BOARD OF HIGHER EDUCATION

REQUEST FOR COMMITTEE AND BOARD ACTION

COMMITTEE: Academic Affairs **NO**: AAC 16-13

COMMITTEE DATE: January 19, 2016

BOARD DATE: January 26, 2016

APPLICATION OF CAPE COD COMMUNITY COLLEGE TO AWARD THE ASSOCIATE IN SCIENCE IN ENGINEERING, TECHNOLOGY, AND ADVANCED MANUFACTURING

MOVED: The Board of Higher Education hereby approves the application of **Cape Cod Community College** to award the **Associate in Science in Engineering, Technology, and Advanced Manufacturing.**

Upon graduating the first class for this program, the College shall submit to the Board a status report addressing its success in reaching program goals as stated in the application and in the areas of enrollment, curriculum, faculty resources, and program effectiveness.

Authority: Massachusetts General Laws Chapter 15A, Section 9(b)

Contact: Winifred M. Hagan, Ed.D.,
Associate Commissioner for Academic Affairs and Student Success

BOARD OF HIGHER EDUCATION

January 2016

Cape Cod Community College
Associate in Science in Engineering, Technology and Advanced Manufacturing

INTENT AND MISSION

The proposed Associate in Science (AS) in Engineering, Technology and Advanced Manufacturing proposal aligns with the Cape Cod Community College (CCCC) mission to be a teaching and learning community, which provides opportunities and pathways that encourage students to achieve their goals. Local employers have expressed interest in seeing CCCC expand its engineering and advanced manufacturing curriculum and it is anticipated that they will be engaged in opportunities for collaboration and internships. It is expected that as the proposed program evolves, a collaborative model where specialized courses are taught by industry partner professionals will ensue. As well, real-time workplace learning experiences in the areas of innovation and business management are expected to lead to fulltime employment for program graduates. CCCC is a participant in the 15 community college Guided Pathways to Success in STEM consortium funded by the Department of Labor.

It is intended that the proposed program will prepare graduates in the skills required for an entry- level general engineering technician, manufacturing technician, or a draftsperson job. CCCC plans that graduates of the proposed program will work as automation specialists, manufacturing technicians, design technicians, CAD designers, engineering aides, field service technicians, technical representatives, and maintenance technicians. It is anticipated that earning this degree will open employment doors to entry-level jobs or provide entry to a baccalaureate program.

The required letter of intent for the proposed program has obtained all necessary governance approvals on campus and was approved by CCCC's Board of Trustees on April 30, 2015. The required letter of intent was circulated on June 2, 2015. One comment was received from the University of Massachusetts Dartmouth, which commended the college's collaboration with the industry, and suggested that the foundational physics course be clearly calculus based.

NEED AND DEMAND

National and State Labor Market Outlook

According to 'Change the Equation', a national coalition committed to improving STEM education, the national outlook for Engineering jobs is projected to grow through 2024 by 12% and Advanced Manufacturing jobs is projected to grow by 16%. In Massachusetts the same organization is projecting a growth in engineering jobs through 2024 of 12% and for the same time period the Advanced Manufacturing growth is estimated to be 14%. CCCC reports that an aging workforce demographic is also adding to the national and regional demand. The number of individuals in the labor force who are 65 years or older is expected to grow by 75 percent while the number of individuals in the workforce who are 25 to 54 is only expected to grow by 2 percent. By 2016, one-third of the total U.S. workforce will be 50 years or older; a group that may number 115 million by 2020. These findings are consistent with the Massachusetts report, 'Staying Power II' published by Northeastern University, which states that 54% of all

manufacturing employees within the state are 45 years of age or older and that number is more than nine percentage points higher than the aging workforce in all other industries.

The Cape and Islands Workforce Investment Board brings capacity to evaluate labor market data, disseminate information about training opportunities, communicate the availability of trained workers to potential employers, and provide employability services to participants who need it. A letter of support underscoring the need for the program has been included in the application for approval. In addition, data recently compiled by the Cape and Islands Workforce Investment Board and the Massachusetts Executive Office of Labor and Workforce Development indicated that the engineering and manufacturing sector is poised to grow in the region between 18% and 38% by 2020.[1] These rates are higher than the overall growth rate for the area, which is projected to grow by 7.6%.[2] In late 2013 there were 219 employers and 2,135 jobs located within the CCCC geographic area and the average earnings for jobs in this sector was estimated at $67,968 per year, compared to median earnings for all jobs estimated at $40,830 annually.[3]

Student Demand

Area educational districts in the region which have expressed support for the proposed program include the Barnstable School District, the Cape Cod Regional Technical High School, the Dennis-Yarmouth Regional School District, the Nauset School District, and the Mashpee School District. In addition, during the spring semester of 2015, CCCC completed a dual enrollment - early college pilot program that focused on recruitment and accelerated training for the region's high school STEM students who take a course without having to leave their high school campuses or install special software on their local computers. Approximately 40 students participated in the pilot and have expressed interest in the program. In addition to this, there are currently about 70 students (50 first year and 20 second year) actively pursuing either an offered certificate or have expressed a desire to earn the proposed AS degree.

Over the last 18 months the college has been conducting a number of on campus events and information sessions to increase awareness and gauge interest in STEM course offerings. For the most recent semester (Fall 2015) 1470 students attended 26 activities. While engineering and manufacturing student numbers were not specifically culled from the STEM populations attending each event, the event organizers when queried about attendance stated that a high percentage of students expressed interest in engineering or manufacturing course offerings.

Another indicator of student demand comes from the objectives identified in the college's Guided Pathways to Success in STEM (GPSTEM), DOL grant. This three year grant (October 1, 2014 through September 30, 2017) has an enrollment objective of 120 total unique participants, with a participant being defined as a US citizen seeking an engineering and advanced manufacturing certificate or one who has enrolled in a course included in the proposed AS degree.

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[1] *http://tinyurl.com/kurz4st; http://tinyurl.com/k93flea Retrieved October 2014*
[2] *ibid*
[3] *www.statscapecod.org Retrieved October 2014*

OVERVIEW OF PROPOSED PROGRAM

The proposed Engineering Technology and Advanced Manufacturing Program includes opportunities to earn stackable certificates that serve to guide students toward specialized pathways. Students may earn the Engineering Technology Certificate as the base certificate, upon which certificates in Green Design & Engineering, Robotics and Manufacturing Automation, and Engineering Innovation & Entrepreneurship can be stacked for increased credentials. The program is also designed to provide students opportunities to develop the core skills and knowledge necessary to earn the AS degree and to further be able to transfer to a baccalaureate in engineering or manufacturing program. Students are expected to learn the advanced math, physics, and computer-aided design concepts that underlie modern engineering/manufacturing processes and procedures. Additionally, they hone their critical thinking skills and become versed in the processes needed to solve problems and to develop an idea into a finished product. Direct hands-on experience in the application and use of state-of-the-art engineering and manufacturing equipment is gained through laboratory sessions that are associated with the majority of the program-specific courses.

Duplication

CCCC is the only institution providing access to comprehensive higher education on Cape Cod. Nine out of the 15 community colleges in Massachusetts offer some form of engineering or manufacturing program. The closest of these are Massasoit and Bristol and each are at least an hour away and not accessible for CCCC student population, 80% of whom reside in nearby Cape Cod towns.

ACADEMIC AND RELATED MATTERS

Admission

CCCC is an open access institution. The proposed Engineering Technology and Advanced Manufacturing Program is not planned to have a selective admission process. Students admitted to the college, possess a high school diploma or GED, meet individual course prerequisites, as outlined in the college catalog, and complete assessments of basic skills in reading, writing, and mathematics are expected to be admitted. A multi-faceted support model is used to ensure that under prepared students are identified and given opportunities to meet course pre-requisites. The support revolves around an intrusive advising model where each student is assigned to a STEM advisor who will help with any college concerns as well as assist students in creating an educational, career, and transfer plan. This plan identifies any gaps in pre-requisites and details the actions required to close the gap. This policy enables students to discover the varied resources available at the college that support their academic concentration and completion.

Grant funding and institutional support have enabled the College to adopt Starfish®, an electronic student retention system. Starfish allows advisors and faculty to engage early and often with students by raising flags of concern, offering positive affirmations, and referring students to campus support services. The College's new Student Success Office, with funding from the Massachusetts Department of Higher Education and with leadership from the Director of Advising and Counseling, will assure coordination of services and support for first-time, academically underprepared students. Furthermore, all new to college engineering and

advanced manufacturing students are encouraged to enroll in the General Education elective course *The College Experience: Success in STEM (COL 101)*. It is specifically designed to help students make a smooth transition to college and be successful in STEM explorations at CCCC. Class lectures explicitly address core STEM program pre-requisite requirements and resolution actions.

Thus, the combination of Starfish®, a full-time Student Success Advisor, the STEM advisors, and committed faculty demonstrates CCCC's full commitment to enabling under-prepared students meet program pre-requisites.

PROGRAM ENROLLMENT

	Number of Students			
	Year 1	**Year 2**	**Year 3**	**Year 4**
New Full-Time	15	20	25	30
Continuing Full-Time	10	10	13	17
New Part-Time	10	20	25	30
Continuing Part-Time	8	10	13	17
Totals	43	60	76	94

Curriculum (Attachment A)

The curriculum includes calculus and other advanced math courses. The Science, Technology, Engineering, and Math department courses and certificate programs include biology, chemistry, physics, environmental studies, horticulture, and construction technology. The CCCC's courses are designed to emphasize cross-curriculum competencies, and include the development of skills in critical thinking, technology, oral communication, reading and writing, and quantitative thinking and understanding.

Internships or Field Studies

CCCC reports that local employers have expressed interest in seeing the institution expand its engineering and advanced manufacturing curriculum and have expressed a willingness to provide opportunities for collaboration and internships. As the program evolves, it is expected that a collaborative model will be constructed such that specialized courses partially taught by industry partner professionals will take place in addition to internships, which will be planned as an integral component of the program. Industry partners have helped CCCC identify high need areas where development of specific knowledge and skills can lead to opportunities for full-time employment for graduates.

RESOURCES AND BUDGET

Fiscal (Attachment B)

The proposed program develops training required to fill engineering technology and advanced manufacturing job openings in the public and private sectors. Combining prior learning assessments, workplace simulations and employer-validated accelerated curriculum, the certificates and program degree will be delivered to 200 participants in the first four years.

Rigorous evaluation and outcomes tracking will ensure this cost-effective program builds capacity to implement innovative educational programs that meet the needs of workers and employers in the engineering/manufacturing sector.

The revenue for the tuition and fee line items was developed using the projected enrollment numbers from the Market Analysis: Student Demand section of the application with tuition calculated using $175.50 per course credit and fees calculated using $25.00 lab fee per lab required course.

Faculty and Administration (Attachment C)

CCCC has dedicated resources for two full-time faculty from the Engineering Sciences & Applied Technology department and plans to employ additional adjunct faculty for specific subject areas of expertise through industry partners. Other departments with faculty involved in the program are the Natural Science and Applied Technology Department and the Mathematics and Computer Science Departments.

Facilities, Library and Information Technologies

All technical resources of CCCC will be leveraged to ensure on-time and on-budget implementation of the program. Laboratories are expected be used for hands-on training with engineering tools as well as additive and subtractive manufacturing equipment. CCCC currently manages a manufacturing laboratory, a robotics laboratory, a computer-aided design laboratory, and an electrical laboratory. All resources are planned to be available to program staff, faculty, and students including classrooms, office space, laboratories, and technological resources. A complete, detailed inventory of all current hardware and software was provided in the application for the proposed program.

Affiliations and Partnerships

Support for the proposed program from local industry includes Flexo Concepts, Onset Computer Corporation, SencorpWhite, Hydroid Inc., Teledyne Marine Systems, McLane Research Laboratory, and the Massachusetts Technology Leadership Council. The proposed program has developed articulation agreements with Massachusetts College of Liberal Arts, the University of Massachusetts Dartmouth, Worcester Polytechnic Institute and the University of Maine. Potential additional articulation agreements are currently underway with Merrimack College, the University of Massachusetts Lowell and the University of Massachusetts Dartmouth.

PROGRAM EFFECTIVENESS

Program Goal	Measurable Objective and Timetable	Strategy for Achievement
Implement problem based learning (PBL) challenges for training students in the engineering process [4]	Incorporate one or more PBL challenges into each of the Engineering Sciences & Applied Technology department courses required in this program for improved learning outcomes.	Work with industry partners to identify and refresh challenges to increase relevancy.
Reduce regional engineering/ manufacturing skill gap.	See Market Analysis, Student Demand : Target Market section and enrollment projections table.	
Implement block schedule for program.	Release program block schedule for full and part time students. Fall 2015: Full time student block schedule. Spring 2016: Part time student block schedule 100% student compliance within three years of release.	Align the program with the DOL Guided Pathways to Success (GPSTEM) Project. Utilize/ implement the Complete College America's (CCA) Guided Pathways to Success (GPS) model.
Implement program meta-major/academic pathway maps, including milestone courses and default academic pathways for both full and part time students.	50% Full time student compliance by Spring 2016 100% Full time student compliance by Spring 2017 25% Part time student compliance by Spring 2016 50% Part time student compliance by Spring 2017	Coordinate with Cape Cod Community College's Transfer Student Advisory Group. Utilize/ implement the Complete College America's (CCA) Guided Pathways to Success (GPS) model.
Implement proactive academic advising and early intervention for all program students.	100% faculty, academic, and career advisors trained. 50% of program students covered by Spring 2016 100% of program students covered by Spring 2017	Develop training procedures and documentation that support intrusive academic advising and early intervention. Train faculty, academic, and career advisors. Establish student process for early degree selection.
Create a viable, cost efficient dual enrollment pathway for high school students who wish to earn college credit while in high school.	80% of dual enrolled students who matriculate into the program earn the degree.	Collaborate with the Cape Cod Regional STEM Network and local school districts. Offer first and second semester Engineering Sciences & Applied Technology department courses with dual enrollment options.

[4] *Problem Based Learning (PBL) pedagogy has been shown to improve student understanding and retention, hone critical thinking and problem solving skills, increase motivation and engagement, and improve one's ability to work in teams which in turn can improve student retention and result in greater program satisfaction (Wood, 2003).*

Recruit a diverse student body, including women, minority, first generation and economically disadvantaged students.	Target of at least 50% of those enrolled fitting one or more of these criteria (women, minority, first generation and economically disadvantaged students).	Utilize a Success Coach to help recruit and retain students in the program. This staff member will strengthen the relationship with high schools and employers, facilitate help organize K-12 outreach and career exploration events, disseminate program information, and act as a case manager to students in the program.
Establish industry internships and high school shadowing.	Implement experiential learning opportunities for student's third and fourth semester students. Require all internees to complete seminar addressing practices associated with successful internship/job performance and career advancement prior to the start of an internship. Each semester offer dual enrolled high school students a shadowing opportunity at one of more industry partner locations.	This will allow students to gain direct on-site work experience and will be able to explore a industry segment of interest. Student internships will typically run between 100 and 150 hours in duration.
Create articulated progressions with public/ private four year institutions for matriculated students.	Review and refresh existing articulation agreements with four-year institutions for all STEM related programs of study. Half of the existing agreements for STEM programs are refreshed by Fall 2016. Secure agreements to develop new articulation pathways with four-year institutions in the targeted STEM area of engineering/advanced manufacturing.	Work with partners and state teams to enhance articulation pathways in engineering/ advanced manufacturing.

EXTERNAL REVIEW AND INSTITUTIONAL RESPONSE

The proposed program was reviewed by Michael Esposito, MS Technology Management; Engineering Manager and Senior Electrical Engineer at Sencorp White in Hyannis, MA, and Robert Melvin, MS Electrical Engineering; Vice President of Engineering at Teledyne Marine Systems in North Falmouth, MA. The reviewers found the program to provide a strong foundation in STEM-related areas and additional depth of knowledge in at least one specific technical discipline. The review team also found that the overview, outcomes, and career outlook outlined for each program provide an easily understandable roadmap for students, and the courses offered for each concentration of the program are consistent with this roadmap. The

team noted that the progression of study assures competency in science and communication, advanced knowledge of mathematics, and an in-depth understanding of the specialized area of study.

In response to the review CCCC expressed gratitude for the time and effort reviewers spent on assessing the Associate in Science in Engineering and Advanced Manufacturing Program.

STAFF ANALYSIS AND RECOMMENDATION

Staff thoroughly reviewed all documentation submitted by the **Cape Cod Community College** and external reviewers. Staff recommendation is for approval of the proposed **Associate in Science in Engineering, Technology, and Advanced Manufacturing**.

ATTACHMENT A: CURRICULUM

Required (Core) Courses in the Major (Total # courses required = 14***)***		
Course Number	Course Title	Credit Hours
ENR101	Introduction to Engineering and Advanced Manufacturing	4
ENR102	3D Mechanical Design I	4
ENR201	Statics	3
MAT240	Calculus I	4
MAT250.	Calculus II	4
MAT260.	Calculus III	4
MAT270	Differential Equations	3
PHY211	University Physics I	4
PHY212	University Physics II	4
CHM151	General Chemistry I	4
ENL101	English Composition I	3
COM103	Human Communication	3
	Behavioral and Social Sciences	3
	Behavioral and Social Sciences	3
	Sub Total Required Credits	50
Elective Courses (Total # courses required = 3 selected from the list***)*** *(attach list of choices if needed)*		
ENR103	Introduction to Robotics	4
ENR104	3D Mechanical Design II	4
ENR105	Circuit Theory and Analysis	4
ENR110	Engineering and Scientific Computing	3
ENR206	Quality Manufacturing	4
CSC120	Computer Programming I: C++	4
MAT245	Linear Algebra	3
CHM152	General Chemistry II	4
BIO151	General Biology I	4
BIO152	General Biology II	4
COL101	College Experience-Success in STEM	3
	Sub Total Elective Credits	10/12
Distribution of General Education Requirements		# of Gen Ed

Attach List of General Education Offerings (Course Numbers, Titles, and Credits) See College Catalog: http://www.capecod.edu/files/catalogs/2015-2016/CCCC-Catalog-2015-16.pdf	Credits
Arts and Humanities, including Literature and Foreign Languages	6
Mathematics and the Natural and Physical Sciences	12
Social Sciences	6
Sub Total General Education Credits	24

Curriculum Summary	
Total number of courses required for the degree	17
Total credit hours required for degree	60/62

Prerequisite, Concentration or Other Requirements: Prerequisite courses are specified in the college catalog:

ATTACHMENT B: BUDGET

One Time/ Start Up Costs		***Annual Expenses***			
	Cost Categories	**Year 1** (10/1/14-9/30/15)	**Year 2** (10/1/15-9/30/16)	**Year 3** (10/1/16-9/30/17)	**Year 4** (10/1/17-9/30/18)
	Full Time Faculty *(Salary & Fringe)*	$65550	$155765	$160440	$165115
	Part Time/Adjunct Faculty *(Salary & Fringe)*	$2283	$16028	$16668	$17308
	Staff	$89941	$144591	$147313	$150035
	General Administrative Costs	$4413	$14905	$15205	$15505
	Instructional Materials, Library Acquisitions	$1000	$1000	$1250	$1400
	Facilities/Space/Equipment	$452	$58366	$14592	$15000
	Field & Clinical Resources	- -	- -	- -	- -
	Marketing		$2000	$3000	$3000
	Other (Starfish software and Travel)	- -	$10000	$10000	$10000
	TOTALS	$163,639	$402,655	$368,468	$377,363

One Time/Start-Up Support		***Annual Income***			
	Revenue Sources	**Year 1**	**Year 2**	**Year 3**	**Year 4**
$40000	Grants	$183,701	$268,902	$274,960	TBD
	Tuition ($175.50 per credit)	$155,844	$210,600	$266,760	$329,940
	Fees ($25 lab fee)	$5,550	$7,500	$9,500	$11,750
	Departmental		$6000	$7000	$8000
	Reallocated Funds				
	Other (specify)				
$40000	**TOTALS**	$345,095	$493,002	$558,220	$349,690

ATTACHMENT C: FACULTY

Summary of Faculty Who Will Teach in Proposed Program							
Name of faculty member (Name, Degree and Field, Title)	**Check if Tenured**	**Courses Taught Put (C) to indicate core course. Put (OL) next to any course currently taught online.**	**Number of sections**	**Division of College of Employment**	**Full- or Part-time in Program**	**Full- or part- time in other department or program (Please specify)**	**Sites where individual will teach program courses**
Bsharah, Fredrick BS Civil engineering MS in Engineering Science Assistant Professor	☐	• Intro to Engineering and Advanced Manufacturing & Lab (Fall 2015) • 3D Mechanical Design I & Lab (Fall 2015) • 3D Mechanical Design II & Lab (Fall 2015) • Circuit theory and Analysis & Lab (Fall 2015) • Engineering and Scientific Computing (Fall 2015) • Quality Manufacturing (Spring 2016) • 3D Mechanical Design I & Lab (Spring 2016) • 3D Mechanical Design II & Lab (Spring 2016) • Engineering and	(1) (1) (1) (1) (1) (1) (1) (2) (2) (1)	Day Day Day Evening Day Day Day Day Day Day	Full-Time	No	• West Barnstable Campus

		Scientific Computing (Spring 2016)					
Miller, Dennis BS Engineering MBA Instructor	☐	• Introduction to Engineering Lab • Introduction to Robotics & Lab	(1) (1)	Evening Day	Part-time	No	• West Barnstable Campus
Search for an Additional Full-time Engineering Instructor in Progress as of November 2, 2015	☐	• TBA	[0]	Day	Full-Time	No	• West Barnstable Campus