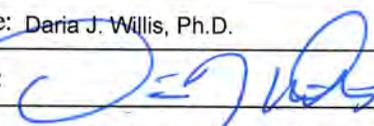# Cover Sheet for In-State Institutions
New Program or Substantial Modification to Existing Program

Institution Submitting Proposal	Howard Community College

*Each **action** below requires a separate proposal and cover sheet.*

- ⦿ New Academic Program
- ◯ New Area of Concentration
- ◯ New Degree Level Approval
- ◯ New Stand-Alone Certificate
- ◯ Off Campus Program

- ◯ Substantial Change to a Degree Program
- ◯ Substantial Change to an Area of Concentration
- ◯ Substantial Change to a Certificate Program
- ◯ Cooperative Degree Program
- ◯ Offer Program at Regional Higher Education Center

Payment Submitted: ⦿ Yes ◯ No	Payment Type: ◯ R*STARS # 0588616 ⦿ Check # 0588616	Payment Amount: $850	Date Submitted: 8/15/23

Department Proposing Program	Workforce, Career, and Community Education
Degree Level and Degree Type	Associate of Applied Science
Title of Proposed Program	Additive Manufacturing
Total Number of Credits	60
Suggested Codes	HEGIS: 5399.01	CIP: 15.0613
Program Modality	⦿ On-campus ◯ Distance Education (fully online) ◯ Both
Program Resources	⦿ Using Existing Resources ◯ Requiring New Resources
Projected Implementation Date (must be 60 days from proposal submision as per COMAR 13B.02.03.03)	⦿ Fall ◯ Spring ◯ Summer Year: 2026
Provide Link to Most Recent Academic Catalog	URL: https://howardcc.smartcatalogiq.com/en/2023-2024/catalog/

Preferred Contact for this Proposal	Name: Minah Woo
	Title: Vice President of Workforce, Innovation & Strategic Partnerships
	Phone: (443) 518-4724
	Email: mwoo@howardcc.edu

President/Chief Executive	Type Name: Daria J. Willis, Ph.D.
	Signature: Date 8/24/23
	Date of Approval/Endorsement by Governing Board:

Revised 1/2021

August 17, 2023

Dr. Sanjay Rai
Acting Secretary of Higher Education
Maryland Higher Education Commission
6 North Liberty Street, 10th Floor
Baltimore, MD 21201

Dear Dr. Rai:

Howard Community College (HCC) requests your approval of a new associate of applied science (AAS) in Additive Manufacturing. This degree is intended to be a stackable credential in conjunction with HCC's existing lower division certificate in Additive Manufacturing, and will offer flexibility and enhanced employment opportunities to our students.

Please contact me if you need additional information or clarification.

Minah Woo
Vice President of Workforce, Innovation, & Strategic Partnerships
mwoo@howardcc.edu
443-518-4724

A. Centrality to Institutional Mission and Planning Priorities:

1. Provide a description of the program, including each area of concentration (if applicable), and how it relates to the institution's approved mission.

Howard Community College (HCC) is committed to providing educational programs that meet the diverse needs of the community and central Maryland region. The foundation for these programs is a commitment to the HCC education ideal of creating a dynamic and effective learning environment for students.

Central to all academic programs at HCC is their adherence to the college's mission of "Providing pathways to success." This Additive Manufacturing Technology associate of applied science (AAS) degree is designed to prepare students for career entry or career advancement in additive manufacturing technology. Manufacturing is becoming increasingly technology dependent, requiring highly skilled workers who are familiar with digital tools. Many of the recent advances in manufacturing involve additive methods, as opposed to traditional subtractive methods. The curriculum emphasizes foundational skills in additive manufacturing technology, computer-aided design, technical physical science, and entrepreneurship, and incorporates practical, collaborative learning experiences. Students will develop critical thinking, problem solving, and communication skills, while applying creativity to the use of additive manufacturing and design tools. Students who complete the degree will have access to employment in a variety of technology sectors including engineering, manufacturing, design, and equipment sales.

2. Explain how the proposed program supports the institution's strategic goals and provide evidence that affirms it is an institutional priority.

HCC's Strategic Goals are:
- Student success, completion, and lifelong learning
- Organizational excellence
- Building and sustaining partnerships

This program aligns with HCC's "Student success, completion, and lifelong learning" priority in that the degree prepares students for well-paying careers in the growing manufacturing industry. Students may also continue their education at a four-year institution, where they will continue to hone their knowledge and skills in industry-specific areas of concentration. In addition to industry preparation, general education courses provide skills in critical and creative thinking, scientific and quantitative reasoning, global competency, technological literacy, information literacy, and ethics.

In addition, HCC's president has identified the development of trade programs as an institutional priority.

3. Provide a brief narrative of how the proposed program will be adequately funded for at least the first five years of program implementation. (Additional related information is required in section L).

HCC currently offers an Additive Manufacturing Technology certificate that will stack into this AAS degree. HCC has invested in the laboratory equipment and infrastructure, along

with maintenance, to sustain hands-on instruction in the degree program. Therefore, adequate funding for ongoing support of the Additive Manufacturing Technology AAS degree's facilities, faculty, and administrative support is currently in place. Only modest additional funding will be required to support additional equipment needed to accommodate larger classes with higher projected enrollment and hire one additional faculty member. HCC's president is committed to supporting these additional expenses in HCC's operating budget.

4. **Provide a description of the institution's a commitment to:**

   a. **ongoing administrative, financial, and technical support of the proposed program**

   HCC vigorously supports aligning academic programs to meet state and local workforce needs. As such, this program is directly aligned to those needs and is a part of HCC's high-priority plan to establish a Trades Center. For long-term support, HCC has garnered the commitment of Howard County to partially fund the design of this center and has aligned its operating and capital budget strategies to support this program. Additionally, HCC currently offers an Additive Manufacturing Technology certificate program. The college already has the laboratory and significant faculty resources to support this degree program. Modest resources will be required to keep lab equipment current with industry progress in additive manufacturing technology. HCC's president is committed to adding one additional faculty member and supplying additional equipment to meet enrollment increases.

   b. **continuation of the program for a period of time sufficient to allow enrolled students to complete the program.**

   If HCC decides to discontinue the program in the future, the college will establish a teach-out plan, and students will be able to complete the program during a set teach-out period. HCC will support students throughout the completion of the program.

B. **Critical and Compelling Regional or Statewide Need as Identified in the State Plan:**

   1. **Demonstrate demand and need for the program in terms of meeting present and future needs of the region and the State in general based on one or more of the following:**

      a. **The need for the advancement and evolution of knowledge**
      b. **Societal needs, including expanding educational opportunities and choices for minority and educationally disadvantaged students at institutions of higher education**
      c. **The need to strengthen and expand the capacity of historically black institutions to provide high quality and unique educational programs**

      The Jacob France Institute (JFI) conducted an analysis of Maryland's manufacturing workforce (JFI Analysis of Lightcast Data, Prepared for the Transforming Maryland Manufacturing Workgroup - Maryland Department of Commerce). JFI's research on

the manufacturing industry identified disparities in gender, ethnic and racial minority demographics for students and faculty, and marginalized student populations living in zip codes with higher poverty rates. Because HCC is an open access institution and provides educational opportunities to students regardless of racial, ethnic, gender, socioeconomic, or educational backgrounds, this program is poised to minimize the disparities in Maryland's manufacturing workforce.

2. **Provide evidence that the perceived need is consistent with the Maryland State Plan for Postsecondary Education (MSPPE).**

"Science, Technology, Engineering and Mathematics (STEM) jobs have grown in importance in the labor market in recent decades, and they are widely seen as the jobs of the future (Black SE, Muller C, Spitz-Oener A, He Z, Hung K, Warren JR. The importance of STEM: High school knowledge, skills and occupations in an era of growing inequality. Res Policy. 2021 Sep;50(7):104249. doi: 10.1016/j.respol.2021.104249. Epub 2021 Apr 2. PMID: 34334836; PMCID: PMC8318355). While many STEM careers are considered to be high-skill jobs, there are also middle-skill STEM jobs. "Recent work suggests that the labor market outcomes of those in the middle of the wage distribution strongly depends on the workers' skills, with more able workers better adapting to the changing labor markets…" (Black). The proposed additive manufacturing STEM program addresses the need for advancement and evolution of knowledge in STEM fields. It will also enable graduates to obtain the skills necessary to gain higher wages and adapt in an evolving labor market.

The proposed Additive Manufacturing Technology program supports Priority 5 of the Maryland State Plan for Postsecondary Education ("the Plan"). The Plan indicates that "[a]dvances in technology and changes in the economic infrastructure will continue to change the needs of the workforce" and "postsecondary education will need to adapt with these changes." This program will apply academic experiences on real-world equipment using project-based learning to address advances in technology and changing needs of the manufacturing workforce.

C. **Quantifiable and Reliable Evidence and Documentation of Market Supply and Demand in the Region and State:**

1. Describe potential industry or industries, employment opportunities, and expected level of entry (*ex: mid-level management*) for graduates of the proposed program.
2. Present data and analysis projecting market demand and the availability of openings in a job market to be served by the new program.
3. Discuss and provide evidence of market surveys that clearly provide quantifiable and reliable data on the educational and training needs and the anticipated number of vacancies expected over the next 5 years.
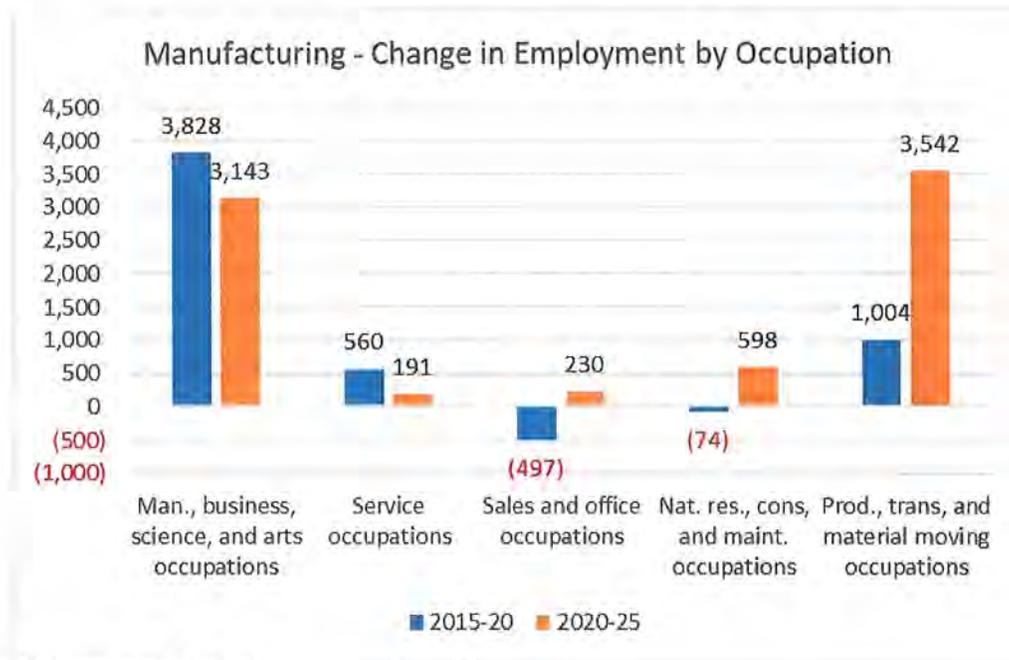4. Provide data showing the current and projected supply of prospective graduates.

Per the Transforming Manufacturing in a Digital Economy Workgroup (Making It in Maryland) report to the Maryland General Assembly (December 2022),

[m]anufacturing is an important industry sector in Maryland. Manufacturing accounts for 4.3% of Maryland jobs but generates 6.4% of Gross Regional Product and 62% of

Maryland exports. Each $1 million in Maryland manufacturing activity generates $1.5 million in Maryland economic activity, supports 4.6 overall jobs in the State, and generates more than $56,000 in State and local tax revenues. Manufacturing is also a growing high wage driver of the Maryland economy. With 108,887 manufacturing jobs distributed across all of Maryland's regions; average annual wages of $107,131, well above the State average; and five-year employment growth of 5%, while Maryland private sector employment fell; manufacturing is a key sector of the State's economy. Manufacturing directly accounts for 4% of Maryland jobs and 8% of Maryland economic activity, and when multiplier effects are included, the sector supports 9% of jobs and 12% of economic activity in Maryland.

The workgroup's research indicates that 55% of the State's manufacturing workforce works in Central Maryland (Workgroup Report).

Manufacturing - Change in Employment by Occupation

| Occupation	2015-20	2020-25
Man., business, science, and arts occupations	3,828	3,143
Service occupations	560	191
Sales and office occupations	(497)	230
Nat. res., cons, and maint. occupations	(74)	598
Prod., trans, and material moving occupations	1,004	3,542

(Workgroup Report)

An emerging process of advanced manufacturing technology that is disrupting the traditional industry is additive manufacturing, or as it is sometimes more commonly called, 3-D printing. Additive manufacturing is the process of creating a 3-D object from a digital file, by layering materials in sequential layers, using a 3-D printer. Whereas traditional manufacturing is a "subtractive" process, which starts with a block of material and removes what is not needed, additive manufacturing creates precise layers and can be more efficient, flexible, and less wasteful. 3-D printing is influencing many industries including automotive, aviation, and medical, with applications ranging from medical devices and prosthetics to automotive and aerospace parts. Advanced manufacturing technicians are members of the manufacturing production workforce.

Howard County employers, such as Johns Hopkins University Applied Physics Lab and Xometry are examples of local employers that hire front line additive manufacturing production workers.

Presently, Maryland's demand for skilled manufacturing workers is outpacing the demand for workers in all other industry sectors. In the last five years, Maryland has outpaced the nation in manufacturing employment (JFI Analysis of Lightcast Data, Prepared for the Transforming Maryland Manufacturing Workgroup - Maryland Department of Commerce).

Figure 2: Employment and Manufacturing Sector Growth
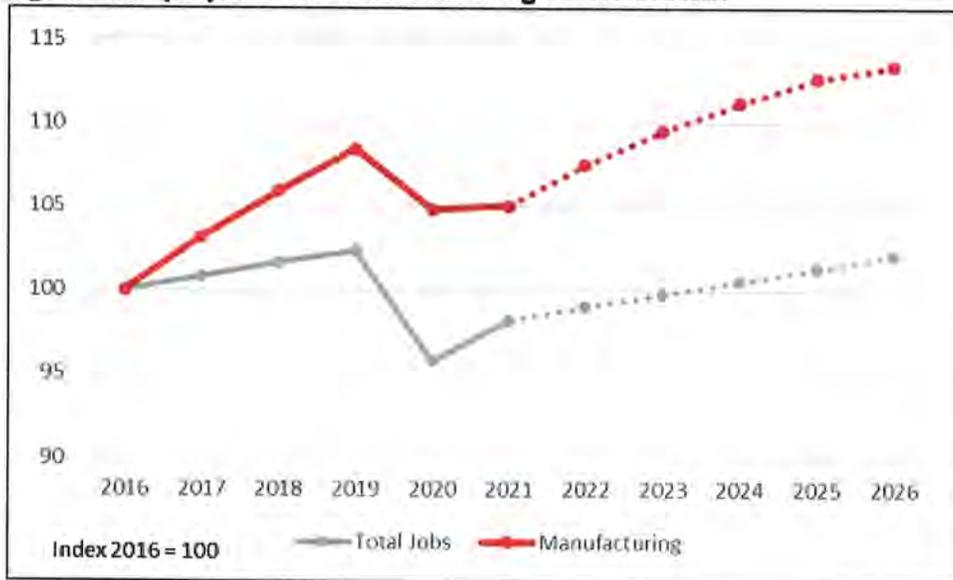
Source: Jacob France Institute

Maryland manufacturing wages are strong and manufacturing jobs provide excellent employment opportunities to earn family sustaining wages with upward mobility (JFI Analysis).

Description	Median Hourly Earnings
First-Line Supervisors of Production and Operating Workers	$33.76
Miscellaneous Assemblers and Fabricators	$17.41
Inspectors, Testers, Sorters, Samplers, and Weighers	$22.95
Packaging and Filling Machine Operators and Tenders	$14.63
Electrical, Electronic, and Electromechanical Assemblers, Except Coil Winders, Tapers, and Finishers	$22.22
Shipping, Receiving, and Inventory Clerks	$17.68
Helpers--Production Workers	$16.57
Industrial Machinery Mechanics	$28.94

Computer Numerically Controlled Tool Operators	$23.12
Machinists	$28.73
Food Batchmakers	$16.45
Production, Planning, and Expediting Clerks	$22.86
Maintenance and Repair Workers, General	$22.55
Production Workers, All Other	$14.38

(JFI Analysis)

Lightcast also predicts an estimated 9,531 annual openings in these professions. Maryland's manufacturing industry wages are the eighth highest in the U.S. providing family sustaining employment opportunities. In Howard County, there are currently 177 job postings in engineering technology professions such as additive manufacturing. The average salary for such positions is $58,661 annually. Lightcast projects the number of these jobs to grow in Maryland. Specifically, in December 2022, there were 822 posted openings for production workers in the State. Lightcast predicts that 3,542 production jobs will be created in Maryland in the next five years.
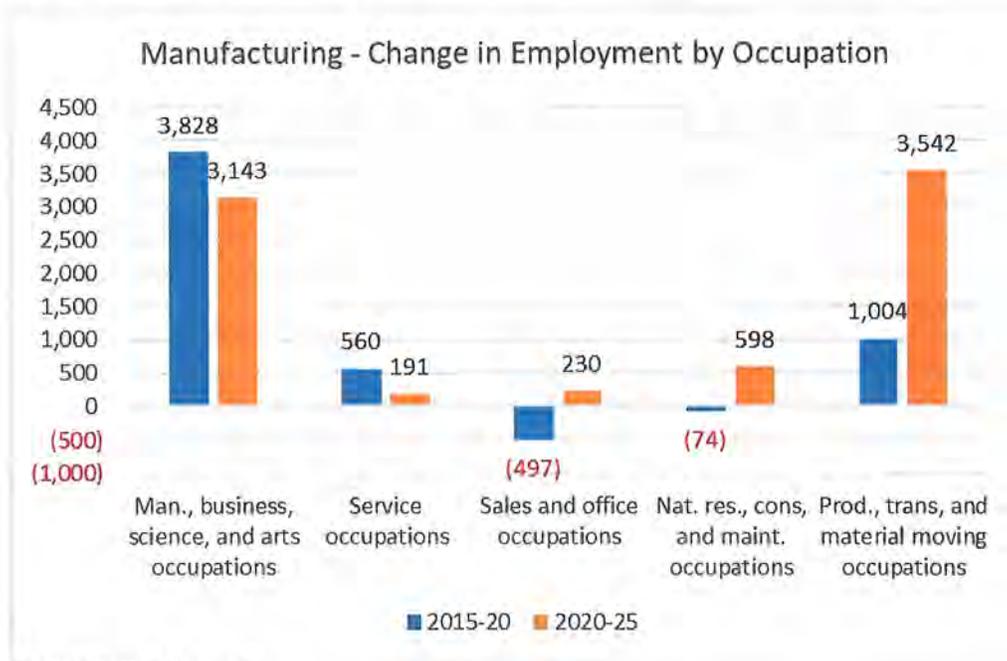
(Workgroup Report)

Data show that the Maryland workforce and talent pipeline is strongly aligned to meet the manufacturing sector's demand for higher skilled occupations. However, the workforce and talent pipeline is not strongly aligned to the sector's demand for production and transportation/material moving occupations. For example, manufacturers accounted for six of the top companies in terms of job openings in 2022. During the same period, the top 20 companies in Maryland account for 50% of all manufacturing openings (JFI Analysis). This program will bolster the talent pipeline to align more closely with the manufacturing sector's demand for higher skilled jobs.

D. Reasonableness of Program Duplication:

1. **Identify similar programs in the State and/or same geographical area. Discuss similarities and differences between the proposed program and others in the same degree to be awarded.**

2. **Provide justification for the proposed program.**

   As discussed above, Maryland's manufacturing workforce and talent pipelines are misaligned. Despite the growing number of middle- and high-skilled manufacturing jobs, only two other colleges within HCC's geographical area offer additive manufacturing programs. Carroll Community College offers a Digital Design and Fabrication A.A.S. and Harford Community College offers an Additive Manufacturing Area of Concentration within its Engineering Technology A.A.S. degree. The Community College of Baltimore County's A.A.S. degree in Design, Fabrication and Advanced Manufacturing overlaps slightly with HCC's proposed Additive Manufacturing Technology degree but is more closely aligned with machining. The student population for these programs is generally associated with their respective counties. The proposed program at HCC will focus on Howard County high school graduates and other residents who want to prepare for additive manufacturing careers.

   In addition to community colleges, the following Maryland universities have graduate programs that deal with additive manufacturing:

   - University of Maryland College Park - Graduate degree and certificate in Additive Manufacturing
   - University of Maryland Baltimore County - Integrated Product Development and Manufacturing - Post-baccalaureate certificate

   University of Maryland Eastern Shore offers a Bachelor of Science Degree in Electrical/Electronics Engineering Technology that includes a 3-D printing component. This program may be a pathway for graduates of HCC's proposed degree.

   Within the realm of non-credit, Maryland's 16 community colleges' manufacturing-related programs focus primarily on welding, which is just one aspect of the broad manufacturing sector, and do not prepare workers for the advanced manufacturing of today and tomorrow. As a result, in 2020, Maryland's community colleges only produced 160 manufacturing non-credit certificate completers (JFI Analysis; Maryland Association of Community Colleges, 2019).

   There is also relatively small participation in manufacturing apprenticeship programs relative to occupation need in Maryland, with only 27 apprenticeships focused on manufacturing (JFI Analysis). Maryland's workforce and talent pipeline is not presently capable of meeting the high demand for skilled manufacturing workers. This program will enable Maryland to expand its capacity to prepare highly skilled workers for high-wage jobs.

E. Relevance to High-demand Programs at Historically Black Institutions (HBIs)

1. Discuss the program's potential impact on the implementation or maintenance of high-demand programs at HBIs.

The proposed program will not impact the implementation or maintenance of programs at HBIs. This program will complement the University of Maryland Eastern Shore's bachelor of science degree in Electrical/Electronics Engineering Technology that includes a 3-D printing component and could be a feeder into that bachelor's degree program. No other Maryland HBIs offer similar programs.

F. Relevance to the identity of Historically Black Institutions (HBIs)

1. Discuss the program's potential impact on the uniqueness and institutional identities and missions of HBIs.

The proposed program will not impact the uniqueness and institutional identities and missions of HBIs; as stated above, the only Maryland HBI currently offering a related program is the University of Maryland Eastern Shore, which offers a bachelor's degree, and which this proposed program could feed into.

G. Adequacy of Curriculum Design, Program Modality, and Related Learning Outcomes (as outlined in COMAR 13B.02.03.10):

1. Describe how the proposed program was established, and also describe the faculty who will oversee the program.

This program is based upon HCC's existing lower division certificate and was also informed by the report of the Maryland Department of Commerce Maryland Manufacturing in the Digital Age Workgroup and the Maryland Manufacturing advisory board. Additionally, research completed and programs developed by Harford Community College's Regional Additive Manufacturing Pathways National Science Foundation project informed the development of this program. This project employed additive manufacturing subject matter experts (SMEs) from local employers, including Survice Engineering and Aberdeen Proving Ground, to work side-by-side with faculty in developing each course in Harford's Engineering Technology A.A.S. Additive Manufacturing concentration and lower division certificate. The SMEs ensured that curriculum was based upon manufacturing workforce demands. Additionally, the proposed program maps to the SME Body of Knowledge and prepares students to pass SME's Additive Manufacturing Fundamentals or Technician Certification Exam.

The program will be overseen by Ghazanfar Bozai, Chair of Engineering & Technology and Associate Professor, Construction Management.

Additionally, a program developer for HCC was appointed by the Governor and currently serves on the Maryland Manufacturing Advisory Board (MMAB) and previously served on the Transforming Manufacturing in a Digital Economy Workgroup (Making It in Maryland).

Information garnered by the MMAB and the Workgroup was used to align program competencies to manufacturing workforce needs.

Also, in support of this program, HCC will be hiring one additional assistant professor with similar qualifications to those above.

2. **Describe educational objectives and learning outcomes appropriate to the rigor, breadth, and (modality) of the program.**

Upon completion of this program, students will be able to:

1. Describe the theory of operation and identify hardware components in a variety of 3D printing equipment.

2. Operate, and perform basic troubleshooting on, 3D printing and scanning equipment.

3. Apply software tools and design principles to create, modify, and process CAD models suitable for additive manufacturing.

4. Explain the role of additive technologies in commercial activities, from product development to production.

5. Plan additive manufacturing projects, including considerations of part requirements, material properties, cost, process selection, and post-processing.

6. Apply communication skills needed to work collaboratively within a technical organization.

7. Understand and apply ethical reasoning in the context of the manufacturing industry.

3. **Explain how the institution will:**

a. **provide for assessment of student achievement of learning outcomes in the program**

Program and course reviews are completed according to the schedule provided by HCC in collaboration with faculty members, department chairs, academic deans, the eLearning department, and the office of learning outcomes assessment (LOA).

b. **document student achievement of learning outcomes in the program**

Artifacts for the assessment of outcomes are collected and shared through HCC's learning management system, Canvas. Course and program reviews are completed with support from the LOA office. Once an assessment is completed, an action plan will address findings as part of the outcomes assessment process.

4. **Provide a list of courses with title, semester credit hours and course descriptions, along with a description of program requirements.**

Additive Manufacturing Technology A.A.S. Degree (Career)

The Additive Manufacturing Technology degree is designed to prepare students for career entry or career advancement in additive manufacturing technology. Manufacturing is becoming increasingly technology dependent, requiring highly skilled workers familiar with digital tools. Many of the recent advances in manufacturing involve additive methods, as opposed to traditional subtractive methods. The program emphasizes foundational skills in additive manufacturing technology, computer-aided design, technical physical science, and entrepreneurship, and incorporates practical, collaborative learning experiences. Students will develop critical thinking, problem solving, and communication skills, while applying creativity and design tools to the use of additive manufacturing. Students who complete the degree will have access to employment in a variety of technology sectors including engineering, manufacturing, design, and equipment sales.

Suggested Summer Term		
Course Number	Title	Minimum Credits
PHYS 101	Technical Physical Science	4

Suggested Semester 1		
Course Number	Title	Minimum Credits
ENGL 121	College Composition	3
CADD 101	Introduction to Computer-Aided Drafting and Design	3
ENGT 101	Introduction to 3D Printing	3
MATH 141	College Algebra (or higher course)	4

Suggested Semester 2

Course Number	Title	Minimum Credits
CADD 103	Intermediate CADD	3
CHEM 103	Fundamentals of General Chemistry	4
ENGT 102	Engineering Materials for Rapid Prototyping	3
Gen Ed Core	Information Literacy Core	3

Suggested Summer Term

Course Number	Title	Minimum Credits
ENGT 201	3D Scanning and Printing	3

Suggested Semester 3

Course Number	Title	Minimum Credits
BMGT 241	Project Management	3
Gen Ed Core	Oral Communication Core	3
ANTH 104 OR ANTH 110	Introduction to Physical Anthropology and Archaeology OR Global Archaeology	3

ENGT 203	Print Troubleshooting and Optimization	3

Suggested Semester 4		
Course Number	**Title**	**Minimum Credits**
ENGT 202	3D Printing Design and Fabrication	4
ENGT 210	Quality Control Metrology for Additive Manufacturing	3
ENGT 150	Professional Skills for Trades and Manufacturing	1
HUMN 115	Entrepreneurship and Creativity	3
Elective	General Elective	4

TOTAL CREDIT HOURS: 60

Course Descriptions

BMGT 241 Project Management - 3 credits
This course is designed to increase the knowledge and skills of students who are managing or working towards managing projects in a way that will be coherent, thoughtful, timely, and in alignment with an organization's objectives. It will teach a wide array of principles and components that include project initiation, planning, executing, performance, monitoring and controlling, cost management, and terminology, among others. It will also provide practical knowledge on managing the project scope, schedule, and resources. Concepts are applied through team projects and tutorials using project management software. Additionally, this course will fulfill the training requirement for the PMI Certified Associate in Project Management (CAPM®) certification for those who elect to become certified.

CADD 101 Introduction to Computer-Aided Drafting and Design - 3 credits
This course introduces students to the Computer-Aided Design system. Students will learn how to adapt basic technical drafting and three-dimensional design techniques to

computer-generated drawings of the various design disciplines. Students will receive hands-on training and will develop the techniques that are essential in today's job market.

CADD 103 Intermediate Computer-Aided Drafting and Design - 3 credits
Students will learn how to adapt the principles of descriptive geometry when applied to 'real-world' applications, involving using the Cadd system to create Isometric and 3-D drawings. Students will have the opportunity to work on drawings used in various technical fields, such as mechanical engineering, architecture, and electronics. Students will learn current production techniques to automate the drawing process and how to develop intelligent technical documents.

CHEM 103 Fundamentals of General Chemistry - 4 credits
Course topics include: matter and measurement, atomic structure, chemical bonding, molecular structure, chemical reactions, stoichiometry, gasses, solutions, thermochemistry, kinetics, equilibrium, and nuclear reactions. The course provides an introduction to inorganic chemistry and general chemical principles for students in the allied health fields. Laboratory experiments require students to collect, analyze, and interpret data to identify unknown chemical substances or properties.

ENGL 121 College Composition - 3 credits
This course teaches students to develop and apply rhetorical knowledge for creating effective text-based communication. Students develop critical inquiry and multi-stage writing processes in order to contribute productively, effectively, and ethically to the social and collaborative practices of academic and other discourses. Coursework guides students toward understanding themselves as authors of texts that hold meaning, and students successfully completing the course will be able to compose texts of at least 1,000 words, demonstrating knowledge of conventions and manuscript presentation relevant to varying rhetorical situations. ENGL 121 transfers as university-parallel freshman English. Students must earn a final grade of C or better to pass this course.

ENGT 101 Introduction to 3D Printing - 3 credits
This course is an introduction to additive manufacturing (the industry term for 3D printing) from an engineering technology perspective. This is the first course in the additive manufacturing certificate program, providing a broad framework of knowledge for further studies. Students will study the history, processes, equipment, industrial and commercial uses, and current trends in additive manufacturing technology.

ENGT 102 Engineering Materials for Rapid Prototyping - 3 credits
This course provides a foundational understanding of engineered materials common in additive manufacturing processes. Students will study the structure, behavior, and properties of plastics, ceramics, metals, and composites, along with the impact of process parameters of material properties. An emphasis will be placed on material selection in the design process for 3D printed components. Material testing will be performed for some physical properties. Prerequisite: PHYS 101

ENGT 201 3D Scanning and Printing - 3 credits
In this course, students will learn the basic principles of 3D scanning and printing. This course will introduce students to the tools and techniques required to use 3D scanners for inspection, reverse engineering, and other applications. Students will also gain hands-on experience operating scanners, processing scan data with software tools, and converting

scan data to printable 3D models. Students will explore the entire cycle from an original artifact to a scan-based model to a reproduction part. Prerequisite: CADD 103 and ENGT 101

ENGT 202 3D Printing Design and Fabrication - 4 credits
In this course, students will learn the basic principles of 3D printing and fabrication. Students will be introduced to the design practices, tools, and techniques required to produce production-quality parts using multiple types of 3D printers. Students will also learn real-world fabrication methods and processes using industry-specific software. Prerequisite: CADD 103 and ENGT 102

ENGT 210 Quality Control Metrology for Additive Manufacturing - 3 credits
This course is designed to explain the challenges encountered when measuring additive manufactured parts. Methods and technologies for measuring, evaluating, and validating additive manufactured parts are explored to convey best measurement practices. Prerequisite: ENGT 201

ENGT 203 Print Troubleshooting and Optimization - 3 credits
This course will explore the root causes and corrective measures for common printing problems, including part defects and machine faults. Various techniques and software applications will be used to modify part geometry and print settings to remedy printing issues. Students will learn troubleshooting techniques for a variety of printing processes and materials. Prerequisite: ENGT 101.

ENGT 150 Professional Skills for Trades and Manufacturing - 1 credit
This course is designed to develop or refresh knowledge and skills required for technical positions in advanced manufacturing and technical trades fields and will focus upon professionalism, critical thinking, communication, and workplace success.

HUMN 115 Entrepreneurship and Creativity - 3 credits
This course is designed to introduce students to the concept of sustainable entrepreneurship, a manageable process that can be applied across careers and work settings. It focuses on building entrepreneurial attitudes and behaviors that will lead to creative solutions within community and organizational environments. Course topics include the history of entrepreneurship, the role of entrepreneurs and intrapreneurs in the 21st century global economy, and the identification of entrepreneurial opportunities. The elements of creative problem-solving, the development of a business concept/model, the examination of feasibility studies, and the social/moral/ethical implications of entrepreneurship are incorporated. This course is directed toward forging views of entrepreneurship and intrapreneurship as they operate in today's world. Credit will only be granted for one of the following: ENTR 100 or HUMN 115.

MATH 141 College Algebra - 4 credits
Topics include functions, mathematics of finance, matrices, and linear programming. Emphasis will be placed on solving problems algebraically and modeling applications involving business, financial literacy, and global awareness. Appropriate technological tools used in business and the social sciences will also be introduced. All sections require the use of the interactive computer program that comes with the software code and a graphing calculator (TI-84 recommended; TI-89 not permitted).

PHYS 101 Technical Physical Science - 4 credits
This physical science course covers basic introductory physics and chemistry and is designed for Allied Health program majors (RadTech and Cardiovascular), technology majors (BMET, Computer Support, and Electronics) and other non-science majors. It consists of basic scientific mathematics and an integrated sequence of physical science and chemical principles. This course will enable students to become aware of, to identify, and to evaluate situations and/or problems in contemporary physical science which include science measurement and dimensional plus statistical analysis techniques. Special emphasis is placed upon learning physics principles and solving mathematical problems in density/specific gravity, gas laws, solutions, pressure, fluids, basic electricity, magnetism, sound and light waves, and the atomic structure of matter. The laboratory program will allow the student to develop an understanding of the fundamental principles of the above-mentioned areas, including problem solving, and their application to physical phenomenon observed.

5. **Discuss how general education requirements will be met, if applicable.**

   Students at HCC meet general education requirements by completing a minimum of 18 credits of approved courses that meet the Code of Maryland (COMAR) regulations, and which include the following goals:

   - Critical and Creative Thinking
   - Global Competency
   - Information Literacy
   - Technological Literacy
   - Scientific and Quantitative Reasoning
   - Written Communication
   - Oral and Expressive Communication

   Students will be required to complete coursework determined by faculty and approved by the general education subcommittee. Once assessment is complete, an action plan will address findings as part of the ongoing general education assessment process.

6. **Identify any specialized accreditation or graduate certification requirements for this program and its students.**

   N/A

7. **If contracting with another institution or non-collegiate organization, provide a copy of the written contract.**

   N/A

8. **Provide assurance and any appropriate evidence that the proposed program will provide students with clear, complete, and timely information on the curriculum, course and degree requirements, nature of faculty/student interaction, assumptions about technology competence and skills, technical equipment**

requirements, learning management system, availability of academic support services and financial aid resources, and costs and payment policies.

HCC will provide students with timely and accurate information on all curriculum requirements, course offering methodology, Canvas, academic support services, financial aid services, and policies regarding costs and payment by making the information easily accessible to students on HCC's website, in the college catalog, schedules of classes, and admissions and orientation materials.

9. **Provide assurance and any appropriate evidence that advertising, recruiting, and admissions materials will clearly and accurately represent the proposed program and the services available.**

All advertising, recruiting, and admissions materials will be clear and accurate in the representation of the proposed program and services available to students.

H. Adequacy of Articulation

1. **If applicable, discuss how the program supports articulation with programs at partner institutions. Provide all relevant articulation agreements.**

N/A

I. Adequacy of Faculty Resources (as outlined in <u>COMAR 13B.02.03.11</u>).

1. **Provide a brief narrative demonstrating the quality of program faculty. Include a summary list of faculty with appointment type, terminal degree title and field, academic title/rank, status (full-time, part-time, adjunct) and the course(s) each faculty member will teach (in this program).**

Name & Degree	Title	Status	Courses/Areas Taught
Edelen, Mark, MS in Mechanical Engineering	Professor and Division Chair	Full-time	ENGT 101 ENGT 102 ENGT 201 ENGT 202 ENGT 203
Hinton, David, BS in Business Information Technology	Professor	Full-time	ENGT 201 CADD 101 CADD 103

Additional coursework will be taught by adjunct faculty experienced in teaching general education and technical courses within the program.

2. **Demonstrate how the institution will provide ongoing pedagogy training for faculty in evidenced-based best practices, including training in:**

   a. **Pedagogy that meets the needs of the students**
   b. **The learning management system**
   c. **Evidence-based best practices for distance education, if distance education is offered.**

   HCC provides continuous teaching improvement and ongoing training for full- and part-time faculty year-round in distance education, the learning management system (Canvas), and other pedagogical-related topics, with concentrated training available during professional development periods in May, August, and January, which always include sessions on learner-specific needs and universal design.

J. **Adequacy of Library Resources** (as outlined in <u>COMAR 13B.02.03.12</u>).

   1. **Describe the library resources available and/or the measures to be taken to ensure resources are adequate to support the proposed program. If the program is to be implemented within existing institutional resources, include a supportive statement by the President for library resources to meet the program's needs.**

   The James Clark, Jr. Library offers a wide array of print and online resources that are adequate for the proposed program. From the library's website, individuals can search the online catalog for approximately 68,000 items, including books, e-books, and audiovisual titles. Library resources may be used or borrowed by current HCC students, faculty, and staff using their HCC ID card. The library also provides access to e-journals through online database subscriptions. Off-campus access to databases, e-journals, e-books, and online course reserves is available to the college community via a current HCC login and password.

   Research assistance is available at the library service desk, by appointment, and via email. Classes and online learning objects for information literacy instruction are regularly offered. Open seven days a week in the fall and spring semesters, the library is outfitted with group study rooms, quiet zones, silent areas, and seating areas for comfortable reading. Computers are available for research and writing and there is wireless connection and power outlets for mobile devices.

   Program faculty may recommend materials for the library collection. First priority will be given to those materials that support the instructional program. Orders for previewing of high-cost video and multimedia items may be arranged through the library. Specialized materials not available in the library and not appropriate for purchase for the College's collection may be requested by faculty through interlibrary loan.

   HCC's president affirms that the college's existing library resources will meet the needs of the proposed program.

K. **Adequacy of Physical Facilities, Infrastructure and Instructional Equipment** (as outlined in <u>COMAR 13B.02.03.13</u>)

1. **Provide an assurance that physical facilities, infrastructure and instruction equipment are adequate to initiate the program, particularly as related to spaces for classrooms, staff and faculty offices, and laboratories for studies in the technologies and sciences. If the program is to be implemented within existing institutional resources, include a supportive statement by the President for adequate equipment and facilities to meet the program's needs.**

The facilities for the program are located in the Science, Engineering, and Technology (SET) building at HCC. These facilities include an additive manufacturing laboratory. The laboratory houses the following equipment:

Additive Manufacturing Program - Printing & Scanning Capabilities, 2023

Capability	HCC Printers (partial list)							
	Stratasys J55	Stratasys F370CR	Stratasys F170	Formlabs Form 3L	Formlabs Form 2&3	Sinterit Lisa Pro	Anycubic Kobra Max	Markforged X7
Multi-material[1]	■							
Full-color	■							
Transparent	■			■	■			
Biocompatible & Dental				■				
0.001" Resolution	■							
Flexible materials	■	■	■	■	■	■	■	■
Support-free						■		
Soluble supports	■	■						
Carbon-fiber reinforcement[2]		■						■

[1] A single part/component composed of multiple materials (e.g. with different durometers).
[2] Includes continuous fiber (Markforged X7) and chopped fiber (Stratasys F370CR).

HCC is also planning a new trades building. This new building will enable HCC to grow and adopt more printing technologies (i.e. metal) in the new building.

Additionally, computer labs are used to support computer aided design of the items to be printed.

The college president affirms that the existing resources, plus planned resources already being procured including the trades center, will be adequate to meet the needs of this AAS degree.

2. **Provide assurance and any appropriate evidence that the institution will ensure students enrolled in and faculty teaching in distance education will have adequate access to:**

   a. **An institutional electronic mailing system, and**

All students who register for a credit course at HCC receive an HCC student email account.

    b. **A learning management system that provides the necessary technological support for distance education**

HCC's office of student computer support (SCS) provides Canvas and Google Apps training and support for HCC students at locations on campus, in classrooms, and online. Technology workshops and "Ask an Expert" sessions are held at various hours and locations each semester. Students can access Canvas through HCC's website. Canvas is the learning management system through which course information and content is provided to students in online and hybrid courses, and faculty can communicate supplemental course material to students in face-to-face classes.

L. Adequacy of Financial Resources with Documentation (as outlined in COMAR 13B.02.03.14)

    1. Complete Table 1: Resources and Narrative Rationale. **Provide finance data for the first five years of program implementation. Enter figures into each cell and provide a total for each year. Also provide a narrative rationale for each resource category. If resources have been or will be reallocated to support the proposed program, briefly discuss the sources of those funds.**

The calculations below represent estimated tuition, consolidated fees, and course fees, based on the estimated number of students in the program each year. No resources will be reallocated to this program.

TABLE 1: PROGRAM RESOURCES					
Resource Categories	Year 1	Year 2	Year 3	Year 4	Year 5
1. Reallocated Funds	$0	$0	$0	$0	$0
2. Tuition/Fee Revenue (c+g below)	$66,531.60	$82,492	$101,711.40	$118,323	$119,688
a. Number of F/T students	8	10	12	15	15
b. Annual Tuition/Fee Rate	$5,110.20	$5,171.20	$5,232.20	$5,293.20	$5,354.20
c. Total F/T Revenue (a x b)	$40,881.60	$51,712.00	$62,786.40	$79,398	$80,313
d. Number of P/T students	10	12	15	15	15
e. Credit Hour Rate	$171	$171	$173	$173	$175
f. Annual Credit Hour Rate	15	15	15	15	15

g. Total P/T Revenue (d x e x f)	$25,650	$30,780	$38,925	$38,925	$39,375
3. Grants, Contract & Other External Sources	$0	$0	$0	$0	$0
4. Other Sources	$0	$0	$0	$0	$0
TOTAL (Add 1-4)	$66,531.60	$82,492	$101,711.40	$118,323	$146,459

All tuition and fees are based on in-county tuition rates.

2. Complete Table 2: Program Expenditures and Narrative Rationale. Provide finance data for the first five years of program implementation. Enter figures into each cell and provide a total for each year. Also provide a narrative rationale for each expenditure category.

TABLE 2: PROGRAM EXPENDITURES					
Expenditure Categories	Year 1	Year 2	Year 3	Year 4	Year 5
1. Faculty (b + c below)	$98,051	$98,051	$100,993	$100,993	$100,993
a. Number of FTE	1	1	1	1	1
b. Total Salary	$75,611	$75,611	$77,880	$77,880	$77,880
c. Total Benefits	$22,440	$22,440	$23,113	$23,113	$23,113
2. Admin. Staff (b + c below)	$0	$0	$0	$0	$0
a. Number of FTE	0	0	0	0	0
b. Total Salary	$0	$0	$0	$0	$0
c. Total Benefits	$0	$0	$0	$0	$0
3. Support Staff (b + c below)	$0	$0	$0	$0	$0
a. Number of FTE	0	0	0	0	0
b. Total Salary	$0	$0	$0	$0	$0
c. Total Benefits	$0	$0	$0	$0	$0
4. Technical Support and Equipment	$125,000[1]	$7,500	$7,500	$7,500	$7,500
5. Library	$0	$0	$0	$0	$0
6. New or Renovated Space	$0	$0	$0	$0	$0
7. Other Expenses	$1,000	$1,000	$1,000	$1,000	$1,000
TOTAL (Add 1-7)	$224,051	$106,551	$109,493	$109,493	$109,493

[1] Note that this expenditure for new equipment is expected to be part of the FF&E funds associated with the new trades center building.

M. Adequacy of Provisions for Evaluation of Program (as outlined in <u>COMAR 13B.02.03.15</u>).

1. Discuss procedures for evaluating courses, faculty and student learning outcomes.

The proposed program will be part of the established institutional assessment process at HCC. Courses are assessed on an ongoing basis. Faculty are evaluated on an annual basis, as part of HCC's routine process.

2. Explain how the institution will evaluate the proposed program's educational effectiveness, including assessments of student learning outcomes, student retention, student and faculty satisfaction, and cost-effectiveness.

Programs are assessed as a whole every five years. Program assessment includes student learning outcomes, retention, and student satisfaction. HCC uses the IDEA survey to monitor student satisfaction. Faculty satisfaction is reviewed annually as part of the faculty evaluation process. Cost effectiveness is reviewed each year as part of the budget development process.

N. Consistency with the State's Minority Student Achievement Goals (as outlined in <u>COMAR 13B.02.03.05</u>).

1. Discuss how the proposed program addresses minority student access & success, and the institution's cultural diversity goals and initiatives.

HCC values diversity and recognizes the critical role of an educational institution in preparing its students, faculty, and staff to become contributing members of the global community. HCC's Diversity, Equity, and Inclusion Committee promotes conversation, exchange, and an increased awareness of diversity issues affecting the college community. HCC acknowledges that diversity is recognizing, appreciating, respecting, listening to, and learning from the unique talents and contributions of all people.

Faculty and staff of HCC are committed to the success of each student. HCC values and has clear policies on diversity, which are followed by all employees. Employees are required to complete online training modules focused on FERPA rights and responsibilities, harassment awareness and avoidance, safety, and emergency operations, and the College Vision, Mission, Values, Beliefs, and Strategic Initiatives. Refresher training models are required at intervals determined by HCC's president's team.

HCC recognizes the importance of addressing the issue of minority student achievement, as evidenced by our Silas Craft Collegians (SCC) program, Ambiciones program, and Howard P.R.I.D.E. program. The SCC program focuses on recent high school graduates whose academic achievement does not reflect their true potential. The program attempts

to close this gap by maximizing academic achievement, retention, graduation, and transfer. The Ambiciones program builds community among Hispanic/Latino students by providing networking opportunities, educational and recreational activities, and workshops with other Hispanic/Latino students and campus organizations. In addition, students can receive specialized guidance with campus services such as advising and financial aid. Howard P.R.I.D.E. encourages the continued academic, professional, and personal development of black and minority male students via tutoring, mentoring, service learning, leadership seminars, and individual academic advising and career plans.

O. Relationship to Low Productivity Programs Identified by the Commission:

1. If the proposed program is directly related to an identified low productivity program, discuss how the fiscal resources (including faculty, administration, library resources and general operating expenses) may be redistributed to this program.

The proposed program is not related to an identified low productivity program.

P. Adequacy of Distance Education Programs (as outlined in <u>COMAR 13B.02.03.22</u>)

1. Provide affirmation and any appropriate evidence that the institution is eligible to provide Distance Education.

This program is not being proposed as a distance education program.

2. Provide assurance and any appropriate evidence that the institution complies with the C-RAC guidelines, particularly as it relates to the proposed program.

Not applicable for this program.