and Industrial Research Organization,* Canberra, Australia, May 29, 2018.
- Recent innovations in Automated Fresh Market Tree Fruit Harvesting, *University of California, Davis*, May 14, 2018.
- Tree Fruit Automation and Mechanization, *WSU Horticulture: Fruit Crops Management Class*, March 1, 2018.
- Precision and Automated Ag Research at WSU, *Hermiston Farm Fair,* Hermiston, OR, Nov 30, 2017.
- Machine vision for automating fruit production, *Heritage University,* Toppenish, WA, Nov 27, 2017.
- Recent innovations in precision and automated agricultural systems (*Key-note Speech*), *Vive Agro 4.0,* Peru, Nov 14-16, 2017.
- Machine vision for automating apple production: Opportunities and Challenges, *13th Workshop on Nondestructive Quality Evaluation of Ag, Livestock and Fishery products,* Taipei, Taiwan, Nov 7, 2017.
- Apple Harvesting Robot, *Robot Revolution,* Pacific Northwest National Lab, Richland, WA; July 27, 2017.
- Automated Fresh Market Tree Fruit Harvesting, *Kathford College of Engineering and Management,* Kathmandu, Nepal; July 3, 2017.
- Automation and Robotics in Agriculture – Global Perspective and Local Context; *Nepal Engineering Association,* June 30, 2017.

- Automation and Robotics in Agriculture – Global Perspective and Local Context; *Workshop on Agricultural Automation and Mechanization,* Tribhuvan University, Kathmandu, Nepal; June 20, 2017.
- Unmanned Aerial Systems in Agriculture, *Summer School on Sustainable Engineering Tools for Agricultural Robotics and Mechanization,* Tribhuvan University, Kathmandu, Nepal; June 18-20, 2017.
- Automation and Robotics in Agriculture, *China Agricultural University;* June 13, 2017.
- Sensing, Control and Automation for Tree Fruit Crops, *NCERA 180: Annual Meeting,* Starkville, MS, May 18, 2017.
- Robotic Apple Harvesting, *Second Biannual SINE FUNCTON,* Spokane Innovator Network, Spokane, WA; April, 19, 2017.
- Automated and Robotic Weeding in Vegetable Crops, *East Washington Ag Expo,* Pasco, WA; Jan 4, 2017.
- Bird Deterrence in Fruit Crops Using UAS, *Washington Small Fruit Conference,* Nov 30 – Dec 2, 2016, Lynden, WA.
- Mechanism for Bundling and Tying of Red Raspberry Promicanes, *Washington Small Fruit Conference,* Nov 30 – Dec 2, 2016, Lynden, WA.
- Automation Technologies for Specialty Crops, *Washington Small Fruit Conference,* Nov 30 – Dec 2, 2016, Lynden, WA.
- UAVs for Pest Management, *2016 Mid-Atlantic Crop School,* Ocean City, MD, Nov 15-17, 2016.
- Automated and Robotic Weeding in Vegetable Crops, *Annual Meeting of Oregon Society of Weed Science,* Hood River, OR, Oct 25, 2016.
- Recent Advancement in Tree Fruit Harvesting Technologies, *IEEE Distinguished Lecture Series, Amrita University,* Kerala, India, August 7, 2016.
- Automated Fresh Market Tree Fruit Harvesting - Where Do We Stand? *Workshop on Smart Life and City,* Beijing, China, July 7, 2016.
- Automated Fresh Market Tree Fruit Harvesting - Where Do We Stand? *Invited Seminar Series, Penn State University,* State College, PA, June 2, 2016.
- Panel Moderator, Recent Development and Future Trend in Precision Chemical Application Technologies, *2016 Precision Ag Expo,* Kennewick WA, Jan 7, 2016.
- Robotic Technologies for Specialty Crop Production - Emerging Technology Panel, *2016 Precision Ag Expo,* Kennewick WA, Jan 7, 2016.
- Robotics and Automation in Agriculture, *Undergraduate Seminar, Heritage University,* Toppenish, WA, Nov 23, 2015
- Engineering Developments – UAVs, *Advanced Technology for Precision IPM: Development and Legal Considerations with Examples from the Field, 8th International IPM Symposium,* Salt Lake City, UT, March 23-25, 2015.
- Human Robot Collaboration for Apple Harvesting, *2nd International Conference on Agricultural and Food Engineering (CAFEi2014),* Kuala Lumpur, Malaysia, Dec 1-3, 2014.
- The State of Drones for Agriculture (Keynote Speech), *Annual Meeting of Washington State Grape Society,* Grandview, WA, Nov 13, 2014.
- Robotics and Automation in Agriculture, *Undergraduate Seminar, Heritage University,* Toppenish, WA, March 19, 2014

- Robotics and Automation in Agriculture (Keynote Speech), *Zillah Robotics Competition,* March 8, 2014.
- Pruning Branch Identification for Automated Pruning of Apple Trees, *IEEE Agricultural Robotics Group Webinar,* May 6, 2013.
- Automation and Mechanization Research for Specialty Crops, *Annual Hermiston Farm Fair and Trade Show,* Hermiston, OR; 11/29/2012.
- Pruning Branch Identification for Automated Pruning of Apple Trees, *Specialty Crop Engineering Solutions Workshop,* Pittsburg, PA; 11/28/2012.
- Precision Agriculture in Specialty Crops: Accomplishments, Challenges and Future Direction. *First International Precision Agriculture Forum,* Richland, WA; 3/15-16/2012.
- Mechanization in Berry Crops*. WA Small Fruit Conference;* Lynden, WA; 12/9/2011.

ADVISEE AWARDS

- Santosh Bhusal, *Outstanding Graduate Student Award,* Biological Systems Engineering Department, Washington State University, 2018.
- Lin Chen, *Best Paper Award,* 2018 Joint International Conference on Smart Agriculture and Bio-Robotics (JICSAB, 2018), July 13-15, 2018; Beijing, China.
- Xin Zhang, *Best Paper Award,* 2018 Joint International Conference on Smart Agriculture and Bio-Robotics (JICSAB, 2018), July 13-15, 2018; Beijing, China.
- Han Fu, *Best Paper Award,* 2018 Joint International Conference on Smart Agriculture and Bio-Robotics (JICSAB, 2018), July 13-15, 2018; Beijing, China.
- Kapil Khanal, *Best Poster Award,* 2018 Joint International Conference on Smart Agriculture and Bio-Robotics (JICSAB, 2018), July 13-15, 2018; Beijing, China.
- Santosh Bhusal, *Outstanding Graduate Student Award,* International Society of Precision Agriculture, 2018.
- Kapil Khanal, *Boyd-Scott Graduate Research Award,* American Society of Agricultural and Biological Engineering (ASABE), 2018.
- Xin Zhang, *Outstanding Graduate Student Award,* Biological Systems Engineering Department, Washington State University, 2017
- Abhisesh Silwal, *ASABE Boyd-Scott Graduate Research Award,* 2017.
- Abhisesh Silwal, *WSU Commercialization Gap Fund,* 2016-2017
- Suraj Amatya, *International Giuseppe Pellizzi Prize,* Club of Bologna, 2016.
- Suraj Amatya, *ASABE Boyd-Scott Graduate Research Award,* 2016.
- Aadit Shrestha, *ASD Inc. Instrument Award,* 2016.
- Abhisesh Silwal, *Outstanding Graduate Student Award,* Biological Systems Engineering Department, Washington State University. 2015
- Suraj Amatya, *Outstanding Graduate Student Award,* Biological Systems Engineering Department, Washington State University. 2014
- De Kleine, M; *Best Poster Presentation Award,* Dr. William R. Wiley Research Exposition, Washington State University. Feb 2013.

PROFESSIONAL ACTIVITIES

- *Guest Editor,* Special Issue on Agricultural Robotics for the Journal 'Robotics', 2017-2019
- *Associate Editor,* Transactions of the ASABE and Applied Engineering in Agriculture
- *Editorial Board Member,* Information Processing in Agriculture
- *Editorial Advisory Board Member,* Computer and Electronics in Agriculture, 2012-present
- *Reviewer*, Trans. of the ASABE, Applied Engineering in Agriculture, Computer and Electronics in Agriculture, Biosystems Engineering, and Journal of Precision Agriculture
- *Member,* Membership Council, ASABE, 2014-2018
- *Chair,* IET-35 Instrumentation and Control Committee, ASABE, 2016-2018
- *Chair,* PM-48/FPE 712 Specialty Crop Engineering Committee, ASABE, 2014-2016

Synergistic Activities

- Panelist, Small Business Innovative Research, Phase I (Animal Production), Feb 6-8, 2019
- *Panelist,* Agricultural Engineering Foundational Program, USDA NIFA, Dec 10-12, 2018.
- *Panelist*, Specialty Crop Research Initiative, USDA NIFA, May 9-13, 2017.
- *Judge and Chair,* ASABE-Boyd Scott Graduates Research Award Competition, 2017.
- *Panelist,* Agricultural Engineering Foundational Program, USDA NIFA, Oct 24-26, 2016.
- *Ad-hoc Reviewer*, BARD Research Proposal, 2014 and 2015
- *Panelist,* USDA SBIR, Phase I and II, 2013 and 2014.
- *Judge,* Iowa Science and Technology Fair, March 28, 2009
- Developed *syllabus and teaching materials* for a graduate level class (WSU-BSysE: Machine Vision for Biological Systems), Spring 2011

Major Grant Awards

- **Karkee, M. (PI)**, Keller, M., Wu, Y., Zhang, Q.; 2018-2021; *SMART IRRIGATION - Big Data approach for accurate water stress detection and precision irrigation in fruit crops;* Cyber Physical Systems - NSF/USDA; Amount Awarded: **$691,508.**
- Shinde, G. U. (PI), **Karkee** et al. 2019-2022. *Center for Excellence for Digital Farming Solutions for Enhancing Productivity by Robots, Drones, and AGVs.* Funding Agency: ICAR-World-Bank. Amount Awarded: $1,500,000.
- **Karkee, M. (PD);** Whiting, M.; Zhang, Q. *Shake and Catch Harvesting for Fresh Market Apples.* USDA-NIFA AFRI; Amount Awarded: $495,480 (2014-2018).
- Slaughter, D. (PD); **Karkee, M.** et al. *Crop Signaling for Automated Weed/Crop Differentiation and Mechanized Weed Control in Vegetable Crops;* USDA Specialty Crop Research Initiative; Amount Awarded: $2,715,901 (2015-2019).
- **Karkee, M. (PI)**, Lewis, K., Mo, C., Zhang, Q. *Human-machine collaboration for automated harvesting of tree fruit*. National Robotics Initiative - National Science Foundation/USDA, $548,735 (2013 - 2017).

- Grieshop, M. (PD); **Karkee, M.** et al. *Development and Optimization of Solid-Set Canopy Delivery Systems for Resource-Efficient, Ecologically Sustainable Apple and Cherry Production.* USDA Specialty Crops Research Initiative, $ 2,472,895 (2011-2014).
- **Karkee, M. (PI)**; Zhang, Q.; Lewis, K. *3D machine vision for improved apple crop load estimation.* Washington Tree Fruit Research Commission, $67,506 (2011-2014).
- Hashimoto, A. (PD), **Karkee, M** et al. *Conversion of High-Yield Tropical Biomass into Sustainable Biofuels;* USDA BRDI. $6,000,000 (2012-2017);

PUBLICATIONS

A. Patent

1. Davidson, J.R., Mo, C., Zhang, Q., Silwal, A. and Karkee, M., Washington State University, 2017. *Robotic systems, methods, and end-effectors for harvesting produce*. U.S. Patent Application 15/383,000.
2. DeKleine, M., Y. Ye, and **M. Karkee.** 2016. *Harvesting machine for formally trained orchards.* US Patent # US 2016/0120124 A1.

B. Book Chapters

1. **Karkee**, M., J. Gordón, B. Salato and M. Whiting, Optimizing fruit production efficiencies via mechanization. 2019. In *Achieving sustainable cultivation of temperate zone tree fruits and berries, Volume 1 - Physiology, genetics and cultivation (Editor: Dr Greg Lang)*. Burleigh Dodds Science Publishing.
2. **Karkee, M.**, Q. Zhang, and A. Silwal. Agricultural Robots for Precision Agricultural Tasks in Tree Fruit Orchards. In *Innovation in Agricultural Robotics for Precision Agriculture (Editor: Avital Bechar*). In Press.
3. Shamshiri, R. R., I. A. Hameed, **M. Karkee**, and C. Weltzien. 2018. Robotic Harvesting of Fruiting Vegetables: A Simulation Approach in V-REP, ROS and MATLAB. In *"Automation in Agriculture - Securing Food Supplies for Future Generations",* book edited by Stephan Hussmann, ISBN 978-953-51-3874-7, Print ISBN 978-953-51-3873-0.
4. **Karkee, M.**, A. Silwal, J.R. Davidson. 2018. Mechanical Harvest and In-field Handling of Tree Fruit Crops. Book Chapter; Chapter on '*Automation in Tree Fruit Production*, *Principles and Practice. Editor: Qin Zhang*'. CABI.
5. Zhang, Q., **M. Karkee**, A. Tabb; The Use of Agricultural Robots in Orchard Management. In *Robotics and Automation for a More Sustainable Agriculture (Editor: John Billingsley)*; Burleigh Dodds Science Publishing. In Press.
6. Zhang, Q., **M. Karkee** and L. Khot. 2017. Mechanization and automation for apple production. *Chapter on 'Achieving Sustainable Cultivation of Apples' Editor: Kate Evans*. Burleigh Dodds (28 pp).
7. **Karkee, M.**, B. Steward, and J. Kruckeberg. 2013. Automation of Pesticide Application Systems. In *Agricultural Automation: Fundamentals and Practices (Q. Zhang and F. Pierce editors; ISBN: 9781439880579).* CRC Press: Boca Raton, Florida, USA.

C. Refereed Journals (Last 5 Years; Total 60)

1. Sharda, A., G. Hoheisel, M. **Karkee**, and Q. Zhang. 2019. Design and evaluation of solid set canopy delivery system for spray application in high-density apple orchards. Transactions of the ASABE. ***Accepted.***

2. Santiago, W. E., N. J. Leite, B. J. Teruel, M. **Karkee**, C. A.M. Azania. 2019. Evaluation of bag-of-features (BoF) technique for weed management in sugarcane production. Australian Journal Crop of Science. ***Accepted.***
3. Khanal, K., S. Bhusal, M. **Karkee**, P. Scharf, and Qin Zhang. 2019. Design of Improved and Semi-Automated Red Raspberry Cane Bundling and Tying Machine Based on the Field Evaluation Results. *Transactions of the ASABE.* 62(3): 821-829.
4. Bhusal, S., K. Khanal, S. Goel, M. Taylor and M. **Karkee**. 2019. Bird Deterrence in a Vineyard using an Unmanned Aerial System (UAS). *Transactions of the ASABE;* 62(2): 561-569.
5. Hohimer, C. J., H. Wang, S. Bhusal, J. Miller, C. Mo, M. **Karkee**. 2019. Design and field evaluation of a robot apple harvesting system with 3D printed soft-robotic end-effector. *Transactions of the ASABE*; 62(2): 405-414.
6. He, L., X. Zhang, Y. Ye, M. **Karkee**, and Q. Zhang. 2019. Effect of Shaking Location and Duration on Mechanical Harvesting of Fresh Market Apples. *Applied Engineering in Agriculture;* 35(2): 175-183.
7. Zhang, J., L. He, **M. Karkee**, Q. Zhang, X. Zhang and Z. Gao. 2018. Branch Detection for Apple Trees Trained in Fruiting Wall Architecture using Depth Features and Regions-Convolutional Neural Network (R-CNN). *Computers and Electronics in Agriculture*. 155: 386-393.
8. Zhang, X., L. He, Y. Majeed, M. **Karkee**, M.D. Whiting, M. D. and Q. Zhang[#]. 2018. A precision pruning strategy for improving efficiency of vibratory mechanical harvesting of apples. *Transactions of the ASABE*. 61(5): 1565-1576.
9. Gongal, A., S. Amatya and M. **Karkee**. 2018. Apple fruit size estimation using a 3D machine vision system. *Information processing in agriculture.* 5(4): 498-503.
10. Ma, S**., M. Karkee**, F. Han, Q. Sun, and Q. Zhang. 2018. Evaluation of shake-and-catch mechanism in mechanical harvesting of apples. *Transactions of the ASABE,* 61(4): 1257-1263.
11. Khanal, K., S. Bhusal, **M. Karkee**, Q. Zhang. 2018. Raspberry Primocane Bundling and Taping Mechanisms. *Transactions of the ASABE.* 61(4): 1265-1274.
12. Ma*, S., M. **Karkee[#],** P. Scharf, and Q. Zhang. 2018. Adaptability of Chopper Harvester in Harvesting Sugarcane, Energy Cane, and Banagrass. *Transactions of the ASABE,* 61(1): 27-35.
13. He, L., M. **Karkee**, Q. Zhang. 2018. Evaluation of a localized shake-and-catch harvesting system for fresh market apples. *Agricultural Engineering International: CIGR Journal*, *19*(4), pp.36-44.
14. Ma, S., P. Scharf, M. **Karkee**, Q. Zhang, J. Tong, and L. Yu. 2017. A Study on the Effects of Harvester Off-track Errors on Stubble Losses. *Applied Engineering in Agriculture.* 33(6): 771-779.
15. Amatya, S., M. Karkee, Q. Zhang, and M. D. Whiting. 2017. Automated Detection of Branch Shaking Locations for Robotic Cherry Harvesting Using Machine Vision. *Robotics*, *6*(4), p.31.
16. He, L., H. Fu, M. **Karkee**, and Q. Zhang. 2017. An Effect of fruit location on apple detachment with mechanical shaking. *Biosystems Engineering*, 157: 63-171.
17. Silwal, A., J. R. Davidson, M. **Karkee**, C. Mo, Q. Zhang, and K. Lewis. 2017. Design, integration, and field evaluation of a robotic apple harvester. *Journal of Field Robotics*. 34(6): 1140-1159.

18. He, L., H. Fu, D. Sun, M. **Karkee**, and Q. Zhang. 2017. Shake and Catch Harvesting for Fresh Market Apples in Trellis Trained Trees. *Transactions of the ASABE.* 60(2): 353-360.
19. Fu, H., L. He, S. Ma, **M. Karkee**, D. Chen, Q. Zhang, and S. Wang. 2017. "Jazz" Apple Impact Bruise Responses to Different Cushioning Materials. *Transactions of the ASABE.* 60(2): 327-336.
20. Zhou, J., L. He, M. Whiting, S. Amatya, P. Larbi, **M. Karkee,** and Q. Zhang. 2016. Field evaluation of a mechanical-assist cherry harvesting system. *Engineering in Agriculture, Environment and Food,* 9(4): 324-331.
21. Silwal, A., **M. Karkee,** and Q. Zhang. 2016. A Hierarchical approach of apple identification for robotic harvesting. *Transaction of the ASABE.* 59(5): 1079-1086**.**
22. Santiago, W. E., N. J. Leite, B. J. Teruel, **M. Karkee,** C. A. M. Azania, and R. Vitorino. 2016. Development and testing of image processing algorithm to estimate weed infestation level in corn fields. *Australian Journal of Crop Science.* 10(9): 12232-1237.
23. Davidson, J., A. Silwal, **M. Karkee,** C. Mo, and Q. Zhang. 2016. Hand Picking Dynamic Analysis for Undersensed Robotic Apple Harvesting. *Transactions and the ASABE,* Vol. 59(4): 745-758.
24. Li, J., **M. Karkee,** Q. Zhang, K. Xiao, and T. Feng. 2016. Characterizing apple fruit robotic picking patterns and detaching parameters. *Computers and Electronics in Agriculture*, 127:633-640.
25. Ma, S., P. A. Scharf, Q. Zhang, **M. Karkee,** J. Tong, and L. Yu. 2016. Effect of Cane Stool Density and Stubble Height on Sugarcane Stubble Damage in Hawaii Fields. Transactions and the ASABE*,* 59(3): 813-820.
26. Amatya, S., and **M. Karkee,** 2016. Integration of visible branch sections and cherry clusters for detecting cherry tree branches in dense foliage canopies. 2016. Biosystems Engineering, 119:72-81.
27. Zhou, J., L. He, **M. Karkee,** and Q. Zhang. 2016. Analysis of shaking-induced cherry fruit motion and damage. Biosystems Engineering, 144: 105-114.
28. Zhou, J., L. He, **M. Karkee**, and Q. Zhang. 2016. Effect of Catching Surface and Tilt Angle on Reducing of Bruise Damage of Sweet Cherry due to Mechanical Impact. *Computers and Electronics in Agriculture,* 121:282-289**.**
29. Amatya, S., **M. Karkee,** A. Gongal, Q. Zhang, M.D. Whiting. 2016. Detection of Cherry Tree Branches in Planner Architecture for Automated Sweet-Cherry Harvesting. *Biosystems Engineering*. 146:3-15.
30. De Kleine, M. E., and **M. Karkee**. 2016. A Semi-Automated Harvesting Prototype for Shaking Fruit Tree Limbs. *Transactions of the ASABE*, 58(6): 1461-1470.
31. Gongal, A., A. Silwal, S. Amatya, **M. Karkee,** Q. Zhang, and K. Lewis. 2016. Apple Crop-load Estimation with Over-the-Row Machine Vision System. *Computers and Electronics in Agriculture, 20: 26–35***.**
32. He, L., J. Zhou, Q. Zhang, **M. Karkee**. 2015. Evaluation of multipass mechanical harvesting on 'Skeena' sweet cherries trained to Y-trellis. HortScience, 50(8): 1178-1182.
33. Ma, S., P. A. Scharf, **M. Karkee**, and Q. Zhang. 2015. Performance Evaluation of a Chopper Harvester in Hawaii Sugarcane Fields. *The Transactions of ASABE, 58(2): 271-279.*

34. Gongal, A., S. Amatya, **M. Karkee**, Q. Zhang, and K. Lewis. 2015. Sensors and Systems for Fruit Detection and Localization: A Review. *Computers and Electronics in Agriculture, 116:8-19*. **Most Downloaded in Jan 2016.**
35. Larbi P., S. Amatya, **M. Karkee,** Q. Zhang, and M. Whiting. 2015. Modification and Field Evaluation of an Experimental Mechanical Sweet Cherry Harvester. *Applied Engineering in Agriculture,* 31(3):387-397.
36. Larbi, P., C. N Vong, **M. Karkee**. 2015. A Study of Operator Performance for a Mechanical Sweet Cherry Harvester: Comparison between Manual and Remote-Controlled Operation. *Journal of Agricultural Safety and Health,* 21(3): 145-157.
37. De Kleine, M.E., and **M. Karkee.** 2015. Evaluating a non-Newtonian Shear Thickening Surface during Fruit Impacts. *The Transactions of ASABE,* 58(3): 907-915.
38. **Karkee, M.**, and B. Adhikari*. 2015. A Method for Three Dimensional Reconstruction of Apple Trees for Automated Pruning. *Transactions of the ASABE*, 58(3): 565-574.
39. Sharda, A., **M. Karkee,** Q. Zhang, J. Brunner, I. Ewlanow, and U. Adameit. 2015. Effect of emitter type and mounting configuration on spray coverage for Solid Set Canopy Delivery Systems. *Computers and Electronics in Agriculture,* 112: 184-192.

D. Peer Reviewed Conference Proceedings (Last 5 Years)

1. Bhusal, S., Khanal, K., **Karkee, M**. and Zhang, Q., Cane Detection and Localization for Automated Cane Management in Red Raspberry Plant. International Conference on Robotics and Automation, 21-25 May 2018 | Brisbane
2. Fu, H.; J. Duan, **M. Karkee**, L. He, D. Chen, D. Sun, and Q. Zhang. 2018. Quantifying Fruit Quality Affected by Mechanical Impact for Selected Apple Varieties. *6th IFAC Conference on Bio-Robotics*; July 13-15, 2018; Beijing, China.
3. Khanal, K., S. Bhusal, **M. Karkee**, and Q, Zhang. 2018. Distinguishing One Year and Two Year Old Canes of Red Raspberry Plant using Spectral Reflectance. *6th IFAC Conference on Bio-Robotics*; July 13-15, 2018; Beijing, China.
4. Fu, L., Y. Feng, Y. Majeed, X. Zhang, J. Zhang, **M. Karkee**, and Q. Zhang. 2018. Kiwifruit detection in field images using Faster R-CNN with ZFNet. *6th IFAC Conference on Bio-Robotics*; July 13-15, 2018; Beijing, China.
5. Majeed, Y., J. Zhang, X. Zhang, L. Fu, **M. Karkee**, Q. Zhang, and M. Whiting. 2018. Apple Tree Trunk and Branch Segmentation for Automatic Trellis Training Using Convolutional Neural Network Based Semantic Segmentation. *6th IFAC Conference on Bio-Robotics*; July 13-15, 2018; Beijing, China.
6. Zhang, X., L. Fu, Y. Majeed, L. He, **M. Karkee**, M. Whiting, and Q. Zhang. 2018. Field Evaluation of Data-Based Pruning Severity Levels (PSL) on Mechanical Harvesting of Apples. *6th IFAC Conference on Bio-Robotics*; July 13-15, 2018; Beijing, China.
7. Wang, H., C. Hohimer, S. Bhusal, **M. Karkee**, C. Mo, and M. John. 2018. Simulation as a Tool in Designing and Evaluating a Robotic Apple Harvesting System. *6th IFAC Conference on Bio-Robotics*; July 13-15, 2018; Beijing, China.
8. Chen, L., **M. Karkee**, L. He, Y. Wei, and Q. Zhang. 2018. Evaluation of a Leveling System for a Weeding Robot under Field Condition. *6th IFAC Conference on Bio-Robotics*; July 13-15, 2018; Beijing, China.
9. Shrestha, A., **M. Karkee**, and Q. Zhang. 2016. Mechanism for Bundling and Tying of Red Raspberry Primocanes. Proceedings of the *5th IFAC Conference on Sensing, Control and Automation Technologies for Agriculture*; Seattle, WA; August 14-17, 2016.

10. Ma, S., **M. Karkee**, H. Fu, D. Sun, and Q. Zhang. 2016. Air Suspension-based Catching Mechanism for Mechanical Harvesting of Apples. Proceedings of the *5th IFAC Conference on Sensing, Control and Automation Technologies for Agriculture*; Seattle, WA; August 14-17, 2016.
11. He, L., H. Fu, **M. Karkee**, and Q. Zhang. 2016. Effect of Fruit Location on Apple Detachment with Mechanical Shaking. Proceedings of the *5th IFAC Conference on Sensing, Control and Automation Technologies for Agriculture*; Seattle, WA; August 14-17, 2016.
12. Fu, H., L. He, S. Ma, **M. Karkee**, D. Chen, Q. Zhang, and S. Wang. 2016. Bruise Responses of Apple-to-Apple Impact. Proceedings of the *5th IFAC Conference on Sensing, Control and Automation Technologies for Agriculture*; Seattle, WA; August 14-17, 2016.
13. Chen, L., S. Kaewkorn, L. He, Q. Zhang, and **M. Karkee**. 2016. Design and Evaluation of a Levelling System for a Weeding Robot. Proceedings of the *5th IFAC Conference on Sensing, Control and Automation Technologies for Agriculture*; Seattle, WA; August 14-17, 2016.
14. Davidson, J.R.**,** A. Silwal, C.J. Hohimer, **M. Karkee**, C. Mo, and Q. Zhang. 2016. Proof-of-Concept of a Robotic Apple Harvester. *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Daejon, Korea, October 9 - 14, 2016.
15. Davidson, J., C. Mo, A. Silwal, **M. Karkee,** J. Li, K. Xiao, and Q. Zhang. 2015. Human-Machine Collaboration for Robotic Harvesting of Fresh Market Apples. *ICRA 2015 Workshop on Robotics in Agriculture;* 30 May, 2015; Seattle, WA.

E. Dissertation/Thesis

1. Modeling, identification and analysis of a tractor and single-axle-towed implement system. *PhD Dissertation*, Iowa State University, 2009.
2. Fusion of stereo-optical and interferrometric SAR DEMs. *Master Thesis*, Asian Institute of Technology, 2005.

F. Student Dissertation/ Thesis

1. Chen, L. 2019. A Weeding Robot Auto-Levelling System for Typical Vegetable Fields in Pacific Northwest Region. *PhD Dissertation*, Washington State University.
2. Khanal, K. 2018. Cane Management in Red Raspberry Crops: A Proof of Concept towards Automation. *MS Thesis*, Washington State University.
3. Silwal, A. 2016. Machine Vision System for Robotic Apple Harvesting in Fruiting Wall Orchards. *PhD Dissertation,* Washington State University.
4. Scharf, P. 2016. Optimization of basecutting parameters in laboratory setting to minimize energy requirements for sugarcane harvesting. *MS Thesis*, Washington State University.
5. Amatya, S. 2015. Detection of Cherry Tree Branches and Localization of Shaking Positions for Automated Sweet Cherry Harvesting. *PhD Dissertation,* Washington State University.
6. DeKleine, M. 2014. Semi-automated End-effector Concepts for Localized Removal and Catching of Fresh-market Apples in Fruiting Wall Orchards. *PhD Dissertation,* Washington State University.
7. Gongal, A. 2014. Improved Apple Crop-load Estimation with an Over-the-Row Machine Vision System. *MS Thesis*, Washington State University.

8. Adhikari, B. 2012. Identification of Pruning Branches in Tall Spindle Apple Trees for Automated Pruning. *MS Thesis*, Washington State University.

TEACHING

Washington State University, Prosser, WA

- Spring 2019 - BSysE 530: Machine Vision for Biological Systems
- Fall 2017 - BSysE 530: Machine Vision for Biological Systems
- Spring 2016 – BSysE 530: Machine Vision for Biological Systems
- Spring 2015 – BSysE 530: Machine Vision for Biological Systems
- Fall 2014 – BSysE 551 (Advanced Topics): Precision Agriculture Technologies
- Fall 2013 – BsysE 598: Seminar Series (Co-Coordinator)
- Summer 2012 – BSysE 552 (Advanced Topics): Data Structures and Algorithms for Geographic Information Systems
- Fall 2012 – BSysE 530: Machine Vision for Biological Systems
- Spring 2011 – BSysE 530: Machine Vision for Biological Systems

Iowa State University, Ames, IA

- Spring 2008 to Fall 2009 - Fluid Power System Technology (TSM 337) and Fluid Power Engineering (AE/ME 413)

Tribhuvan University, Nepal

- Fall 2002 to Summer 2005 - Four undergraduate level classes

SUPERVISION

PhD Students

- Zixuan He – PhD Student; Fall 2019 – present
- Daniel Borrenpohl – PhD Student; Fall 2019 – present
- Chenchen Kang – PhD Student; Fall 2018 – present (co-supervision)
- Uddhav Bhattarai – PhD Student; Summer 2018 – present
- Santosh Bhusal – PhD Student; Spring 2017 – present
- Xin Zhang – PhD Student; Fall 2016 – present
- Yaqoob Majeed – PhD Student; Fall 2016 – present (co-supervision)
- Aadit Shrestha – PhD Student; Spring 2015 – Spring 2016
- Lin Chen – PhD Student; Spring 2015 – Summer 2019 (co-supervision)
- Abhisesh Silwal – PhD Student; Spring 2014 – Fall 2016 **(Graduated**; now at Carnegie Mellon University**)**
- Suraj Amatya – PhD Student; Fall 2011 – Fall 2015 **(Graduated**; now at John Deere**)**
- Mark De Kleine – PhD Student; Fall 2011 – Fall 2014 **(Graduated**; now started De Kleine Machines**)**

MS Students

- Martin Churuvija - MS Student; Fall 2019 – present
- Sushma Thapa – MS Student; Fall 2018 – present
- Kapil Khanal – MS Student; Fall 2016 – Spring 2018 **(Graduated**; now at Pix4D**)**
- Patrick Scharf – Master Student; Spring 2012 – Spring 2016 **(Graduated**; now at Washington State University**)**
- Aleana Gongal – Master Student; Fall 2012 – Fall 2014 **(Graduated**; now at John Deere**)**
- Bikram Adhikari – Master Student; Spring 2011 – Fall 2012 (**Graduated**; now at a Robotic Startup in British Columbia)

Others (2 research scientists/associates; 3 post-doctoral researchers; 19 Visiting Scholars)

Gail Norris – Siemens Industry, Inc.

College Name:	Clover Park Technical College	**BAS Degree Title:**	META
Reviewer Name/ Team Name:	Gail Norris	**Institutional or Professional Affiliation:**	Siemens Industry, Inc.
Professional License or Qualification, if any:		**Relationship to Program, if any:**	SMSCP Sponsor
Please evaluate the following Specific Elements			
Concept and overview	Is the overall concept of the degree program relevant and appropriate to current employer demands as well as to accepted academic standards? Will the program lead to job placement?		
	Comment Mechatronics is a system-level problem solving discipline. This program provides deep knowledge in skills which are in the top 10 sought by industrial clients: critical thinking, problem solving, creativity, systems thinking.		
Degree Learning Outcomes	Do the degree learning outcomes demonstrate appropriate baccalaureate degree rigor?		
	Comment Yes – they cover both the details needed to develop mechatronics skills as well as the high level strategic thinking/communications necessary for a 4 year BAS grad.		
Curriculum Alignment	Does the curriculum align with the program's Statement of Needs Document?		
	Comment Completely		
Academic Relevance and Rigor	Do the core and elective courses align with employer needs and demands? Are the upper level courses, in particular, relevant to industry? Do the upper level courses demonstrate standard academic rigor for baccalaureate degrees?		
	Comment Core/GE courses expand the mindset and provide ethical / moral parameters for decision making in technical areas, which becomes more critical as digitalization rolls out. Electives further enhance those technical needs of employers. So, yes.		

General Education Requirements	Are the general educations requirements suitable for a baccalaureate level program? Do the general education courses meet breadth and depth requirements?
	Comment See above
a) Preparation for Graduate Program Acceptance	Do the degree concept, learning outcomes and curriculum prepare graduates to enter and undertake suitable graduate degree programs?
	Comment From the documentation provided, this program would provide a solid foundation for MA or MS degree requirements.
Faculty	Do program faculty qualifications appear adequate to teach and continuously improve the curriculum?
	Comment From the observed participation in the SMSCP instructor certification class, yes.
Resources	Does the college demonstrate adequate resources to sustain and advance the program, including those necessary to support student and library services as well as facilities?
	Comment Not able to comment
Membership and Advisory Committee	Has the program received approval from an Advisory Committee? Has the program responded appropriately to it Advisory Committee's recommendations?
	Comment Not able to comment.

Overall assessment and recommendations	Please summarize your overall assessment of the program.
	Comment This is one of the programs most thoroughly aligned to industry and regional needs that I have had the pleasure to review. The faculty and school did a phenomenal stakeholder analysis to ensure their offer aligned with the needs of the students and employers, and I believe it will be successful at engaging both.

Reviewer Bio or Resume

Gail Norris is the Director of SITRAIN – Digital Industry Academy for Digital Industry. Developing people is a special passion. She has been responsible for Siemens customer product learning services since 2011 and has been the primary driver behind the development of a Continuous Learning approach, with the incorporation of Digital Technology.

Previous experience includes Program Management, Business Excellence and Procurement for Siemens, as well as in Supply Chain, Operation Accounting, Audit and Consulting for manufacturing and service organizations

Appendix E: Statement of Need

Statement of Need for

Bachelor of Applied Science:

Mechatronics Engineering Technology and Automation

July 15th, 2019

By

Clover Park Technical College
4500 Steilacoom Blvd. SW
Lakewood, WA 98499
cptc.edu

COVER SHEET
STATEMENT OF NEED

Program Information

Institution Name: **Clover Park Technical College**

Degree Name: **BAS-Mechatronics Engineering Technology and Automation** CIP Code: 15.0403

Name(s) of existing technical associate degree(s) that will serve as the foundation for this program:

Degree: Mechatronics AAT CIP Code: 15.0403 Year Began: **2014**

Degree: Mechatronics AAS-T CIP Code: 15.0403 Year Began: **2014**

Proposed Start Implementation Date (i.e. Fall 2014): **Fall 2020**

Projected Enrollment (FTE) in Year One: 16 at Full Enrollment by Year: **2025**

Funding Source: State FTE: ☒ Self-Support: ☐ Other: ☒

Mode of Delivery

Single Campus Delivery: **Hybrid**

Off-site:

Distance Learning:

Statement of Need: *Please see criteria and standard sheet.* ***Page Limit: 20 pages***

Contact Information (Academic Department Representative)

Name: Mabel Edmonds

Title: Vice President of Instruction

Address: 4500 Steilacoom Blvd, Lakewood WA 98499

Telephone: 253-589-5510

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Email: Mabel.edmonds@cptc.edu

Chief Academic Officer | Date

Mechatronics has expanded as more consumer and industrial products started including advanced electronics. Cars now include electronic systems that are intrinsic to the mechanical function in the vehicle. This melding of electronic and mechanical systems will become even more pronounced as autonomous and all-electric vehicles proliferate. Mechanical engineers are well aware they are expected to have more than a cursory familiarity with electronics.[1]

Introduction

Mechatronics is a new and increasingly high-demand field with few training providers in our area. We propose implementing a BAS: Mechatronics Engineering Technology and Automation (BAS-META) degree to better prepare our mechatronics associate degree graduates for today's job market. Mechatronics associates graduates enjoy an excellent employment record in entry-level advanced manufacturing careers. The new degree would build upon our current AAS-T in mechatronics by adding additional engineering math and physics, as well as hands-on work with cutting edge industrial technology and practices such as IIOT, Digital Twins, Sustainable Manufacturing, and Data Analytics. Upon completion of this degree, graduates will demonstrate achievement of the following outcomes:

1. Devise solutions to broadly-defined engineering problems in complex mechatronics systems through the application of knowledge, techniques, skills and modern tools of mathematics, science, engineering, and technology
2. Design systems, components, or processes meeting specified needs for broadly-defined engineering problems for mechatronics systems
3. Compose written, oral, and graphical communication in broadly-defined technical and non-technical environments
4. Evaluate appropriate technical literature for application in mechatronic systems;
5. Evaluate the results of standard tests, measurements, and experiments for the improvement of processes, efficiency, and sustainability in mechatronic systems
6. Build effective technical teams both as a member, as well as a leader.

We believe that this degree will be unique to the state and therefore have no risk of saturating the market. Our proposal differs from other engineering technology degrees in the state in both approach and scope, as well as the content of the offerings.

Our capacity to meet Criteria 1-6 is explained, in order, below.

[1] **Is All Engineering Mechatronics Now?**, Design News, https://www.designnews.com/automation-motion-control/all-engineering-mechatronics-now/71192217457489 (visited *July 12, 2019*).

Criteria 1

CRITERIA	STANDARD
1. Relationship to institutional role, mission, and program priorities.	Describe how the proposed program reflects and supports the role and mission of the institution and reflects program priorities.

Institutional Role

The technical college's role is to serve the community as an open admission educational resource that is responsive to both student and business needs. The BAS: Mechatronics Engineering Technology and Automation (BAS-META) program will uniquely serve our community in this role. As the first Mechatronics Engineering Technology program in the state, the BAS-META will fulfill the needs of place-bound, working practitioner adults needing a four-year degree to progress in their field, as well as regional graduates of other mechatronics associate programs. Our Advisory Committee, composed of representatives from local business, is enthusiastic about this proposed degree. They represent major local employers and reflect the "business needs" side of our role.

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Similarly, our AAS-T students have been asking for a baccalaureate option to continue their studies. Currently, they only have our more general and management focused Operations Management program to continue to a bachelor's level degree. If they want more technical engineering content they have had no options in mechatronics, and few distant options for other engineering technology disciplines that are offered well outside the local area and Pierce County. The nearest engineering technology programs are in Bellingham(BTC) and Ellensburg (WVC and CWU) which are roughly 3 hour drives one way from our community. University of Washington (Tacoma), while closer, has only computer and electrical professional engineering programs, as opposed to the more hands-on engineering technology approach. A Clover Park Technical College BAS-META would be responsive to our students' needs and thus fulfill our institutional role.

Mission

The Bachelor of Applied Science: Mechatronics Engineering Technology and Automation (BAS-META) supports Clover Park Technical College's mission, "Educating tomorrow's workforce" by producing graduates with the skills and hands-on experience to maintain, optimize, deploy and design mechatronic systems to keep pace with the rapid automation in our local manufacturing industry.

The BAS-META degree has the potential to serve the workforce of virtually all local and regional industries. Mechatronic systems are everywhere, and growing increasingly complex. The rapid

adoption of automation solutions across a broad swath of industries from manufacturing to processing to distribution to foodservice, will act as an accelerator for the demand of mechatronics engineering positions. As these systems all have a complex interplay between what were separate engineering disciplines, the clear advantage of a multidisciplinary system approach is apparent. In fact, it is difficult to find a deployment of a purely mechanical or a purely electrical system. Mechatronics graduates possess a unique strength in the creation and use of such systems as they understand the interfaces between all these disciplines. It is imperative for the economic growth of our community and region that there is a qualified workforce to meet these forthcoming technological changes. BAS-META graduates will be prepared to fulfill these needs while driving innovation in our industry forward.

The demand for this skillset is an essential part of the workforce of the future. The competitive advantage that China has held in manufacturing is slightly diminishing as labor costs and shipping costs increase, while the cost of automation decreases.

> "Today's American factories are becoming more reliant on robotics, automated optical inspection equipment, and other automation technologies. With greater efficiency, these companies are able to be more cost-competitive with its overseas counterparts now that China's labor rates are on the rise. Increasing throughput for an OEM allows for them to compete with higher product sales, which in turn leads to larger bottom-line margins."[2]

For local manufacturers, both large and small, access to talented graduates who understand how and when to implement complex automation solutions is a precursor to being able to capitalize on these changing trends. From an economic development perspective, having such a workforce is a key factor attracting new manufacturers to locate production in our state.

As mechatronics graduates can perform across a broad array of tasks, the benefit to small manufacturers is particularly large. Being able to bring the full spectrum of automation skills in-house has been prohibitively expensive, as it used to require multiple hires of differentiated employees. Any one of these positions may not have been fully utilized based upon the scale of work at the company. Mechatronics allows for greater efficiency and agility in these smaller firms. Larger companies will also benefit as better coordination and integration, facilitated by the skills overlap, will reduce costly re-design times and improve efficiency.

Finally, the unstated mission of a technical college situated in an area with a large population of economically disadvantaged individuals is to raise students from poverty into living wages. In 2015, according to a NACE study, mechatronics overtook all other engineering disciplines as having the highest salaries for graduates.[3]

The following bubble graph from SBCTC's workforce supply and demand data gives a stark impression of the local availability of graduates in the related sectors of industry. Since

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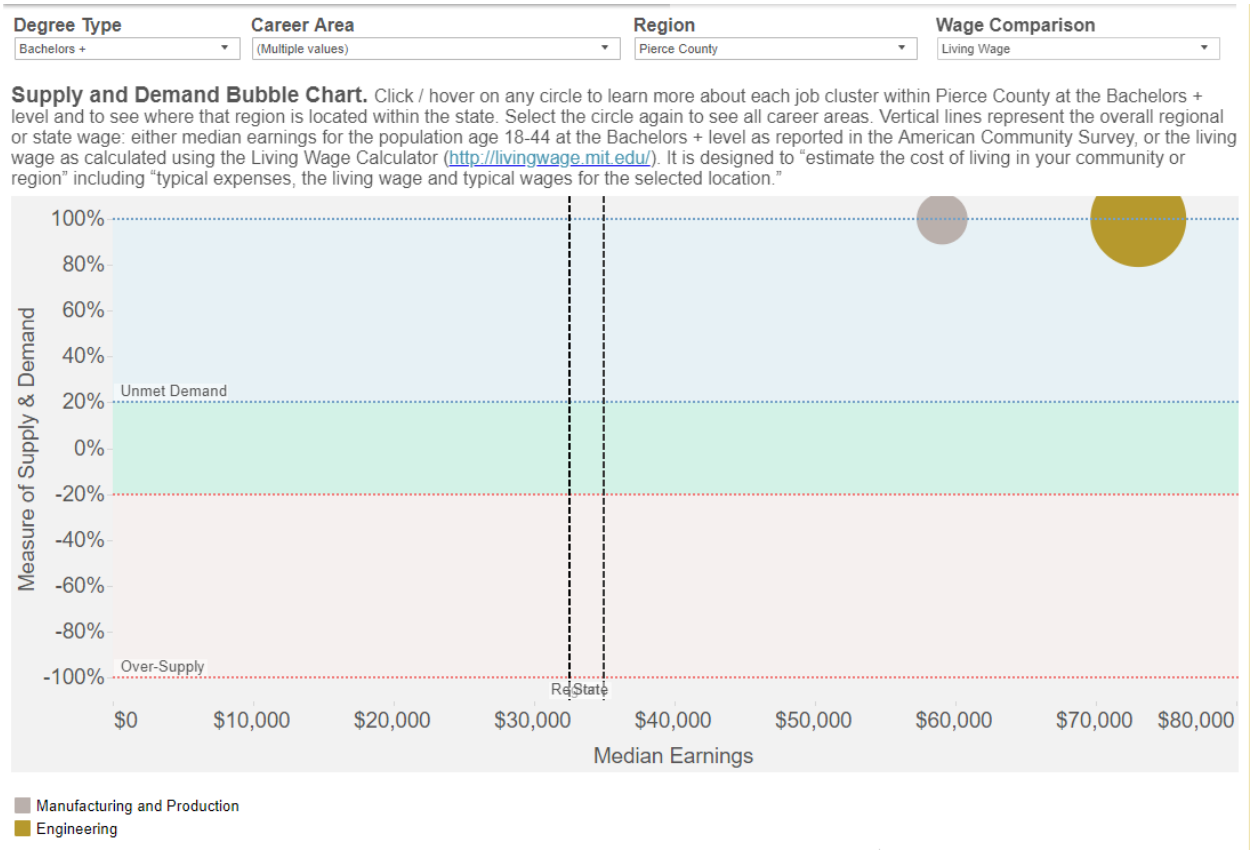
[2] Top 7 Reasons to Follow the On-Shoring Trend. (2018) Riverstar Inc. Retrieved from https://riverstarinc.com/on-shoring-trends/

[3] Top Paid Engineering Grads: Mechatronics. (2016) NACE. Retrieved from https://www.naceweb.org/job-market/compensation/top-paid-engineering-grads-mechatronics/

mechatronics bridges both engineering and manufacturing/production, we included data that covers both industries. The number of local graduates qualified for either career cluster is zero. Manufacturing and production have an annual local demand of 97.3 positions, and engineering has a demand of 344.3 positions. The annual earnings are 169% and 209% of the regional median salary, respectively. The BAS-META program has the potential to serve a gap in employable skills in our area, while simultaneously lifting our students to rewarding careers earning well above the median income.



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Program Priorities

The Mechatronics program has three priorities: To prepare students to enter the workforce as highly adaptive employees; Give students, not only the skills but the ability to become self-learners, capable of staying ahead of the changing technologies in the workplace; and maintain an over-the-horizon curriculum that looks to not just equal industry standards, but anticipate the future trends. The proposed program completely supports all three priorities.

Graduates awarded the BAS-META degree will be well prepared to enter tomorrow's workforce. Our current Mechatronics AAT and AAS-T graduates currently enjoy an excellent employment rate with above living wage compensation. This is in a large part because we use a

[4] Washington State Board for Community and Technical Colleges Workforce Supply & Demand bubble chart for King-Pierce Counties Living Wage comparison: https://cube.nchems.org/views/SBCTCSupplyandDemandVisualization/SBCTCSupplyandOutcomesVisualization?:isGuestRedirectFromVizportal=y&:embed=y retrieved July 12, 2019

hands-on systems-based approach to reinforce the theory of mechatronics. Our students understand the theory because they have created a working demonstration in the real world. Our industry partners will attest to the efficacy of this approach in preparation for the workforce.

BAS-META graduates, though still well qualified for technician positions, would have expanded options for engineering level positions, as well as technical sales and field service. This should move them up the pay scale initially and position them for future promotion without the need for additional training. The BAS-META program will achieve this preparation by providing complex technical experience into emerging and higher-level skills, adding significant project management experience, and also by equipping graduates with advanced communication, quantitative, and reasoning skills. Advanced subjects such as Data Analytics, Digital Twin Simulations, Robotic Integration, and the Industrial Internet of Things (IIoT) will give graduates a future-minded skillset that will allow companies to hire not just for the skill that they need currently, but the for the knowledge to expand their technological capabilities.

BAS-META supports our program quality priority with a high-quality, hands-on program vetted by the advisory committee. The program will employ a highly-skilled faculty, a brand new state-of-the-art facility, and the increased student supports already in place for BAS students in the College's existing applied bachelor's programs. The BAS-META will take advantage of components of the College's existing accredited BAS programs, thereby ensuring excellence from the start. We view this proposal as building on our existing high quality.

Criteria 2

CRITERIA	STANDARD
2. Support of the statewide strategic plans.	Describe how the program will support SBCTC Mission goals outlined in the Mission Study and WSAC policies and goals for higher education as articulated in the Strategic Master Plan for Higher Education.

The BAS-META supports the State Board of Community and Technical Colleges (SBCTC) 2008 Mission Study (MS) published in May 2010. It also supports the Washington Student Achievement Council (WSAC) 2017-19 Strategic Action Plan (December 1, 2016) and the Strategic Master Plan Update 2012. WSAC acquired many of the duties of the Higher Education Coordinating Board when the State abolished the latter and created the former. WSAC also inherited the 2008 Strategic Master Plan for Higher Education in Washington. It published a Strategic Master Plan Update and several Strategic Action Plans as well as Road Maps.

The SBCTC 2008 Mission Study's overarching goal was "to find more and better ways to reduce barriers and expand opportunities so more Washingtonians can reach higher levels of

education."[5] It lays out a ten-point action plan addressing underserved populations, skills gaps, increasing baccalaureate degrees, pathways, modern learning infrastructure and modalities, and increased efficiency.

The WSAC Strategic Action Plans have as their goal achieving 100% high school graduation or equivalent and 70% of residents achieving a postsecondary credential by 2023.[6] An applied baccalaureate, by its nature, will not move the needle in either of these goals. Applicants will already have a high school and postsecondary credential. The BAS-META will contribute to the majority plan's strategies to increase attainment. These strategies include supporting our education continuum; college and career readiness; supporting access, affordability, and quality; expanding innovative, targeted student supports to increase completion; adult reengagement; and addressing workforce shortages.

The WSAC Strategic Master Plan Update 2012 had as its theme "Raising educational attainment during challenging economic times."[7] Its seven steps to more successful higher education outcomes in Washington State include: increase capacity of higher education to serve more students, maintain commitment to access for low-income students, build on efforts to increase transitions and completion, provide a simple funding initiative to increase the number of graduates (and) quality of education, define and develop K-12 to postsecondary program pathways, promote accelerated learning programs for high school students and adult learners, and maintain commitment to the original 2008 degree goals.

The BAS-META supports SBCTC and WSAC goals in many ways. It will promote diversity, access, opportunity, lifelong learning, affordability, increased capacity, bridge the skills gap in STEM, and address workforce shortages. The BAS-META will also address and provide a skillset for many of the changes and developments happening in industry that has no representation at all.

Increasing access, opportunity, and diversity

Clover Park Technical College is located in Lakewood, Washington. Lakewood is poorer and more diverse than Washington State overall. Lakewood's median household income is lower than the State's ($47,636 vs $70,979). It is more diverse (49.2% vs 31.2% persons of color).[8] By locating an open enrollment applied baccalaureate in this community, we will increase access and opportunity to place-bound adults, economically disadvantaged students, and to students of color. Upon graduation, these underserved populations will enjoy an opportunity to compete for many more jobs than are available at the associate's level and for substantially higher pay. A 2012 Georgetown University Center for Education study found that new high

[5] Mission Study Washington, May 2010, Community and Technical College System Mission Study Task Force, https://www.sbctc.edu/resources/documents/about/agency/initiatives-projects/sbctc-mission-study.pdf, retrieved July 12, 2019

[6] 2017-19 Strategic Action Plan, December 2016, Washington Student Achievement Council, https://www.wsac.wa.gov/sites/default/files/2016.12.01.SAP.pdf, retrieved July 12, 2019

[7] Strategic Master Plan Update 2012, November 2011, Higher Education Coordinating Board, https://www.wsac.wa.gov/sites/default/files/SMP2012Update.pdf, retrieved July 12, 2019

[8] Data USA: Lakewood, WA, DataUSA, https://datausa.io/profile/geo/lakewood-wa/, retrieved July 12, 2019

school graduates were about three times more likely to be unemployed or underemployed than were new bachelor's degree graduates.[9]

	Washington	Pierce County	Lakewood
Median Household Income	$70,979	$69,278	$47,636
White Residents	68.8%	66.7%	50.8%
Home Ownership	62.8%	63.2%	45.0%

Role models and moving the needle in educational attainment

A less obvious but important influence in increasing educational attainment is the effect of increasing diversity among graduates in the community. By locating the BAS-META in Lakewood, we will be helping to create very influential role models and ambassadors of diversity and success. Furthermore, as the associates-level mechatronics program is a majority-minority program, the BAS-META will have a very diverse enrollment from our feeder program. The attainment of the degree is important, but so is the higher salary and access to more specialized positions in larger companies. We cannot overemphasize the importance of local role models of success. This is true with regards to increasing the attractiveness of STEM in general and with women in particular. Role models work to motivat high school students to continue on to college, and motivate adults to return to college. These all contribute to educational attainment. Nothing can be as influential as meeting a successful person from our town that looks as we do. The BAS-META program will be a strong, though indirect, force in moving the needle on educational attainment.

Lifelong Learning

The BAS degree is friendly to life-long learners by its course scheduling and its focus on state-of-the-art knowledge and skills. The degree is designed to accommodate current associate degree holders. We will at first offer hybrid courses with the intention of exploring early morning and/or early evening courses. While day classes may be more difficult for working adults to attend, we currently see significant traffic in our associate-level offerings by already employed adults upskilling or changing career focus. Some are recently unemployed and available for day classes. Others are adjusting their work schedule to accommodate daytime attendance. The nature of upper-level baccalaureate courses will permit a broader range of direction and personalization than our associate degree offerings. This should encourage lifelong learning and improve access to place-bound adults.

Economic Growth and Innovation

The BAS-META creates graduates to fill "unmet enrollment in high-demand STEM fields." For our community, it improves STEM accessibility for place-bound adults.

The mechatronics field is developing and changing at a very rapid rate. As many traditional businesses become more automated, new businesses are emerging in fields like IIOT (Industrial internet of things). These changing traditional businesses, as well as new emerging ones, are currently suffering a significant shortage of people with the skillset to service, design, and optimize mechatronic systems. The CPTC mechatronics program frequently receives visitors

[9] The Barriers to a College Degree, February 20, 2013, Population Reference Bureau, https://www.prb.org/us-college-attainment/, retrieved July 12, 2018

from local and regional business who end up becoming strong supporters of the program for the advanced technical skillset found within the program's curriculum. . The BAS-META will provide the next tier of skillsets sought after by our local and regional partners.

Develop Performance-Based Improvement Strategies

The BAS-META will benefit from a strong advisory committee, already in place for the mechatronics associate degrees. Members of the advisory committee provide feedback to the faculty, who adjust and emphasize curriculum accordingly. The development and implementation of a BAS is based upon this feedback.

The mechatronics program firmly relies on lean process principles when it comes to program improvement and development. Standardization, continuous improvement, and visualization allows the faculty to constantly be working on a new iteration of the program where all decisions are based upon facts. Alumni feedback allow the faculty to close the feedback loop. Diagram 1 below shows an example of a tool used within the mechatronics program for development.

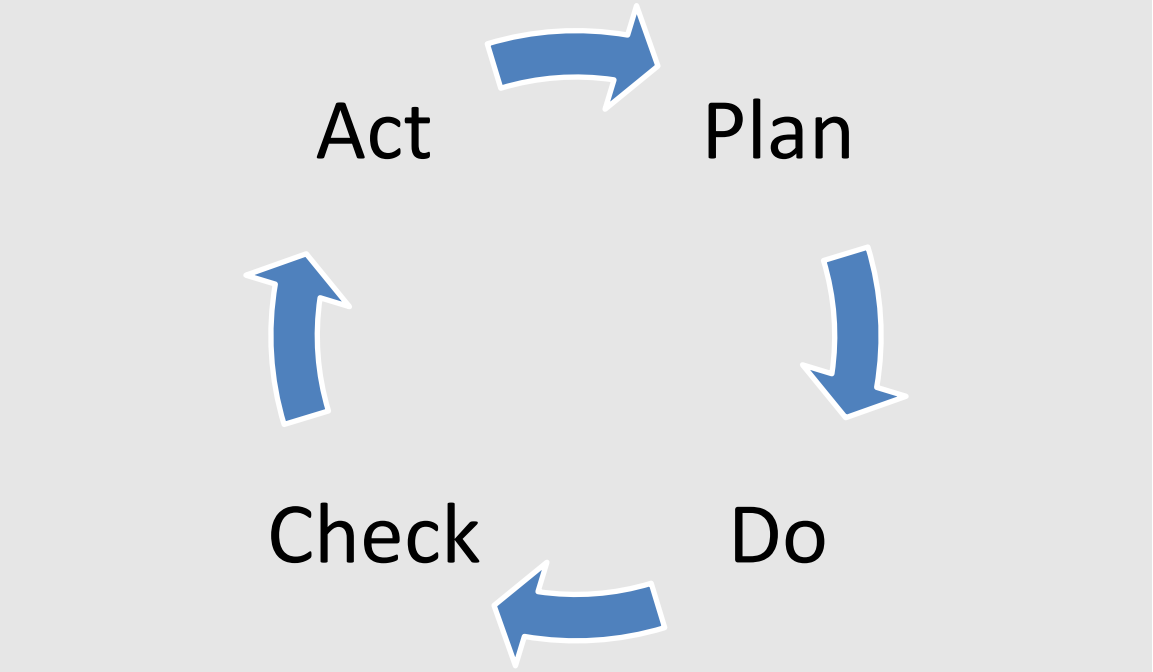


Diagram 1. The Assessment Cycle for Program and Course Improvement

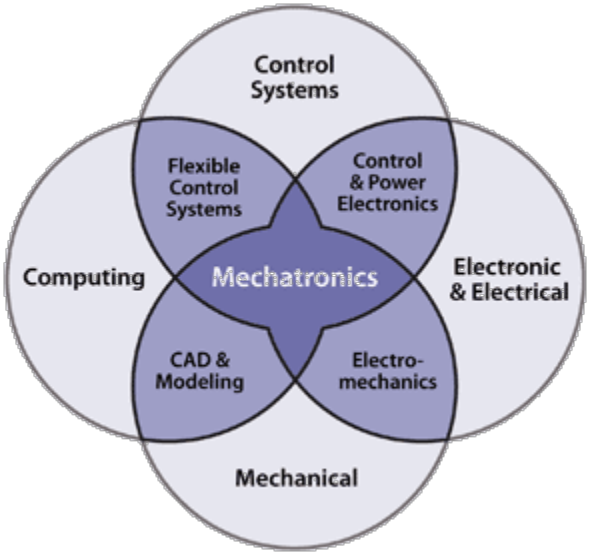
Criteria 3

CRITERIA	STANDARD

3. Employer/community demand for graduates with baccalaureate level of education proposed in the program.	•Employer demand must exceed regional supply of graduates with relevant degrees. •Demand must be based on data sources including but not limited to local employer survey, traditional labor market data, industry data, trade associated data, and other transactional data. Please provide evidence of the gap between the numbers of program graduates the number of job opening locally and regionally. Refer to attached supply/demand gap rubric for additional guidance.

Included Occupational Job Titles

Mechatronics, as both an emerging and an interdisciplinary field, is difficult to pin down all the occupational titles for which graduates would qualify. The BLS occupation codes only provide established job titles, and in a dynamic industry, this leaves us with a fragmented picture of what current job title trends are. Many traditional job titles in industry seem to be losing favor, such as electro-mechanical technicians (SOC 17-3024). While the work performed remains, companies title this position differently. . There is no sign of significant settling on nomenclature for these emerging job titles, with significant regional and sector variance between the job titles for the mechatronic skillset.



Typical Mechatronics Related Jobs:

- Application Engineer/Technician
- Systems Engineer/Technician
- Manufacturing Engineer/Technician
- Production Engineer/Technician
- Automation Engineer/Technician
- Control Systems Engineer/Technician
- Development Engineer/Technician
- Mechatronics Engineer/Technician
- Prototyping Engineer/Technician
- Hardware Development Engineer/Technician
- Quality Engineer/Technician
- Reliability Engineer/Technician

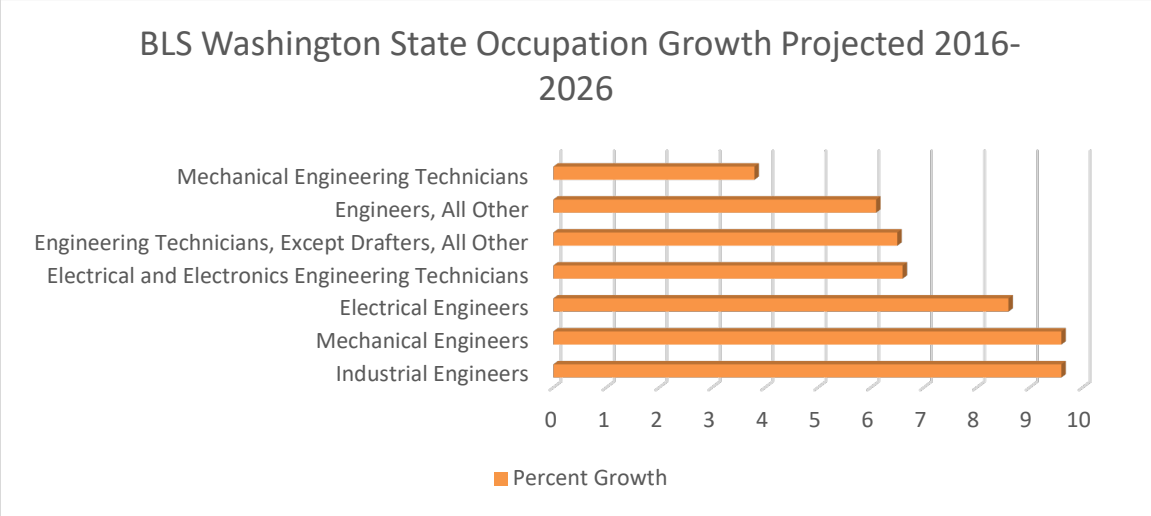
The above list provides some of the top current position titles available to mechatronics graduates. Unfortunately, this has little overlap with the available SOC catalog. The closest related titles we can look at are below:

SOC	Occupation Name
17-2112	Industrial Engineers
17-2141	Mechanical Engineers
17-2071	Electrical Engineers

17-3023	Electrical and Electronics Engineering Technicians
17-3029	Engineering Technicians, Except Drafters, All Other
17-2199	Engineers, All Other
17-3027	Mechanical Engineering Technicians

All these titles are continuing to grow in demand; however, we lack the granularity of data on these to fully understand the multivariant mechanics at play in their growth rates and absolute numbers. By elimination, the bulk of mechatronics positions would fall under these categories, however, the scope of jobs *requiring* a multi-disciplinary mechatronics approach is unclear. What is clear is that there are sizeable gaps in supply and demand in these areas, and our graduates would be able to compete for these positions, regardless of whether or not a mechatronics skillset is required.

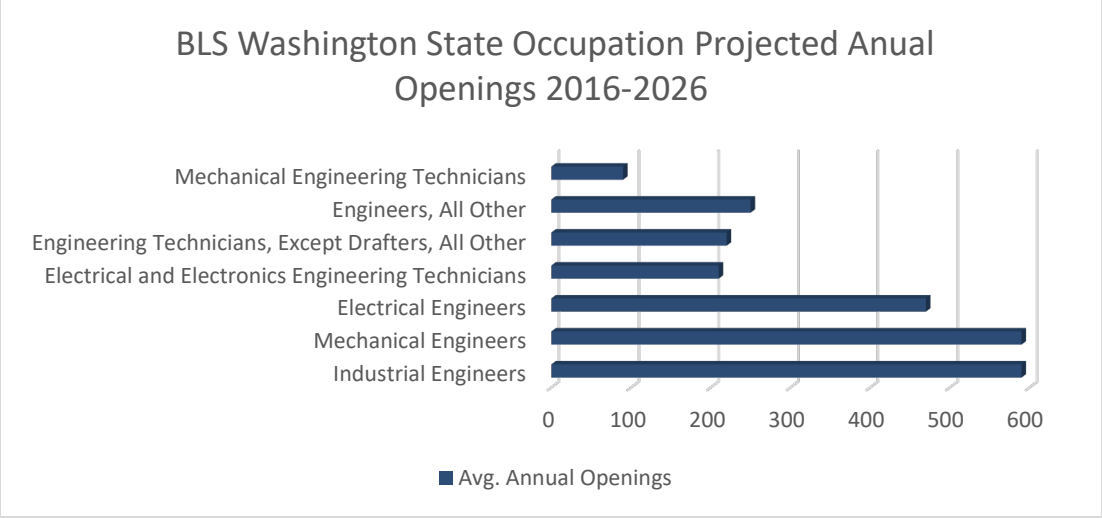
Employer Demand and Growth Statewide



[10]

The growth in the traditional SOC job categories is pronounced when we look at the statewide picture. The number of job openings per year is also very high:

[10] BLS job projections for Washington state by Projections Central - State Occupational Projections: https://projectionscentral.com/Projections/LongTerm retrieved July 13, 2019

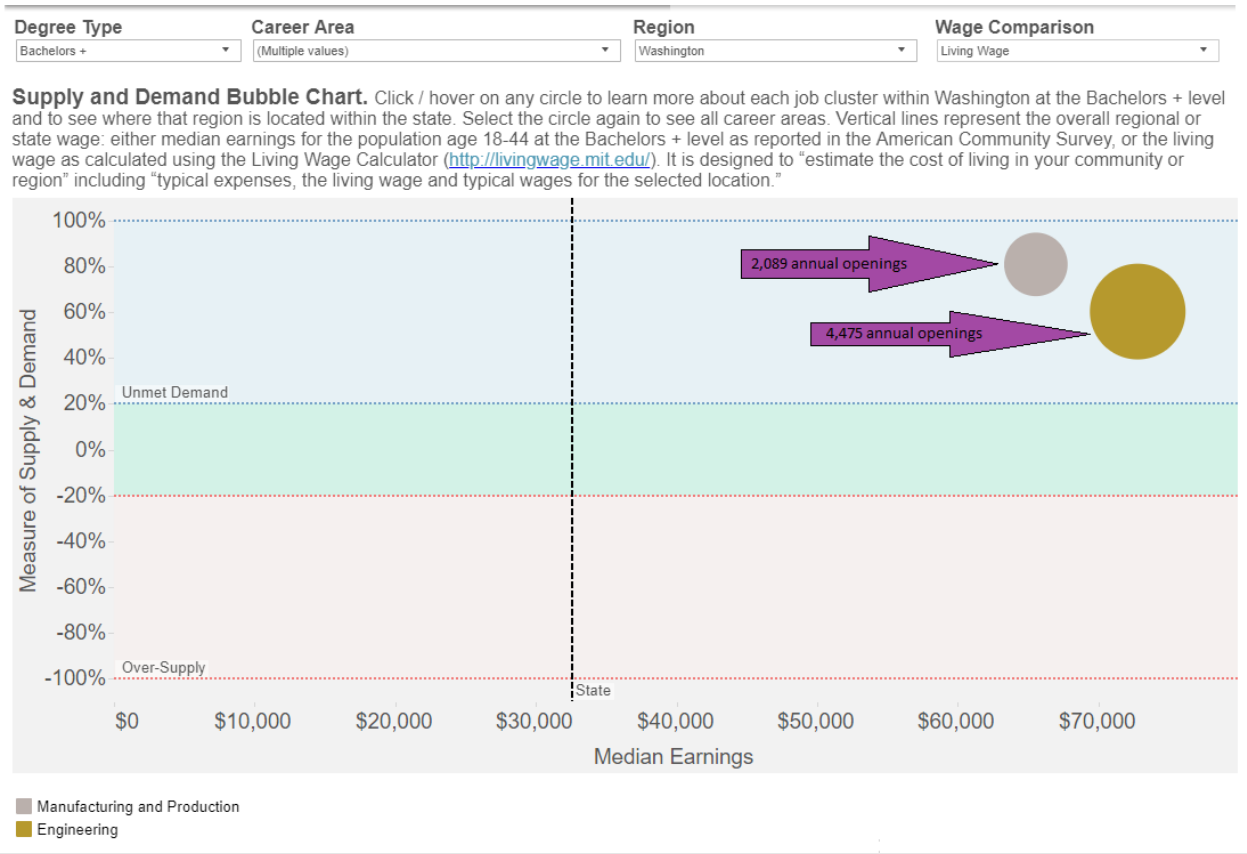


[11]

There is clear evidence here of significant continued growth in the demand for engineers statewide. Summing these job opportunities up we get average openings for all titles of 2,420. SBCTC's data finds annual average open engineering positions requiring a minimum of a bachelor's degree or higher levels of education at 4,745.[12] Add in the Manufacturing and Production category, and there are upward of 6,500 position openings:

[11] ibid.

[12] Washington State Board for Community and Technical Colleges Workforce Supply & Demand bubble chart for statewide engineering data: https://cube.nchems.org/views/SBCTCSupplyandDemandVisualization/SBCTCSupplyandOutcomesVisualization?:isGuestRedirectFromVizportal=y&:embed=y retrieved July 14, 2019



13

Though these data sources lack the granularity to determine the precise demand for a specific mechatronics skillset, they do speak to the growing demand for the broader category of engineering.

Statewide Supply

As there is no supply in the state for graduates of a bachelor's level mechatronics degree, no matter what the actual demand, there is a shortage of supply. Once again, the lack of data resolution requires us to look at the broader scope of engineering and manufacturing:

Washington State Supply and Demand				
Career Cluster	**Education Level**	**Job Announcements**	**Graduates**	**Gap**
Engineering	**Sub-baccalaureate**	**1,580**	**1,086**	**494**
	Baccalaureate +	**4,745**	**1,883**	**2,862**
Manufacturing and Production	**Sub-baccalaureate**	**12,763**	**3,312**	**9,451**
	Baccalaureate +	**2,089**	**399**	**1,690**

14

[13] State Board for Community & Technical Colleges Workforce Supply & Demand. Retrieved from https://cube.nchems.org/views/SBCTCSupplyandDemandVisualization/SBCTCSupplyandOutcomesVisualization?:isGuestRedirectFromVizportal=y&:embed=y (accessed July 14, 2018).

[14] ibid.

The clear shortfall of workforce supply in these career clusters is evident across the board. Tallying up the gap for both manufacturing & production, and engineering at the baccalaureate and beyond level, there are 4,552 job postings each year that do not have a corresponding in-state graduate to fill them. These numbers are lower but still in line with findings from the National Center for Educational Statistics, which reports 2,312 bachelor's degrees conferred by postsecondary institutions in Washington State in Engineering during the 2016-2017 academic year.[15] This completion rate is still not meeting half the reported statewide demand. The data represents a clear employment opportunity for graduates of the BAS-META program.

Regional and Local Supply and Demand

Looking more closely at regional level data we can see the trend continue for significant gaps in supply across all dimensions:

King and Pierce Supply and Demand				
Career Cluster	**Education Level**	**Job Announcements**	**Graduates**	**Gap**
Engineering	**Sub-baccalaureate**	**877**	**435**	**442**
	Baccalaureate +	**2,524**	**978**	**1,546**
Manufacturing and Production	**Sub-baccalaureate**	**6,185**	**1,161**	**5,024**
	Baccalaureate +	**941**	**152**	**789**

[16]

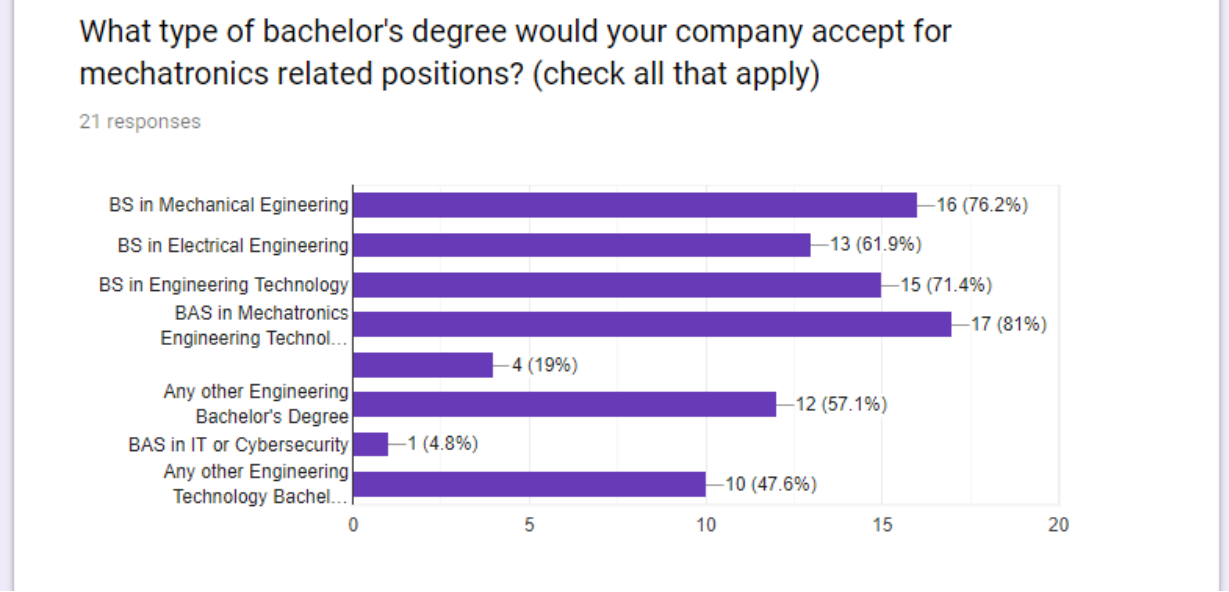
If the data is examined for just Pierce county, as seen in the bubble chart in the introduction, there are no local baccalaureate level graduates. As such, the local unmet demand is at 100%.

Survey of Regional Manufacturers

In an industry survey undertaken as part of this proposal (full report in appendix), The supply and demand issues remain starkly apparent. 76.2% of respondents have had difficulty filling bachelors level mechatronics positions, and 81% anticipate future difficulties. Just in this small sample of small to medium-sized manufacturers, the respondents indicated that they anticipate the need in the next three years for between 56 and 120 mechatronic positions that will prefer bachelor's degree candidates. 55.6% of respondents have had mechatronic positions open for three months or more, with another 11.1% having openings last for 2-3 months. Finally, the respondents report acceptance of a BAS-META at or above the levels of other alternative degrees offered in the state:

[15] Table 319.30. Bachelor's degrees conferred by postsecondary institutions, by field of study and state or jurisdiction: 2016-17, National Center for Educational Statistics, 2018, https://nces.ed.gov/programs/digest/d18/tables/dt18_319.30.asp , retrieved July 14, 2019.

[16] State Board for Community & Technical Colleges Workforce Supply & Demand. Retrieved from https://cube.nchems.org/views/SBCTCSupplyandDemandVisualization/SBCTCSupplyandOutcomesVisualization?:isGuestRedirectFromVizportal=y&:embed=y (accessed July 14, 2019).



Regional Employer Demand Greatly Exceeds Supply

Any way that we divide or project the numbers, the regional demand greatly exceeds supply. With current unemployment at a generational low and the economy growing at a generationally high rate, all of the above data, which is at least two years old, may understate the scope of this workforce shortfall. Though the BAS-META program will not make much of a dent in these numbers on its own, the scope of the unmet demand is such that we can clearly state that there is no danger of our graduates saturating the market. Clearly, the regional demand greatly exceeds supply.

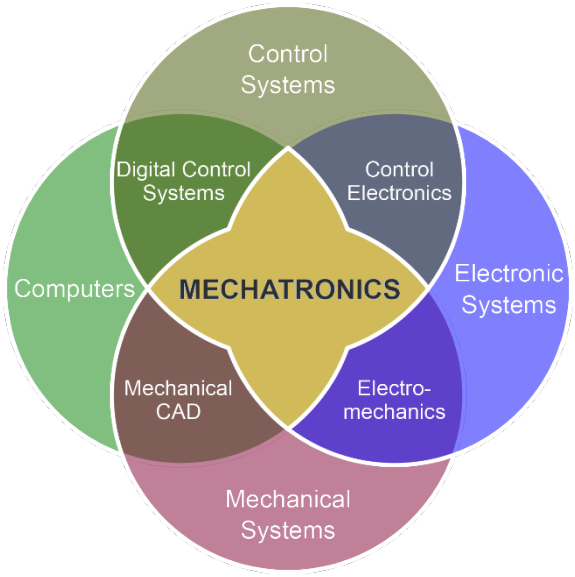
Criteria 4

	CRITERIA	STANDARD
4.	Applied baccalaureate program builds from existing professional and technical degree program offered by the institution.	Describe the existing professional and technical degree program that will be used as the foundation for applied baccalaureate program. Include how long the program has been in existence and the enrollment history of the program over the past five years.

Foundational Program: Mechatronics

Clover Park Technical College has been offering Associate level degrees in Mechatronics since 2015. Mechatronics is a multidisciplinary field combining mechanical, electrical, telecommunications, control, and computer engineering and focusing on the design and production of automated equipment. Trained mechatronics professionals design and drive the future of industry, as mechatronics systems form the backbone of every computer-controlled machine and sophisticated consumer product. The interdisciplinary nature of CPTC's Mechatronics program prepares students for roles as mechatronics technicians or engineers in a wide range of career fields. Graduates gain experiences that cross different disciplines and prepare for a rapidly changing economy with the help of CPTC's dedicated faculty and the latest

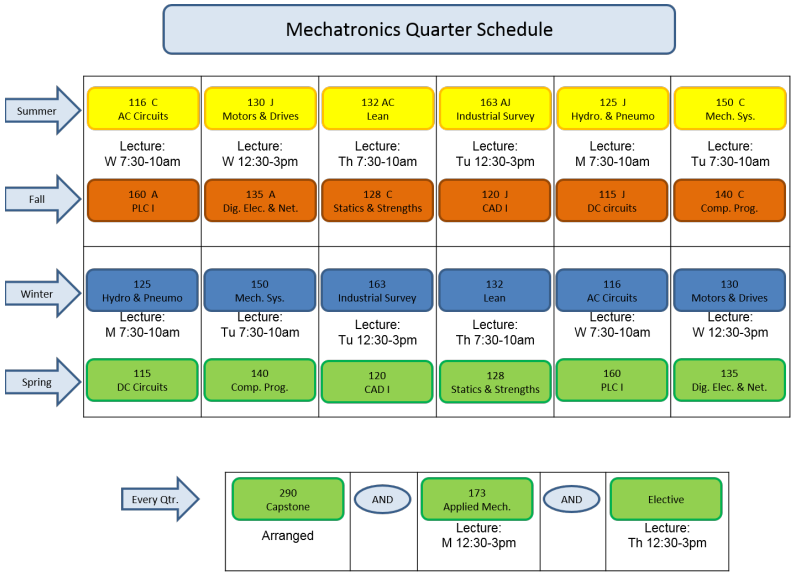
industrial equipment. Students acquire work-ready practical skills as they move towards a specialization such as robotics, agricultural automation, PLC programming, control systems, smart infrastructure, or industrial automation.
While the program offers several standalone certificates for both entry-level and returning student study, its most popular offering is the AAT / AAS-T degree.



Picture 1. Mechatronics definition

AAT/AAS-T Degrees

The AAT / AAS-T curriculum provides robust college-level general education as well as all the foundational pieces that symbiotically make up this exciting field. The program begins with courses that establish a solid base of technical skills and an understanding of the various disciplines that make up mechatronics as well as lean manufacturing and quality standards. Courses are taught with an eye toward linking disciplines together for larger mechatronic systems. Subsequent courses then build expertise in the foundational skills while increasingly integrating all skills into the design, construction, optimization, maintenance, and repair of full mechatronics systems. Every course offered in the mechatronics program has at least one third party certification possibility associated with the course.
The culminating experience for the AAT/AAS-T student is a capstone project or internship ideally done at a local company where the student can showcase their skills on a resumé building real live project.



Picture 2. Mechatronics course offering

Co-op certs

The "Co-Operative Certificates" are specifically designed for people already employed in industry. The co-op certs were designed and offered based upon needs by industry to upskill professionals while still maintaining their employment. The co-op certs allow employees to gain defined skills that help meet their professional talent needs. Employers may offer workers in a co-op certificate program release time (2 days per week) to attend class and engage in studies. Frequently, employers also help fund tuition and other expenses of participating workers.

Enrollment History

The enrollments for mechatronics have steadily been increasing since the founding of the program in 2014. The original structure for the program was to have enrollment every spring and fall. In 2018 the program was restructured to accept enrollments every quarter at a cap of 12 entering students per quarter. Every quarter enrollment, together with a change in how courses were offered, led to an increase in capacity and better pathways for students to completion.

The enrollment for the last 18 months has been at capacity with a few courses being overenrolled and a slight attrition among students towards the final courses of the program. During the summer of 2019 the Mechatronics program will be moving into a brand-new building allowing for yet another increase in capacity.

Year	Headcount per seat available
2019	63/64
2018	64/64
2017	46/48
2016	20/48
2015	10/48

Table 3. Mechatronics enrollment history per seat

Program History

New to the United States, Mechatronics has been a well-established discipline in the industrialized world since the early 2000s. To mitigate the gap between the United States and its counterparts in Europe and Asia, the Department of Labor setup grants to establish Mechatronics programs across the United States. Clover Park Technical College was awarded the DOL grant in 2014 and the program has been continuously developing since then. The program is currently housed in Building 25 on the Lakewood campus of CPTC but will be moving into the just finished CAM-T building (Center for Advanced Manufacturing and Technology) during the summer of 2019.

Criteria 5

CRITERIA	STANDARD
5. Student demand for the program within the region.	Evidence of student interest and demand from multiple sources, such as but not limited to: students graduating with technical associate degrees in the region, survey of students within region, demand in excess of opportunity to enroll in related traditional bachelor's programs, and changes in industry standards. Include enrollment projections for each year over the next five years.

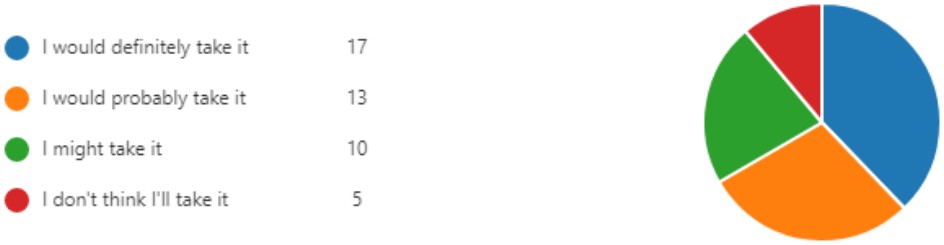
Graduates in the Region

In addition to our AAS-T students that desire a bachelor's program, the BAS-META will attract transfers from our sister colleges in the area. Bates Technical College, Greenriver College, Renton Technical College, and Centralia College, and all offer associate-level degrees in related areas but offer no corresponding bachelor's degree options. We will seek articulation agreements with all of these nearby colleges for our baccalaureate degree.

Student Demand

As part of the preparation for this proposal, we conducted a survey of our current students to gauge their interest in continuing their studies with the proposed BAS-META degree. The responses pretty much speak for themselves:

14. Clover Park is exploring the creation of a BAS in Mechatronics Engineering Technology and Automation. This Degree would take 6 quarters (1.5 years) to complete after completion of a mechatronics AAS-T degree. Given the subjects below, how would you describe your interest in continuing into this Bachelor's degree program?



Projected Enrollment

The survey of current students of the associates level mechatronics program at Clover Park indicates a high level of probable enrollment in this further degree if offered. 65% of students surveyed indicated that they would definitely or probably enroll in such a degree program, which equates to 10 highly interested students every other quarter. From this data, we can conservatively project with a 40% enrollment conversion factor, that our internal pipeline would provide a steady annual enrollment of 8 students. We project that pent-up demand may cause the initial enrollment to be even higher, with the inclusion of former students coming back to enter the degree. Later in the five-year projections, we anticipate seeing enrollments grow from both external sister school transfers (projected as four every other quarter) as well as higher participation rates (stepping to 8 every other quarter) internally as students begin to enroll in our AAS-T specifically to continue to the BAS-META. Below are our rough five-year enrollment projections:

Entry Quarter	BAS-META 1st quarter enrollment	BAS-META 3rd quarter enrollment	BAS-META 5th quarter enrollment	BAS-META total enrollment
Fall 2020	8	0	0	8
Spring 2021	8	8	0	16
Fall 2021	6	8	8	22
Spring 2022	8	6	8	22
Fall 2022	10	8	6	24
Spring 2023	12	10	8	30
Fall 2024	12	12	10	34
Spring 2025	12	12	12	36
Fall 2025	12	12	12	36

Criteria 6.

CRITERIA	STANDARD
6. Efforts to maximize state resources to serve place-bound students.	Describe how the program will serve place-bound working adults. Identify similar program offered by public or independent institutions in the region. Describe options that have been explored for collaboration with other public baccalaureate institutions, businesses, and /or community organizations considered in the development of the proposal and include a brief description of initial conversations. Describe collaboration with similar CTC BAS programs and related CTC Centers of Excellence. Describe unique aspects of the proposed program that differentiate it from similar programs and/or describe why expansion would be desirable or necessary.

Serves Local, Place-Bound Working Adults

Once operational and running, the Clover Park Technical College BAS-META program will be the only open-admission Mechatronics BAS program in the western half of the United States. The BAS-META program would offer a continued path for all of the associate level mechatronics graduates of our immediate neighboring colleges such as Centralia College, Clark College, Everett Community College, Renton Technical College, Shoreline Community College, Green River Technical College, North Seattle College, and South Seattle College.

In addition to our residents who are placebound by home and family commitments, we serve the Joint Base Lewis-McChord community. It is our intention to develop an academic bridge for associate degree graduates in fields relatable or complementary to mechatronics to increase the accessibility of the program.

Course Schedule

We will be primarily offering hybrid courses with some options for online general education. It is the intention to explore evening courses and Co-op paths for the program as well. Students will be able to choose from a variety of courses to control the focus of the program to their and industry-specific needs.

Collaboration

We will be continuing our collaboration with local and regional business partners to make sure that our future BAS-META graduates leave the program with a developed skillset leading to fulfilling and well-paying employment. It is the ambition of the mechatronics program to not only graduate students who have the skillset industry need, but also the skillset industry wants in order to develop and grow. The mechatronics field is expanding and developing so fast that industry is looking for educational partners to upskill their workforce and relying on graduates

to bring new technologies in-house. The mechatronics program has several graduates that have obtained engineering level jobs due to the need for this type of knowledge. The BAS-META will solidify this skillset and increase the number of available graduates.

While establishing the BAS-META, the intention is to satisfy the demand from associate degree graduates from the mechatronics program at CPTC, but we will also be offering a path for associate-level graduates from other mechatronics programs in the state.
The merger of IT with production and interconnectivity of processes and machines in industry provides substantial collaboration opportunities between the BAS-META and other programs on campus. An obvious collaboration would be between CPTCs CNIS program as well as the computer programming program.

Unique Program
Currently, there are an estimated nine baccalaureate programs for mechatronics in the United States, 11 if satellite campuses are included. The proposed BAS-META program would be the 10th baccalaureate program for mechatronics in the entirety of the United States. The majority of already established programs exist in the eastern United States centered around automotive manufacturing regions. There are additional programs that offer various concentrations in mechatronics, but those programs serve a purpose different from that described in the BAS-META proposal. The automotive industry is considered a strong adopter of automation and technology with well-established connections to European manufacturers and OEM's (Original Equipment Manufacturers). Europe, in comparison, has well over a hundred bachelors level degrees in mechatronics. The proposed BAS-META would be a unique program for our region and the programs future graduates would provide industry with extremely important skills and services, skills and services that currently have to be contracted from companies located in the eastern United States and Europe.
As pointed out in this proposal, mechatronics as a field is growing rapidly. The cost of automation is going down and with it, the barrier of entry for small and medium-size business and manufacturing. The BAS-META program provides a unique opportunity for our region to establish local competence that leads to increased productivity, higher wages, and safer work environments for small as well as large industry.

Conclusion

Mechatronics is an emerging, , and in-demand field with large gaps between Washington job opportunities and graduates produced by any other related program. The BAS-META would be first of its kind in the state and be among a very few nationwide. Given the industry trends for ever increasing levels of automation, the demand for these skills can only grow. As workers are displaced by automation, the BAS-META would provide workers an opportunity to upskill for the future workforce. Lakewood, being much more diverse than Washington in general, is an ideal place to anchor a mechatronics baccalaureate program as a lever to increase inclusiveness and provide an opportunity to an underserved population.

Applied Baccalaureate Degree Supply/Demand Gap Rubric for College

The goal of this rubric is to help you build a program that will meet the needs of your community. We have given you options about the information you can use to support the need for your new program. Also, the guidelines for estimating the supply/demand gap are similar to the ones we use for other program applications. We hope this makes the rubric more familiar to you. If not, contact Joyce Hammer at jhammer@sbctc.edu for further information.

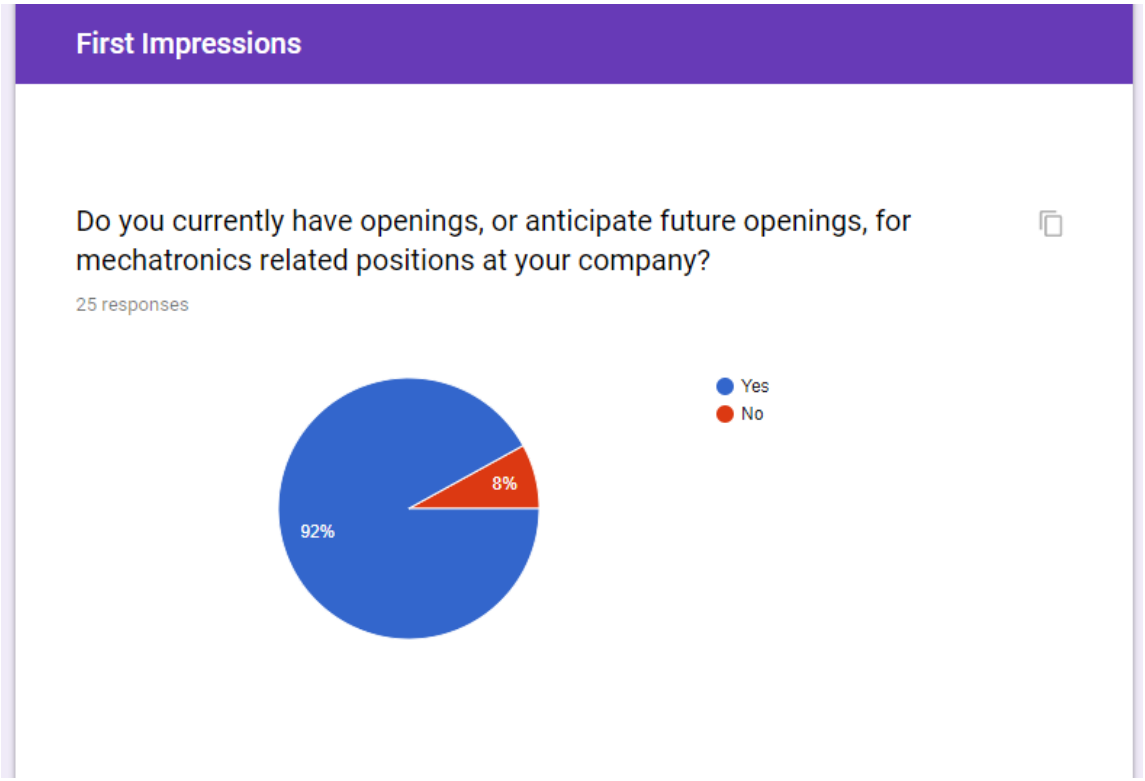
The application needs to show the information below for program approval:

- employers demand* the level of technical training proposed within the program, making it cost-effective for students to seek the degree;
- lead to high wage-earning jobs; and
- the proposed program fills a gap in options available for students because it is not offered by a public four-year institution of higher education in the college's geographic area.

College Name: Clover Park Technical College	
Program Name: Computer Networking and Information Systems Security	
Select one: Existing Occupation ☒ **or** Emerging Occupation ☐	
If local demand/supply information is available for the specified degree program and target occupation(s),**	
For demand: Provide local/regional demand data for the targeted occupation job title(s) from traditional labor market data, industry data, trade association data, or other transactional data. (*Provide absolute numbers, not just percentages*)	***The facts and figures below are documented within the Statement of Need.***
For supply gap: Provide data on the number of programs and the number of annual program graduates for all four-year colleges that supply your region. Is the number of current annual graduates insufficient to meet current and projected demand? (The result of demand minus supply).	***The facts and figures below are documented within the Statement of Need.***
OR, if demand information is not available or it is a new/emerging/changing occupation, **	
For demand: Provide employer survey results for local demand for the targeted occupation job title(s) to support the demand and education level for the program. Survey requirements are listed below.	Survey respondents indicated that there are up to 90 mechatronics openings at their companies that would prefer a bachelor's degree in the next 3 years.

For supply gap: Provide employer survey results for local supply for the targeted occupation job title(s) to support that there is a gap in the number of qualified applicants available to fill jobs. Survey requirements are listed below.	There are no other programs in mechatronics locally to provide graduates qualified for these positions. Respondents indicate that the BAS-META will be accepted at rates above other related programs not offered locally but in the western half of the state.
OR, if based on a statutory or accreditation requirement, **	
Select one: Statutory Requirement☐ **or** Accreditation Requirement ☐	
For demand: Provide labor market information on the current education requirements for the job, including evidence of recent openings for requiring or preferring bachelor's degrees or above. Cite the statute or certifying body, your proposed program is based upon that has specified a bachelor's or above in the field is needed.	
For supply gap: Provide employer survey results for local supply for the targeted occupation job title(s) to support that there is a gap or that employers anticipate a gap in the number of qualified applicants that will be available to fill jobs with the new requirements. Survey requirements are listed below.	
* Demand is defined by state law as "***an occupation with a substantial number of current or projected employment opportunities.***" **Applications may include information related to more than one option (i.e., labor market data to support the local demand for the occupation and a local employer survey to support that there is a gap in the number of qualified applicants available to fill jobs).	

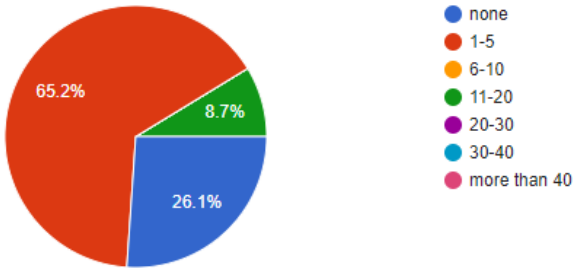
Appendix I: Industry Survey of Workforce Supply and Demand



General Current Demand

How many mechatronics related positions are currently open at your company?

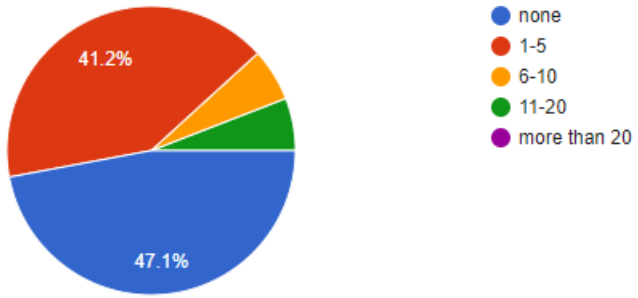
23 responses



Current Demand for Bachelor's Degree

How many open mechatronics related positions does your company have that either prefer or require candidates to hold a 4 year bachelor's degree?

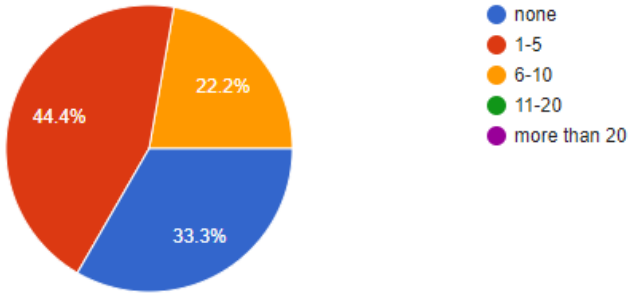
17 responses



Current Bachelor's Degree Demand - Part 2

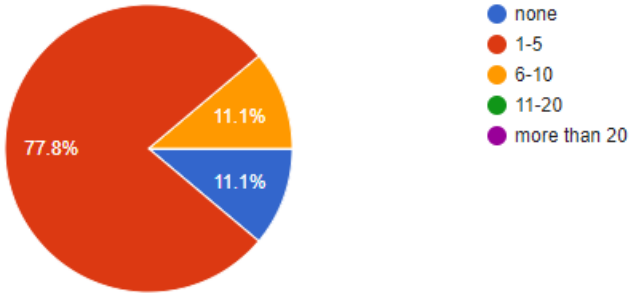
How many of your open mechatronics related positions require a bachelor's degree?

9 responses



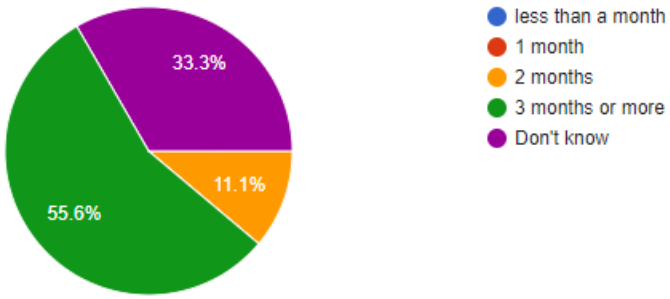
How many of your open mechatronics positions prefer a bachelor's degree?

9 responses



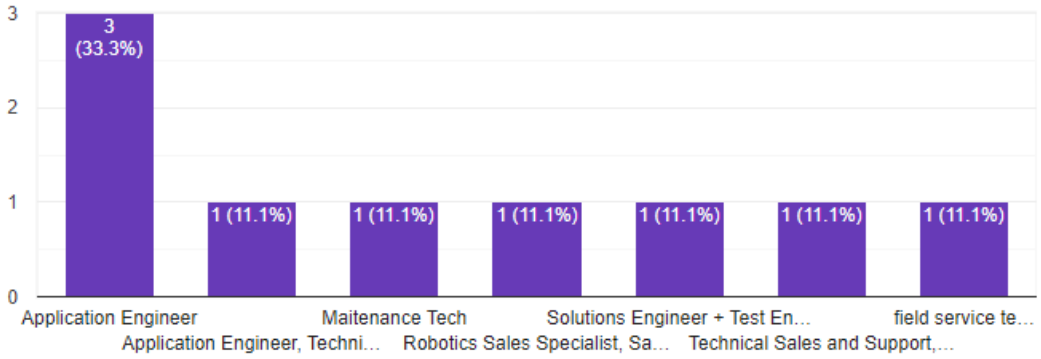
What is the average length of time these positions have been open?

9 responses



What are the top mechatronics related job titles you are currently recruiting for?

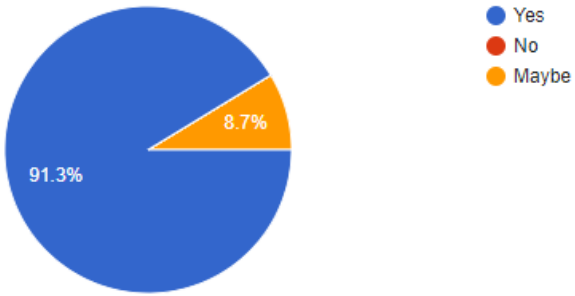
9 responses



General Future Demand

Do you anticipate a future demand for mechatronics related positions at your company?

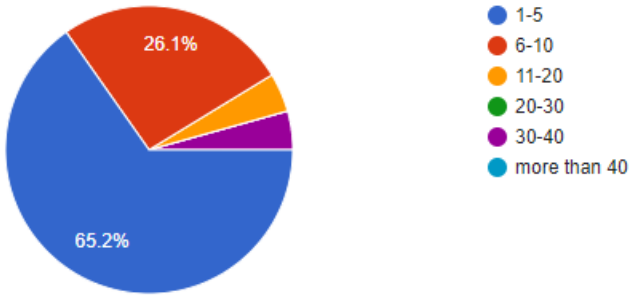
23 responses



Future Demand for Mechatronics

How many mechatronics related positions do you anticipate opening in the next 3 years at your company?

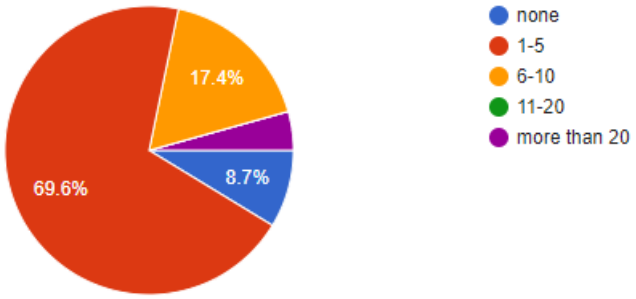
23 responses



Future Demand for Bachelor's Degree

How many mechatronics related positions does your company anticipate opening in the next 3 years that either prefer or require candidates to hold a 4 year bachelor's degree?

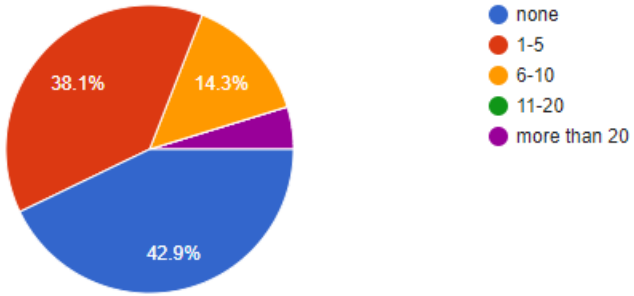
23 responses



Future Bachelor's Degree Demand - Part 2

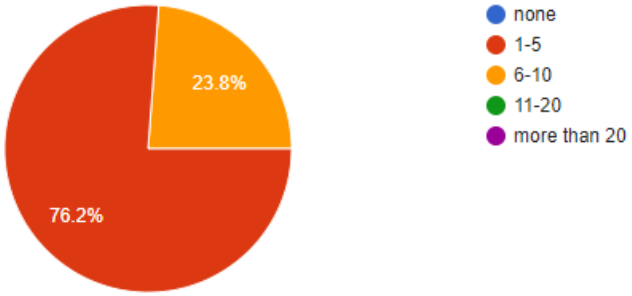
How many of your anticipated mechatronics related position openings in the next 3 years will require a bachelor's degree?

21 responses



How many of your anticipated mechatronics related position openings in the next 3 years will prefer a bachelor's degree?

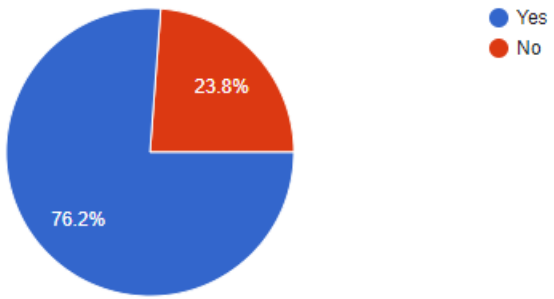
21 responses



Bachelor's Degree Supply

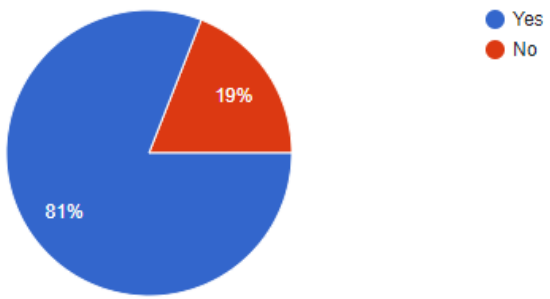
Have you had difficulty finding bachelor's level candidates to fill mechatronics related positions?

21 responses



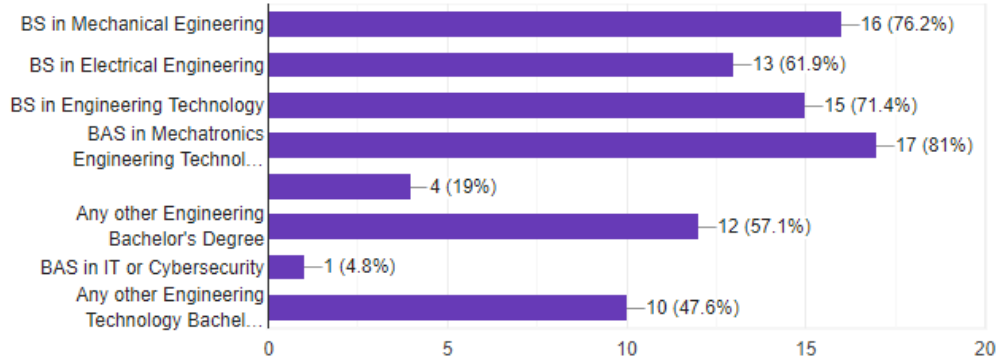
Do you anticipate having future difficulty finding bachelor's level candidates to fill mechatronics related positions?

21 responses



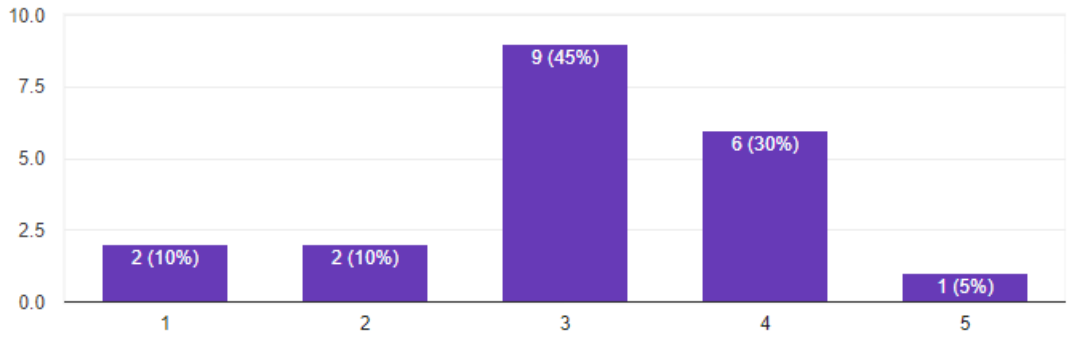
What type of bachelor's degree would your company accept for mechatronics related positions? (check all that apply)

21 responses



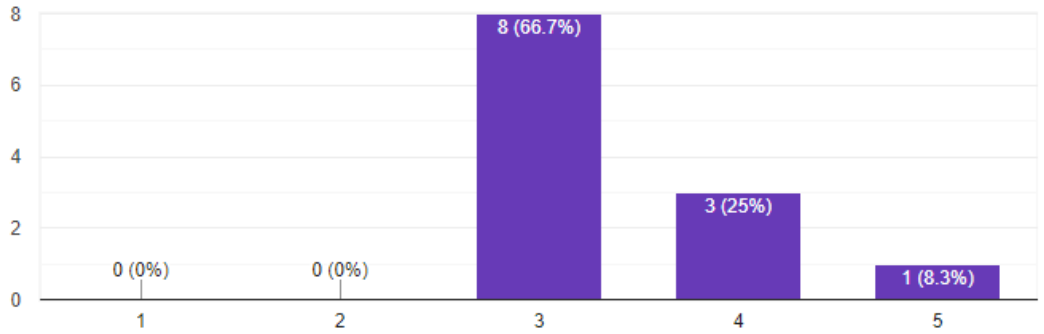
How important is ABET accreditation in evaluating whether or not to accept a degree?

20 responses



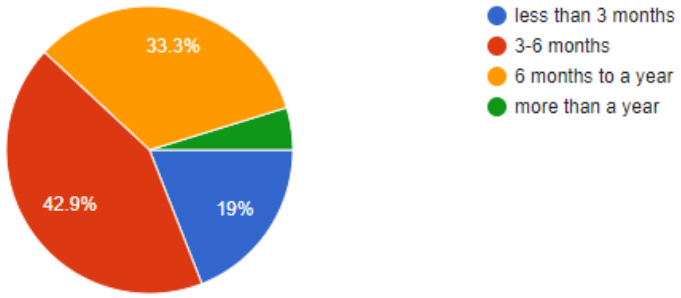
How well prepared for work in mechatronics have you found recent graduates of existing bachelor's degree programs? (please skip if you do not know)

12 responses



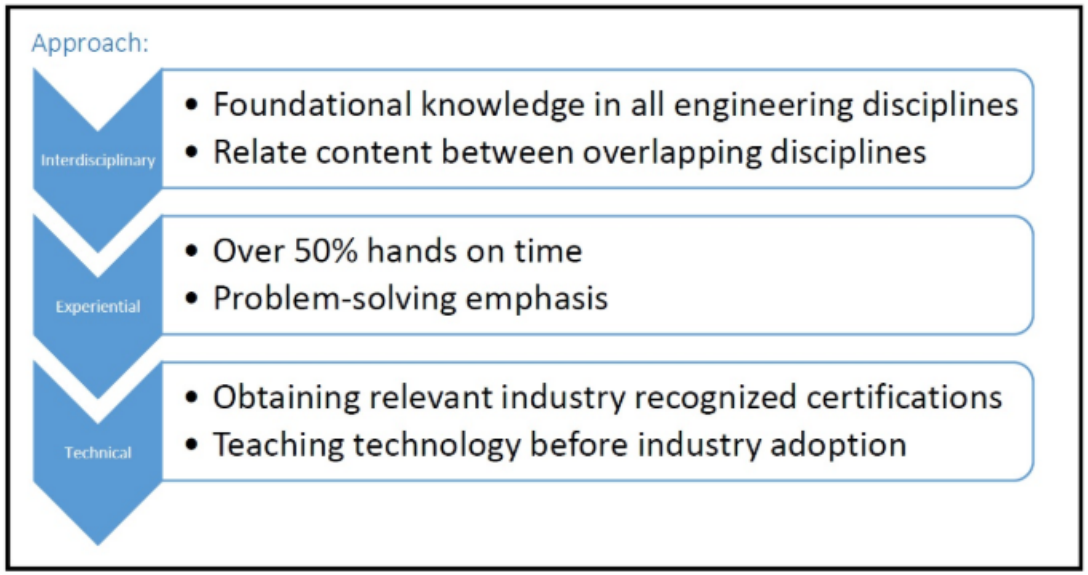
On average how long of do you anticipate the on-boarding/training period for new mechatronics hires to last?

21 responses

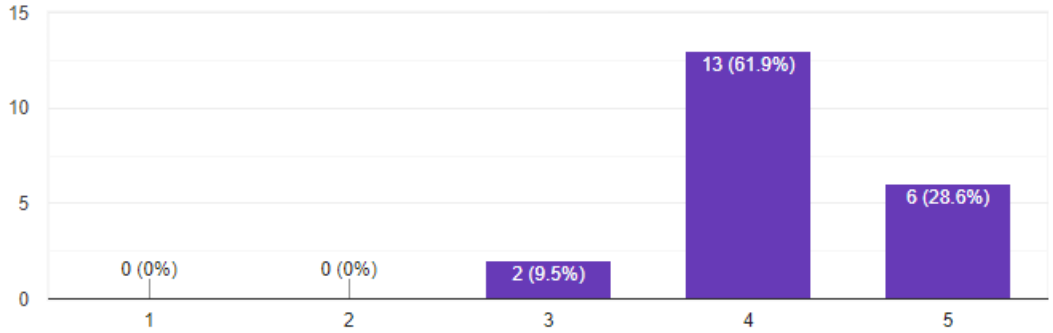


Program Development Feedback

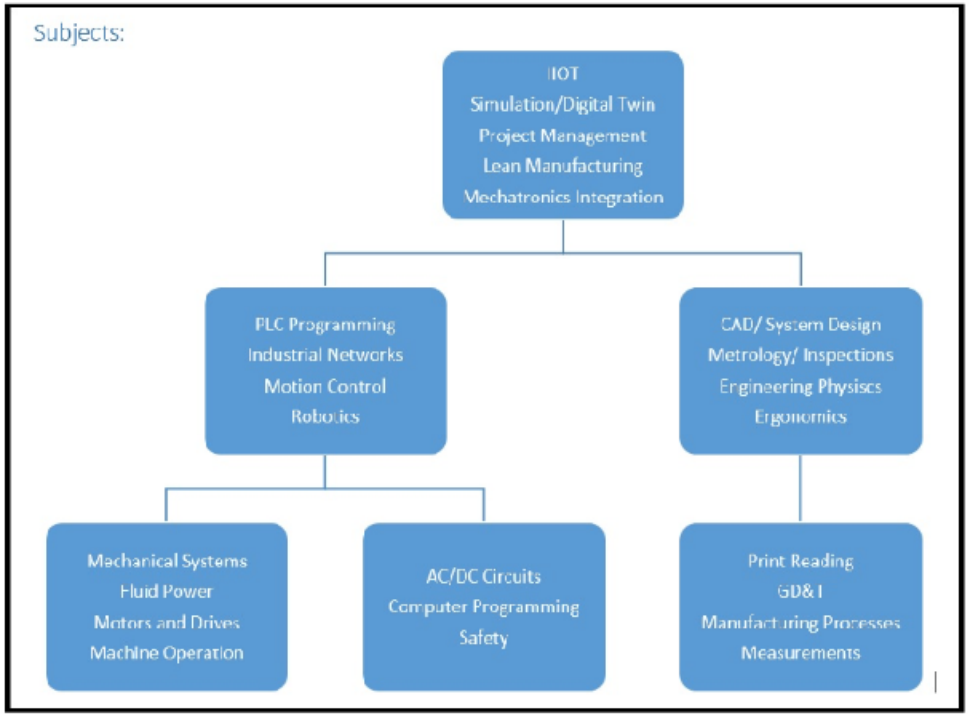
Does the following proposed program approach for a bachelor's degree align with your company's workforce needs?



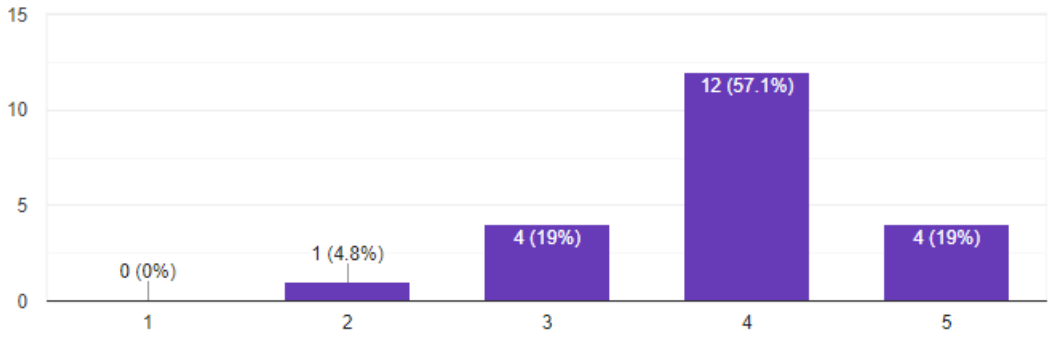
21 responses



Does the following proposed subject matter for a bachelor's degree align with your company's needs?



21 responses



Will the proposed program, as outlined in the above approach and subjects, assist you in finding qualified candidates for your mechatronics positions?

21 responses