



September 24, 2018

James D. Fielder, Jr., Ph.D.  
Secretary of Higher Education  
Maryland Higher Education Commission  
6 North Liberty Street  
Baltimore, MD 21201

Dear Dr. Fielder,

The purpose of this letter is to submit three new academic program proposals for an Associate of Applied Science degree in Digital Design and Fabrication, a Certificate in Digital Design and Fabrication, and a Certificate in SOLIDWORKS at Carroll Community College. These proposed degree and certificate programs will be the only programs in the State of Maryland with a unique focus on design and conceptual problem solving instead of manufacturing and we are therefore seeking Statewide Program Designations.

The complete proposals accompany this cover letter. Thank you in advance for the Commission's consideration of these new programs.

If there are questions regarding the program or materials, please direct them to Dr. Melody Moore, Associate Vice President for Program Development and Partnerships, [memoore@carrrollcc.edu](mailto:memoore@carrrollcc.edu) or 410-386-8412.

Sincerely,

A handwritten signature in blue ink that reads 'Rosalie Mince'.

Rosalie Mince, Ph.D.  
Vice President of Academic and Student Affairs

cc: Dr. Melody Moore  
Mr. Scott Gore

Office Use Only: PP#



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

Institution Submitting Proposal	Carroll Community College
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Each action below requires a separate proposal and cover sheet.

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|--|--|
| <input checked="" type="radio"/> New Academic Program<br><input type="radio"/> New Area of Concentration<br><input type="radio"/> New Degree Level Approval<br><input type="radio"/> New Stand-Alone Certificate<br><input type="radio"/> Off Campus Program | <input type="radio"/> Substantial Change to a Degree Program<br><input type="radio"/> Substantial Change to an Area of Concentration<br><input type="radio"/> Substantial Change to a Certificate Program<br><input type="radio"/> Cooperative Degree Program<br><input type="radio"/> Offer Program at Regional Higher Education Center |
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Payment Submitted: <input checked="" type="radio"/> Yes <input type="radio"/> No	Payment Type: <input type="radio"/> R*STARS <input type="radio"/> Check	Date Submitted: ..
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Department Proposing Program	Applied Theatre and Arts		
Degree Level and Degree Type	Associate of Applied Science (A.A.S.)		
Title of Proposed Program	Digital Design and Fabrication		
Total Number of Credits	60		
Suggested Codes	HEGIS: 5399	CIP:	
Program Modality	<input checked="" type="radio"/> On-campus <input type="radio"/> Distance Education (fully online) <input type="radio"/> Both		
Program Resources	<input checked="" type="radio"/> Using Existing Resources <input type="radio"/> Requiring New Resources		
Projected Implementation Date	<input checked="" type="radio"/> Fall <input type="radio"/> Spring <input type="radio"/> Summer             Year: 2019		
Provide Link to Most Recent Academic Catalog	<a href="https://www.carrollcc.edu/uploadedFiles/CarrollCCedu/Content/PDF/Credit_Publications/Catalog/2018-2019%20Catalog%20for%20Web.pdf">https://www.carrollcc.edu/uploadedFiles/CarrollCCedu/Content/PDF/Credit_Publications/Catalog/2018-2019%20Catalog%20for%20Web.pdf</a>		
Preferred Contact for this Proposal	Name: Melody L. Moore		
	Title: Associate Vice President for Program Development and Partnerships		
	Phone: (410) 386-8412		
	Email: memoore@carrollcc.edu		
President/Chief Executive	Type Name: James Ball		
	Signature:		Date: 09/24/2018
	Date of Approval/Endorsement by Governing Board:		09/19/2018

Revised 6/13/18

## Digital Design and Fabrication A.A.S. Carroll Community College

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### A. Centrality to institutional mission statement 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.
2. Explain how the proposed program supports the institution's strategic goals and provide evidence that affirms it is 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.
4. Provide a description of the institution's commitment to:
  - a. ongoing administrative, financial, and technical support of the proposed program
  - b. continuation of the program for a period of time sufficient to allow enrolled students to complete the program.

*Description.* Digital Design and Fabrication (DFAB) is a design and production process that combines 3D modeling or computer-aided design (CAD) with additive manufacturing (AM), also known as 3D printing. With applications in a myriad of industries from manufacturing to architecture to fashion, Digital Design and Fabrication allows designers to create physical models in order to test the success of a design and prepares students to conceptualize and design for 21st century manufacturing.

Carroll Community College (CCC) proposes a 60 credit Associate of Applied Science (A.A.S.) degree in Digital Design and Fabrication, along with two related certificates, one in Digital Design and Fabrication (41 credits) and the other in SOLIDWORKS (20 Credits). Separate proposals will be sent for each of these programs. In response to rapid changes in manufacturing, consumer-driven customizable design, and entrepreneurship theories, this program will integrate design-object literacy, problem solving strategies, entrepreneurship, and advanced manufacturing technology. Students will learn how to use contemporary manufacturing tools and thinking in "traditional" applications like transitioning manufacturing skillsets to advanced manufacturing processes. Digital Design and Fabrication students also will discover how to apply this technology in a diverse range of disciplines. Thus, this program is unique in that students will leverage contemporary fabrication tools, coupled with design-thinking and problem solving, not only to solve manufacturing problems, but to engage broader issues as well.

*Relation to Strategic Goals.* The Digital Design and Fabrication program aligns with two of CCC's Strategic Goals.<sup>1</sup> It supports Goal 1, "to provide associate degree programs, career and credentialing preparation, job skill enhancement, continuing professional education, and career resources and support to strengthen the regional workforce.," in that graduates of the program will be highly trained specialists prepared to enter the regional workforce and compete against those who have earned bachelors degrees in similar fields. This program is a response to the rapid changes in manufacturing, consumer-driven customizable design thinking, product design and development, and entrepreneurship theories.

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<sup>1</sup>Carroll Community College. (2018). Strategic plan for FY2019. Retrieved from [https://www.carrollcc.edu/uploadedFiles/CarrollCCedu/Content/Html/Facts\\_and\\_Figures/FY2019%20Strategic%20Initiatives%20FINAL.pdf](https://www.carrollcc.edu/uploadedFiles/CarrollCCedu/Content/Html/Facts_and_Figures/FY2019%20Strategic%20Initiatives%20FINAL.pdf)

The program also supports Goal 3, “to deliver training and essential services to businesses and entrepreneurs, and create and sustain strategic community partnerships to support business and economic development.” This program is designed to inspire entrepreneurial thinking, as well as to ignite the entrepreneurial spirit. Entrepreneurial thinking will be taught specifically in one of the program’s required courses, Introduction to Entrepreneurship. However, this concept will be reinforced throughout the program. Technology, coupled with design thinking and CAD skills, is likely to motivate new entrepreneurs and at-home innovators to print models of products that they intend to manufacture. As 3D printers continue to become more affordable and advanced, the number of small businesses that begin as “household manufacturers” is likely to skyrocket.

*Funding.* CCC expects that, given the need for these job skills by the state, tuition revenue will be sufficient to fund the program adequately for the first five years of the program.

*Institutional Commitment.* This program will be housed in the Division of Applied & Theater Arts and one of its full-time instructors, Scott Gore, is already in residence. Through the Division, administrative and financial support for the Digital Design and Fabrication program already is, and will continue to be, provided. Technical support will be provided by the College’s Network and Technology Services Department. If, in the future, a decision is made to discontinue the A.A.S. in Digital Design and Fabrication degree program, a comprehensive teach-out plan will be developed and executed to ensure that all students in the program will have the opportunity to obtain all courses needed to complete 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
2. Provide evidence that the perceived need is consistent with the *Maryland State Plan for Postsecondary Education*.

*Demand.* Maryland is primed to be a hub for 3D printing and additive manufacturing in the mid-Atlantic region, drawing on and expanding the region’s significant core competencies and assets. A recent white paper by the Economic Alliance of Greater Baltimore highlights the potential for the adopting of AM and 3DP in the region: “Greater Baltimore claims a number of distinctive qualities that creates a fruitful region, poised for a position of leadership in the growth of 3D printing. The region produces some of the most innovative minds in the country, and when combined with Washington, DC, the corridor is arguably one of the best-educated regions in the country. The Baltimore Metropolitan Statistical Area offers strengths and opportunities to innovators in, or seeking to enter, the 3D printing industry. No region is better positioned for improving, refining, and creating new methods and uses for 3D printing.”<sup>2</sup>

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<sup>2</sup> [http://www.greaterbaltimore.org/portals/\\_default/publications/3dprint.pdf](http://www.greaterbaltimore.org/portals/_default/publications/3dprint.pdf)

The entire industry needs to address the current lack of training and create an adaptive workforce at all points on the spectrum: at the grass-roots level, locally with users with proven track records, drawing on both industry and education to institute changes in K-16, vocational training and apprenticeship programs, and retraining programs. Wider adoption of the technology surrounding digital fabrication is inevitable; we need to ensure that the workforce is prepared to respond. The current value of the additive manufacturing technology and service industry is \$1.7 billion, with an overall compound annual growth rate of 29.4%. At current levels of growth, the industry is forecasted to be worth \$8.4 billion by 2020—assuming organic growth based only on today’s technologies. Additive manufacturing sector analysts accept that penetration is currently 8% of the potential market opportunity. With technical development and far-reaching adoption (>8% penetration), the industry could be worth \$105 Billion by 2028.<sup>3</sup>

To quote the Econolyst, “Studies have shown that students who are educated in AM processes are among the first to bring the advanced hands-on technologies to their employers.”<sup>4</sup> The Digital Design & Fabrication program aims to train students to become professionals in the industries that are aware of these changes and are prepared to specialize in, or begin to implement, additive manufacturing technologies into their business models. We are rapidly moving into an environment where manufacturing is based on the digitization of the development and industrialization cycle of the products we consume. The digitalization of the matter will lead all the productive processes, being this an essential aspect of the new paradigm of the Industry 4.0. The advantages of Additive Manufacturing involve a change in the rules of the game by allowing the direct passage of bits to atoms, both in terms of addressing the design of products and processes and business model.

*Consistency with the Maryland State Plan for Postsecondary Education.* This program meets a critical and compelling regional or statewide need as identified in the *Maryland State Plan for Postsecondary Education*, Section 3 on Innovation, Strategy 8: Develop new partnerships between colleges and businesses to support workforce development and improve workforce readiness.<sup>5</sup>

The Maryland State Plan states, Postsecondary institutions are vital to helping Maryland meet changing workforce education and training needs. An educated workforce that can adapt to changes in the global market is a vital resource in creating and attracting new businesses and in supporting a healthy, knowledge-based economy. In addition, scholarly research and development must continue to ensure that innovations are brought to market to generate greater economic growth. To remain nationally and globally competitive, Maryland’s postsecondary institutions must continue to innovate and collaborate with private industry, nonprofits, and each other so that 1) graduates’ education and training align with business and workforce prerequisites and emerging needs, and 2) intellectual properties developed through innovation and invention at the State’s university research facilities are commercialized. Strategy 8 of *Maryland State Plan* outlines key considerations for developing partnerships addressing the State’s education and training needs as well as promoting the commercialization of research.<sup>6</sup>

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<sup>3</sup> Econolyst, “Building Small Business Around 3D Printing”  
<http://www.econolyst.co.uk/resources/documents/files/Presentation%20-%20Oct%202012%20-%203D%20printshow%20London%20UK%20-%20Building%20a%20small%20business%20around%203D%20printing.pdf>

<sup>4</sup> *ibid*

<sup>5</sup> <https://mhcc.maryland.gov/About/Pages/2017StatePlanforPostsecondaryEducation.aspx>

<sup>6</sup> <https://mhcc.maryland.gov/About/Pages/2017StatePlanforPostsecondaryEducation.aspx>

In addition, as noted in the *State Plan*, “The contemporary workplace is changing rapidly, and long-held beliefs about academic majors, career paths, and the connections between them have been transformed. More than ever, employers seek employees who have the flexibility to understand changing conditions and solve emerging problems. Technical knowledge is not enough.”<sup>7</sup> The Digital Design and Fabrication program supports this ideology through an emphasis on design thinking and creative problem solving. This program goes beyond how the technology of Additive Manufacturing is used in advanced manufacturing; it explores how to leverage this technology to solve various industry and human-based problems.

Also, as noted elsewhere in the *State Plan*, “The postsecondary community in Maryland should develop partnerships with businesses and other organizations to open multi-dimensional communication channels. The postsecondary community should embrace these opportunities to create and nurture a relationship with businesses and industries.”<sup>8</sup> This program addresses this through its in-demand skills which are ripe for research partnerships and dialogue between the college and local businesses. This partnership between the college and local employers will improve workforce development and readiness by providing the institution with critical information about skills and knowledge required for employment and by opening the door for students to seek and secure employment. In addition, the students from this program will begin working closely with the Carroll Technology Council through the creation of a Carroll Community College Technology Council, which will be run by students with guidance from the Digital Design and Fabrication Program Director and the Carroll Technology Council’s Board of Trustees.

### **C. Quantifiable & reliable evidence and documentation of market supply & 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 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.

*Employment Opportunities and Entry Level.* The diversification of industries associated with the broad area of Digital Design and Fabrication is immense, making it extremely challenging to anticipate the number of vacancies expected over the next 5 years. The technology behind 3D printing is progressing rapidly, with companies around the world investing billions of dollars into research and development to improve hardware, software, printable plastics, and other materials. Meanwhile, the use of 3D printing has gone mainstream. As a result, knowing how to use a 3D printer has become an in-demand job skill. A recent report from *Wanted Analytics* found that in one month, 35 percent of engineering job listings from a variety of fields, including biomedical, software, and transportation industries, required applicants be familiar with 3D printing and its additive manufacturing processes.

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<sup>7</sup> *ibid*

<sup>8</sup> *ibid*

The same report found that companies are having a difficult time finding candidates with the right skills.<sup>9</sup>

"We're seeing a lot of growth in engineering job requests related to additive manufacturing skills and knowledge," said Upwork's Director, Ryan Johnson. Upwork is the world's largest online workplace for professional freelancers. Mr. Johnson continues, "As the costs of 3D printing come down, more companies are getting into AM, and they want to fill their talent gap for civil, structural, and mechanical engineers. They're looking for 3D modelers, 3D printer technicians, and design engineers, people who can contract with service bureaus to get prototypes made, or individuals doing models and prototyping."<sup>10</sup>

*Market Demand and Availability of Jobs.* In a recent article from *Design News*, data indicates that during the first half of this year, demand for independent contractors to create physical products and/or prototypes, or work with a service bureau to get it done, rose 94% over the same period last year. Demand for 3D rendering skills rose 83%, and for CAD and AutoCAD-related skills, by 227%. That last category includes programs like AutoCAD, 3ds Max, and Google SketchUp. Demand for engineers skilled in SOLIDWORKS for 3D printing rose by 94%, and for Rhinoceros 3D experts by 83%. Most of the engineering demand is in the design stage, where companies are looking for engineers with 3D modeling/design software skills, primarily in 3D model design for prototyping.<sup>11</sup>

The chart below lists almost 30 technical job categories associated with AM technology and skills. Collected, analyzed, and averaged from various online employment sites specializing in technology industries, this data shows that as of today there are roughly 28,507 jobs available in Digital Fabrication in the state of Maryland, with 5,178 just in Carroll County.

<b>Table 1. Digital Fabrication Jobs in Maryland and Carroll County</b>		
<b>Job Title</b>	<b>Maryland</b>	<b>Carroll County</b>
Digital Fabrication	103	38
SOLIDWORKS Designer	61	24
Product Designer	9,311	351
Industrial Designer	7,086	253
3D Printing	37	12
Additive Manufacturing	1,284	30
3D Scanning	10	8
Model Maker	271	10
Manufacturing	4,257	2,479
Manufacturing Designer	1,891	127
Manufacturing Design Engineer	1,204	362
3D Designer	327	62
3D Design	325	67
3D Modeler	195	10

<sup>9</sup> [https://www.wantedanalytics.com/analysis/posts/demand-for-3d-printing-skills-soars?utm\\_source=Google%2B&utm\\_medium=Google%2B&utm\\_campaign=9\\_4\\_2014\\_3DPrinting](https://www.wantedanalytics.com/analysis/posts/demand-for-3d-printing-skills-soars?utm_source=Google%2B&utm_medium=Google%2B&utm_campaign=9_4_2014_3DPrinting)

<sup>10</sup> <https://www.designnews.com/design-hardware-software/your-next-job-may-be-3d-printing-consultant/33418730445392>

<sup>11</sup> <https://www.designnews.com/design-hardware-software/your-next-job-may-be-3d-printing-consultant/33418730445392>

3D Systems	14	41
3D Printing Technician	4	1
3D Printing	37	12
3D Printer	10	10
3D Printer Tech	3	1
3D Printing Lab Technician	4	4
3D Printing Lab Manager	93	2
Fabrication Studios	23	23
Fabrication Studio Manager	17	3
Engineering Specialist	38	683
Rapid Prototyping	162	71
Prototype Engineer	924	136
Rapid Prototype Engineer	145	29
AutoCAD	671	329
<b>TOTAL</b>	<b>28,507</b>	<b>5,178</b>

**Data collected, analyzed, and averaged from various online employment sites, such as, but no limited to, *indeed.com* and *glassdoor.com***

*Educational and Training Needs.* Most job sites list a bachelor’s degree in an applicable field or an associate degree with certification as a Certified SOLIDWORKS Professional (CSWP) as their requirements for hire. SOLIDWORKS is one of the most widely used solid modeling computer programs in the industry. It is currently used by over 2 million professional engineers and designers in over 165,000 companies worldwide. Those that earn the certification have proven their ability to design and analyze parametric parts and moveable assemblies using a variety of complex features in SOLIDWORKS software. With these certifications, students will have the credentials to validate their SOLIDWORKS expertise with cutting-edge skills, which businesses seek out and reward.

*Projected Supply of Graduates.* There are currently 19 students enrolled in the first two Digital Design and Fabrication courses. This is an impressive number considering the college does not yet have an approved certificate or associate degree program. Based on this, and a significant number of inquiries, there appears to be strong interest in the program. Since the program is driven by market demand, and there are many employment opportunities in the field in the region, it is estimated that the program will graduate approximately 10-15 students per year.

**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.

*Program Duplication.* There are a few other community colleges in Maryland that offer fabrication and advanced manufacturing or related industrial engineering technology programs, but none serve the northeastern part of the state. In addition, none of these programs have a philosophy and framework similar to CCC’s unique program. Students in CCC’s Digital Design and Fabrication Program not only use contemporary manufacturing tools and thinking in “traditional” applications, they apply this technology to a diverse range of disciplines. CCC’s Program also specializes in SOLIDWORKS and its associated industry certifications.



Baltimore City Community College offers an A.A.S. and Certificate in Computer Aided Drafting (CAD), but the entire program is geared toward drafting and design with no focus on digital fabrication, additive manufacturing, or subtractive manufacturing. The College of Southern Maryland offers a Manufacturing Engineering Technology A.A.S. degree and a Manufacturing Technology certificate. Students in this program develop competencies in the general skills of engineering technology and study related subjects necessary to provide a broad educational foundation. The Community College of Baltimore County offers an A.A.S. and Certificate in Design, Fabrication, and Advanced Manufacturing but emphasis is placed on manufacturing rather than on design thinking, entrepreneurship, conceptual problem solving, and technology, as the CCC program does. In addition, the CCBC program does not offer a SOLIDWORK focus or associated industry certifications. Hagerstown Community College offers an A.A.S. degree in Advanced Manufacturing Systems. This program prepares students to enter the advanced manufacturing process and distribution industry but is geared heavily to traditional manufacturing. Harford Community College offers a few similar courses as part of their Engineering Technology program, but the emphasis is on engineering, with none of their courses being design or fabrication oriented. WorWic Community College offers a Manufacturing Engineering A.A.S. degree, a transfer option, and two certificates of proficiency. Because they are manufacturing engineering options, more stress is placed on the engineering side rather than the design and technology side, as in the CCC program.

*Justification.* With thirty years of existence and recent accelerated growth, 3D printing, additive manufacturing, and rapid prototyping are here to stay. Boeing has been 3D printing non-critical parts for decades. The \$1 million question for most companies is not whether to get in, but when. Scaled direct digital manufacturing is coming. There is a learning curve with these technologies at each point on the continuum, which is where academic training comes into play.

Digital Fabrication is about to revolutionize how we invent and create, changing the way we design and bring to market new technology products. Whereas traditionally, skilled craftspeople created prototypes and concept models using labor-intensive and costly manufacturing techniques, 3D printers can now produce the same artifacts in a few days at a fraction of the cost. Thus, a shift is on its way. This shift is that manufacturing jobs will decrease, and design job will increase. This shift will also impact how consumers see, value, and purchase products. Buyers are gravitating toward the acquisition of one-of-a-kind products instead of mass-produced objects. Lastly, this shift will change the degree to which consumers are involved in the creation of products. Instead of buying off-the-shelf products, consumers will now have a personal hand in the actual design through the customization of 3D printed objects. Thus, brand loyalty will diminish in favor of one-of-a-kind products that people can design, purchase, and have shipped to them the same day.

#### **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.

*Impact on HBIs.* No such program currently exists at any of Maryland's Historically Black Institutions (HBIs).

#### **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.

*Relevance to HBIs.* The proposed program will not have an impact on the uniqueness or institutional identity of any Maryland HBIs.

**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.
2. Describe the educational objectives and learning outcomes appropriate to the rigor, breadth, and (modality) of the program.
3. Explain how the institution will:
  - a. provide for assessment of student achievement of learning outcomes in the program
  - b. document student achievement of learning outcomes in the program
4. Provide a list of courses with title, semester credit hours and course descriptions, along with a description of program requirements.
5. Discuss how general education requirements will be met, if applicable.
6. Identify any specialized accreditation or graduate certification requirements for this program and its students.
7. If contracting with another institution or non-collegiate organization, provide a copy of the written contract.
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.
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.

*Program Establishment.* The curriculum was developed based on faculty research and expertise. Additionally, the designer of the program formed an advisory committee of community stakeholders and workforce experts in order to ensure that the program would meet the needs of local business and industry. The program will be overseen by the Division Chair of the Applied and Theatre Arts, Scott Gore. The Division Chair manages, supervises and provides quality oversight to program content, technology, staffing, budget, and facilities associated with this program.

*Educational Objectives and Learning Outcomes.* The educational goals of this program are to prepare individuals to:

1. Use industry-standard digital fabrication tools and techniques to design and produce functional prototypes that meet specific human factors and design criteria.
2. Analyze how key factors have shaped manufacturing, established current and emerging 3D printing applications in a variety of industries, and created various advantages/limitations in both use and economic implications.
3. Effectively articulate digital fabrication concepts and evaluate the designs of others in both verbal and written form.

4. Develop a research-based, problem solving design process that meets the parameters of specific project requirements.
5. Generate a portfolio of work that clearly demonstrates innovation and effectiveness in working within a maker studio environment to design, build, test and revise products that meet client timeline, design and quality requirements.

*Assessment and Student Learning Outcomes.* The College has a rigorous course and program assessment process. Course assessment takes place by using assignments that address specific course learning outcomes. Data from these course assessments are collected and analyzed to improve courses and student learning.

Complete program assessment takes place every five years, with progress toward achievement of program learning outcomes being evaluated annually. Data regarding enrollment, retention, and graduation is collected and analyzed against program outcomes, courses offered, and other variables. Each program must have an advisory board consisting of professionals in the field to assist in the construction and analysis of program review data.

Faculty members are evaluated yearly by students and administrators. Each year, faculty members have their course material and student evaluations assessed by their division chairs, with final verification of the assessment conducted by the Vice President and Academic and Student Affairs. In order to receive high evaluations, faculty members must demonstrate effective teaching above all, but professional development in the discipline and participation in departmental, divisional, and college-wide activities is also assessed. The process also provides administrators the opportunity to set out action plans for faculty improvement in teaching, professional development, and/or college service in order for each or any of those facets of the faculty member’s career to be enhanced.

*Program Requirements.*

<b>Table 2. Associate of Applied Science Digital Design and Fabrication</b>		
<b>Program Requirements</b>		
<b>Course Number</b>	<b>Course Title</b>	<b>Credits</b>
<b>Major Courses</b>		
ART 110	3-D Design	3
BUAD 130	Introduction to Entrepreneurship	3
DFAB 100	Drawing Techniques for Designers	3
DFAB 101	Introduction to 3D Printing	3
DFAB 102	Digital Sculpting	3
DFAB 104	Introduction to Subtractive Manufacturing	3
DFAB 105	SOLIDWORKS Introduction	3
DFAB 106	Introduction to 3D Scanning	3
DFAB 205	SOLIDWORKS Fundamentals	3
DFAB 206	SOLIDWORKS Essentials	3
DFAB 207	SOLIDWORKS Advanced	3
DFAB 270	Capstone in Digital Fabrication	3
Elective	Any Elective (Internship Recommended)	4
<b>General Education Requirements</b>		
ART 125	Arts and Humanities	3

Elective	Arts and Humanities	3
Elective	Biological and Physical Sciences	4
Elective	English Composition and Literature	3
MATH 111	Fundamentals of Geometry and Measurement	4
Elective	Social and Behavioral Sciences	3
	<b>Total Credits</b>	<b>60</b>

**Table 3. Certificate in Digital Design and Fabrication**

Course Number	Course Title	Credits
ART 110	3-D Design	3
MATH 111	Fundamentals of Geometry and Measurement	4
DFAB 100	Drawing Techniques for Designers	3
DFAB 101	Introduction to 3D Printing	3
DFAB 102	Digital Sculpting	3
DFAB 104	Introduction to Subtractive Manufacturing	3
DFAB 105	SOLIDWORKS Introduction	3
DFAB 106	Introduction to 3D Scanning	3
DFAB 205	SOLIDWORKS Fundamentals	3
DFAB 206	SOLIDWORKS Essentials	3
DFAB 207	SOLIDWORKS Advanced	3
DFAB 270	Capstone in Digital Fabrication	3
Elective	Any Elective (Internship Recommended)	4
	<b>Total Credits</b>	<b>41</b>

**Table 4. Certificate in SOLIDWORKS**

Course Number	Course Title	Credits
MATH 111	Fundamentals of Geometry and Measurement	4
DFAB 105	SOLIDWORKS Introduction	3
DFAB 205	SOLIDWORKS Fundamentals	3
DFAB 206	SOLIDWORKS Essentials	3
DFAB 207	SOLIDWORKS Advanced Modeling	3
DFAB 270	Capstone in Digital Fabrication	3
	<b>Total Credits</b>	<b>19</b>

See Appendix A for course descriptions

*General Education Requirements.* As an A.A.S. degree program, students will be required to complete a minimum of 18 credits in General Education courses. CCC has seven General Education goals that meet the Code of Maryland Regulations (COMAR 13B.06.01.03). Specific courses have been identified within the curriculum that will be used to assess these general education competencies.

- 1) Communication (Written and Oral) - Students will communicate effectively in writing and in speech, and interpret the written and oral expressions of others.
- 2) Critical Thinking - Students will practice analytical and evaluative thinking with a view toward continuous improvement.
- 3) Quantitative and Scientific Reasoning - Students will apply mathematical and scientific concepts and theories to identify and analyze problem-solving situation.

- 4) Information & Technology Literacy - Students will research, create, and communicate information through appropriate technology.
- 5) Creativity - Students will explore and appreciate the creative processes that shape the human experience.
- 6) Global Awareness - Students will acknowledge and comprehend the beliefs, behaviors, and values of diverse populations within a global environment.
- 7) Personal Development and Social Responsibility – Students will recognize and engage in personal and social behaviors responsible for the wellness of self and community.

*Specialized Accreditation.* There are no specialized accreditation or certification requirements for this program.

*Contracts.* At this time, there are no agreements with other institutions or non-collegiate organizations.

*Assurance of Clear, Complete, and Timely Information.* Carroll Community College pledges to do the best job possible to retain all students that walk through its doors. All potential new students meet with an admissions counselor upon making application to the college. These individuals assist students by guiding them through the next steps in the enrollment process such as placement testing, advising, registration, tuition payment and financial aid. When they meet with an academic advisor, the advisor will help them select an appropriate program of study. After program selection, the student meets with a designated advisor or faculty member with expertise in the students major. This is to assure that the student receives relevant, timely information about their curriculum, courses, and degree or certificate requirements. Being a relatively small institution allows faculty to get to know their students and address challenges before the students feels lost and drop out. These relationships, as well as the schedule of classes, college catalog, and other promotional materials provide students with information they need about prerequisites, technical equipment, the learning management system (Blackboard) and services such as tutoring.

*Assurance of Accurate Materials.* Educational programs and services offered are the primary emphasis of all advertisements, publications, promotional literature, and recruitment activities at the College. All statements and representations are reviewed to ensure that it they are clear, factually accurate, and current.

Catalogs and other official publications are readily available and accurately depict the institutional mission and core themes, entrance requirements and procedures, basic information on programs and courses, with required sequences and frequency of course offerings explicitly stated, degree and program completion requirements, including length of time required to obtain a degree or certification of completion, faculty (full-time and part-time) with degrees held and the conferring institution, student services, institutional facilities readily available for educational use, rules and regulations for conduct, tuition, fees, and other program costs, opportunities and requirements for financial aid, policies and procedures for refunding fees and charges to students who withdraw from enrollment, and the academic calendar.

#### **H. Adequacy of articulation**

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

*Articulation.* The Digital Design and Fabrication degree will be an Associate of Applied Sciences degree; thus it is designed for students to enter into the workforce and is not intended or designed for transfer. While the General Education courses in the program will transfer, many specialized courses will not, beyond being considered a lower level elective by the transfer institution.

**I. Adequacy of faculty resources (as outlined in COMAR 13B.02.03.11)**

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).
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. Evidenced-based best practices for distance education, if distance education is offered.

*Quality of Program Faculty.* Below is the Digital Design and Fabrication program course faculty. General Education courses and college-wide, non-DFAB specific courses, are not included. Seven of the 10 program-specific courses will be offered once a year until enrollment dictates otherwise. Course reassignments and additional faculty hires will occur at that time, if applicable.

Full-time Instructional Staff:

- **Faculty: Scott Gore**  
**Credentials:** Division Chair & Program Director | Associate Professor | Master of Fine Art in Graphic Design | Pending CSWA & CSWP Certifications | Pending Makerbot Level 1 & Level 2 Certifications.  
**Courses:** Introduction to 3D Printing, SOLIDWORKS Introduction, SOLIDWORKS Fundamentals, SOLIDWORKS Essentials, SOLIDWORKS Advanced Modeling, and Capstone in Digital Fabrication.
- **Faculty: New Faculty Member**  
**Credentials:** Funds allocated for the acquisition of a fulltime Digital Design and Fabrication faculty member in Fall 2019. Course assignment based on credentials and area of expertise.

Part-time Instructional Staff:

- **Faculty: Chet Andes**  
**Credentials:** Adjunct | Master of Education (Technology in Education) | 15 years teaching STEM, Technology education in secondary education environment  
**Courses:** Drawing Techniques for Designers, Introduction to 3D Printing, Introduction to Subtractive Manufacturing, SOLIDWORKS Introduction, SOLIDWORKS Fundamentals, SOLIDWORKS Essentials, SOLIDWORKS Advanced Modeling, Introduction to 3D Scanning
- **Faculty: Howard Riopelle**  
**Credentials:** Adjunct | MFA in Painting and Drawing, Minor in Sculpture  
**Courses:** Drawing Techniques for Designers, Digital Sculpture
- **Faculty: James Gilford**  
**Credentials:** Adjunct | Master of Liberal Arts (focus in science and engineering) | Project Lead the Way Master Teacher, Maryland State Advanced Professional Certificate, & H.S. Engineering Instructor | Expert in 3D CAD and computer integrated Manufacturing.

**Courses:** Introduction to 3D Printing, Introduction to Subtractive Manufacturing, Introduction to 3D Scanning

*Ongoing Pedagogy Training for Faculty.* Training in pedagogy that meets the needs of students is provided through yearly through the use of Teaching Squares, mentoring, faculty coaching, and faculty workshops and supported by evidence-based best practices. Training for those new to the college's learning management system, Blackboard, is offered through open drop-in workshops every week. The college supports faculty attendance at related regional and national conferences.

**J. Adequacy of library resources (as outlined in COMAR 13B.02.03.12)**

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.

*Library Resources.* The Digital Design and Fabrication program is supported by the Carroll Community College library, which purchases print and electronic reference sources, DVDs, and books; subscribes to periodical database and streaming media services; and other resources to facilitate student research and learning in the subject area of digital fabrication. An assigned librarian serves as the divisional liaison and coordinates material purchasing and collection development with full and part-time faculty depending upon departmental and class learning outcomes.

**K. Adequacy of physical facilities, infrastructure and instructional equipment (as outlined in COMAR 13B.02.03.13)**

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.
2. Provide assurance and any appropriate evidence that the institution will ensure student enrolled in and faculty teaching in distance education will have adequate access to:
  - a. An institutional electronic mailing system, and
  - b. A learning management system that provides the necessary technological support for distance education

*Facilities.* Current physical facilities, equipment, and infrastructure at Carroll Community College are adequate to offer the new degree program without the need for additional resources. The college previously converted a computer lab into a Fabrication Lab and Smart Classroom. Digital Design and Fabrication equipment was purchased with funds raised by the College Foundation. In addition, the room has Internet access and the latest instructional equipment which includes computers and audio and visual devices. Carroll's Information Technology department supports this equipment with software updates and any maintenance or repairs necessary to maintain quality instruction.

*Access to Email and the Learning Management System.* Carroll Community College faculty receive an employee email address and access to the college email system on their first day of employment. Students receive a student email address upon enrollment. Students receive access instructions at the email address listed on their application. Students are requested to activate their college email account immediately and must use that email address for all College correspondence. Once activated, this is

also the only email address that the college will use to contact students. Students are asked to check their Carroll email, even when classes are not in session.

To facilitate learning, all credit-courses use Blackboard (Bb), Carroll’s learning management system. Blackboard sites support easy access to course materials, interactions with the instructor and other students, course grades, and much more. Students are automatically enrolled into Blackboard course sites. Faculty are given Blackboard assess and training within their first week of employment. At a minimum, faculty are required to use Blackboard to post their syllabus, faculty contact information, and announcements and course communications. In addition, the gradebook within Blackboard must be used to provide students with a reasonable understanding of the status of their grades through the duration of the course.

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

<b>TABLE 1: RESOURCES</b>					
<b>Resource Categories</b>	<b>Year 1</b>	<b>Year 2</b>	<b>Year 3</b>	<b>Year 4</b>	<b>Year 5</b>
	<b>2019-2020</b>	<b>2020-2021</b>	<b>2021-2022</b>	<b>2022-2023</b>	<b>2023-2024</b>
1. Reallocated Funds	0	0	0	0	0
2. Tuition/Fee Revenue (c + g	\$48,850	\$69,952	\$92,270	\$115,631	\$140,676
a. Number of F/T Students	10	13	16	19	22
b. Annual Tuition/Fee Rate	\$3,907	\$4,024	\$4,145	\$4,269	\$4,398
c. Total F/T Revenue (a x b)	\$39,070	\$52,312	\$66,320	\$80,921	\$96,756
d. Number of P/T Students	4	7	10	13	16
e. Credit Hour Rate	\$163	\$168	\$173	\$178	\$183
f. Annual Credit Hour Rate	15	15	15	15	15
g. Total P/T Revenue (d x e x f)	\$4,780	\$17,640	\$25,850	\$34,710	\$43,920
3. Grants, Contracts & Other	0	0	0	0	0
4. Other Sources	\$32,500	\$32,500	0	0	0
<b>TOTAL (Add 1 – 4)</b>	<b>\$81,350</b>	<b>\$102,452</b>	<b>\$92,270</b>	<b>\$115,631</b>	<b>\$140,676</b>

Narrative for Table 1: Resources

1. Reallocated Funds: Carroll Community College does not anticipate any need to reallocate funds from any other area to support this program.
2. Tuition and Fee Revenue: The cost of both full-time and per-credit tuition is subject to a 3% increase each year.
3. Grants and Contracts: Not applicable.
4. Other Sources: The College Foundation has already raised \$65,000 for this program. It will be used for the purchase of commercial-grade printers during the first two years.



TABLE 2: EXPENDITURES:					
Expenditure Categories	Year 1	Year 2	Year 3	Year 4	Year 5
	2019-2020	2020-2021	2021-2022	2022-2023	2023-2024
1. Faculty (b + c below)	\$79,562	\$81,949	\$84,407	\$86,938	\$89,545
a. # FTE	1	1	1	1	1
b. Total Salary	\$58,935	\$60,703	\$62,524	\$64,899	\$66,330
c. Total Benefits	\$20,627	\$21,246	\$21,883	\$22,539	\$23,215
2. Admin. Staff (b + c below)	0	0	0	0	0
a. # 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. # FTE	0	0	0	0	0
b. Total Salary	0	0	0	0	0
c. Total Benefits	0	0	0	0	0
4. Equipment	0	0	0	0	0
5. Library	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000
6. New or Renovated Space	0	0	0	0	0
7. Other Expenses	\$14,500	\$14,500	\$14,500	\$14,500	\$14,500
<b>TOTAL (Add 1 – 7)</b>	<b>\$95,062</b>	<b>\$97,449</b>	<b>\$99,907</b>	<b>\$102,438</b>	<b>\$105,045</b>

Narrative for Table 2: Expenditures

1. Faculty (#FTE, Salary, and Benefits):  
The College has already committed to adding one full-time faculty member by the time the program begins in fall 2019.
2. Administrative Staff:  
No additional administrative staff is expected in the first 5 years of the program.
3. Support Staff:  
No additional support staff is expected in the first 5 years of the program.
4. Equipment:  
No additional equipment, other than that being funded by the College Foundation, is expected in the first 5 years of the program.
5. Library:  
The current library loan mechanism and the electronic retrieval methods will be used for the program. New library holdings related to Digital Fabrication will be added each year for the first five years of the program.
6. New or Renovated Space:  
A classroom has already been renovated for this program.
7. Other Expenses:  
Yearly cost of consumables is \$13,500. Additional funds are for marketing and faculty development.

**M. Adequacy of provisions for evaluation of program (as outlined in COMAR 13B.02.03.15)**

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

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.

*Program Evaluation.* Students in the Digital Design and Fabrication A.A.S. program will be required to demonstrate their competency with regard to the stated learning outcomes for each major course and the program. This will be achieved through various deliverables, which include projects, written quizzes and exams, exercises, written assignments, and oral presentations. Courses and faculty will be evaluated based on their effectiveness of student learning, as well as, through the parameters outlined in the student evaluation process.

*Program Effectiveness.* The Program Director and faculty will conduct and document an annual assessment report of select objectives that are chosen and responded to on a yearly basis. In addition, as part of the quality improvement process, a comprehensive program review is conducted once every five years. The purpose of the review is to evaluate the effectiveness of the academic program through the evaluation of curriculum, faculty, student enrollment and retention, and student learning outcomes. The review process ensures that the following are reflected in the document:

- a. The mission of the college and how the needs of the community are met
- b. Student performance
- c. Transferability and /or workforce applicability
- d. Curriculum strengths and weakness
- e. Adequacy of resources to support the program

The Vice President of Academic and Student Affairs, along with the Student Learning Improvement Committee, the General Education Committee, and the Program Review Committee coordinate these processes.

**N. Consistency with the State's minority student achievement goals (as outlined in COMAR 13B.02.03.05 and in the State Plan for Postsecondary Education):**

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

*Minority Student Achievement Goals.* CCC has long been committed to the recruitment and retention of minority students and will expand its services and policies to include this program. Data on minority enrollment in the Digital Design and Fabrication program will be monitored by the Division Chair to determine how underrepresented minorities can be recruited and retained. CCC currently provides academic tutorial support and a retention alert system to identify academic related issues students are experiencing. A College-wide Diversity Committee identifies and promotes service-learning projects that are tied into academics and diversity awareness among the campus community.

**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.

*Relationship to low productivity programs.* The Digital Design & Fabrication degree program is not related to any low productivity programs identified by the Maryland Higher Education Commission.

**P. Adequacy of Distance Education Programs (as outlined in COMAR 13B.02.03.22)**

1. Provide affirmation and any appropriate evidence that the institution is eligible to provide Distance Education
2. Provide assurance and any appropriate evidence that the institution complies with the C-RAC guidelines, particularly as it relates to the proposed program.

*Distance Education Program.* Although individual courses may be offered online for this program, at least 50% of the courses will be offered face-to-face. For the online component of the program, CCC has been approved by MHEC to offer distance education programs and is fully approved by the Middle States Commission on Higher Education to offer distance education programs. While not an individual member of C-RAC, the College complies with each of the nine guidelines through MHEC who is responsible for the academic integrity of higher education in Maryland.

## DIGITAL DESIGN & FABRICATION COURSE DESCRIPTIONS

**ART-110, 3D Design**, introduces materials, methodology, and basic concepts applicable to sculpture, display, interior and architectural design, industrial design and other areas dealing with three-dimensional form. This is a hands-on studio course intended for students who will be taking additional art courses which involve applications for the concepts developed in 3-D Design and is recommended for 3D/animation students. Advanced Placement Exam (Art 3-D with a score of 3) accepted. Prerequisite: ART-101, DFAB-100 (or two years of high school art with advisor signature) and exemption/completion of READ A-D or ENG-001. Two hours lecture. Two hours lab each week. Three credits. Three billable hours. Offered Spring and Fall terms.

**BUAD-130, Introduction to Entrepreneurship**, explores fundamental concepts associated with the study and practice of starting and operating a small business. Major topics of discussion include the recognition of opportunities, planning and executing a business plan, developing the marketing mix, selling, financing the business, legal issues, and ultimate realization of harvesting the business. Prerequisite: exemption/completion of READ A-F. Three hours lecture each week. Three credits. Three billable hours. Offered Fall and Spring terms.

**DFAB-100, Drawing Techniques for Designers**, introduces students to visualization techniques used by contemporary product designers, including freehand sketching, digital rendering, information graphics, and presentation skills. Students will learn how to read, understand, and create engineering drawings. This course focuses on the theories, practices, and appreciation of drawing as a communication method. The course emphasis will be on traditional compositional theory, drawing principles, fundamentals of observing and describing form. Students will gain a strong understanding of tonal and dimensional perspective while focusing on producing dimensional models that are functionally correct. Projects may include sketchbooks and assignments in addition to class work. Prerequisite: Exemption/Completion Of ENGL-001. Three hours lecture each week. Three credits. Three billable hours. Offered Fall Term Only.

**DFAB-101, Introduction to 3D Printing**, will provide students with a hands-on immersive experience in digital design and fabrication by utilizing cutting edge, 3D printing technology. Students will obtain a rich understanding of what 3D printing is, how 3D printers work, and how this new technology is being used by both individuals and companies to revolutionize our world. Students will learn key historical facts that have shaped manufacturing, including the advantages, limitations, applications and economic implications. Students will acquire the knowledge, skills, tools, and understanding necessary to transform ideas into real physical objects. Prerequisite: eligibility for ENGL-101, plus exemption/completion of MAT-095 or MAT097. Two hours lecture. Two hours lab each week. Three billable hours. Offered Fall and Spring terms.

**DFAB-102, Digital Sculpting**, presents basic concepts and fundamentals of computer modeling, taking an artistic approach to the creation of 3D polygonal geometry. Students will focus on critical concepts of proportion, form, and translation of 2D design to 3D figures. Various tools and techniques will be discussed, allowing for the creation of custom workflows and methodologies. No prior experience with 3D animation, modeling, or industry professional software required. Prerequisite: eligibility for ENGL-101. Two hours lecture. Two hours lab each week. Three credits. Three billable hours. Offered Fall Term Only.

**DFAB-104, Introduction to Subtractive Manufacturing**, introduces carving, CNC milling, and laser

cutting into the Digital Fabrication Studio, while exploring the relationship between laser cutting, engraving, and vector graphics in digital fabrication processes. Students will learn advanced Inventor software techniques and how to integrate this knowledge with 3D printing and CAM software to prepare parts for prototyping and manufacturing of objects. In addition, students will learn a variety of techniques for generating vectors based output, using them to create both two-dimensional and three-dimensional forms. Emphasis will be placed on applications development and proper file preparation for output devices. Prerequisite: eligibility for ENGL-101 and MAT-095. Three hours lecture each week. Three credits. Three billable hours. Offered Spring term only.

**DFAB-105, SOLIDWORKS Introduction**, acquaints students to the subject of solid modeling as a method of creating editing solid entities using the SOLIDWORKS mechanical design automation software to build parametric models of parts and assemblies. In addition, students will learn to use the key functions of the program, in the development of full solid models in a simulated environment for both design and analysis. This course will provide preparation for the Certified SOLIDWORKS Associate (CSWA) and Certified SOLIDWORKS Professional (CSWP) exams. Prerequisite: eligibility for ENGL-101, plus pre or co-requisite MATH-111. Completion of DFAB-101 is strongly recommended. Two hours lecture. Two hours lab each week. Three credits. Three billable hours. Offered Spring and Fall terms.

**DFAB-106, Introduction to 3D Scanning**, introduces scanned data in Digital Fabrication Studio. This studio explores the relationship between 3D scanned data and digital fabrication processes. Students will learn a variety of processes and methods for translating real world objects into digital form. In this course students will explore the implications of these technologies to contemporary artistic practice. Emphasis will be placed on an exploration of scale and the ways that scanned data can be manipulated artistically through digital fabrication. Advanced more complex techniques based on parametric designs for reverse engineering will be studied, allowing each student to be able to build physical forms using 3d printing. Prerequisite: DFAB-105. Two hours lecture. Two hours lab each week. Three billable hours. Offered Fall term only.

**DFAB-205, SOLIDWORKS Fundamentals**, will cover advanced fundamental functions required to model and document a d design in SOLIDWORKS. This course prepares students to complete the Certified SOLIDWORKS Associate (CSWA) exam as the final exam. Certification is not guaranteed. Prerequisite: DFAB-105 with a "C" grade or better. Can be taken concurrently with DFAB-270 with permission of the Division Chair. Three hours lecture each week. Three billable hours. Offered Spring Fall term only.

**DFAB-206, SOLIDWORKS Essentials**, teaches students how to maximize their use of the assembly modeling capabilities of SOLIDWORKS mechanical design automation software. In addition, students will learn how to use multibody solids, sweeping and lofting features, and the more advanced shaping capabilities of SOLIDWORKS. This course will also include preparation for the Certified SOLIDWORKS Professional (CSWP) exam. Prerequisite: DFAB-105 with a "C" grade or better. Can be taken concurrently with DFAB-270 with permission of the Division Chair. Three hours lecture each week. Three billable hours. Offered Fall term only.

**DFAB-207, SOLIDWORKS Advanced**, cover the production of sheet metal parts using SOLIDWORKS mechanical design automation software. Specific activities include building standalone sheet metal parts and converting conventional parts to sheet metal, including in assembly context. In addition, students will learn how to create welded structures with standard structural members and weld beads. This course will also include preparation for the Certified SOLIDWORKS Professional (CSWP) exam. Prerequisite: DFAB-105 with a "C" grade or better. Can be taken concurrently with DFAB-270 with

permission of the Division Chair. Three hours lecture each week. Three billable hours. Offered Spring term only.

**DFAB-270, Capstone in Digital Fabrication**, is an intensive study and research course for students pursuing the Associates of Applied Science (A.A.S.) degree, Digital Design and Fabrication Certificate, or the SOLIDWORKS Certificates. Students will complete an independent, comprehensive, field-specific project and related presentation. Specific focus will be placed on professionally-oriented activities, including the development and presentation of a portfolio to be used as part of the job search process. This course prepares students to complete the Certified SOLIDWORKS Professional (CSWP) exam as the final exam. Certification is not guaranteed. Independent, directed studio experiences available. Should be completed during the last semester of study. Prerequisite: DFAB-105 with a "C" grade or better. Prerequisite: DFAB-205, DFAB-206, and DFAB-207 with "C" grades or better may be completed concurrently with Division Chair permission. Three credits. Three billable hours. Offered Spring and Fall terms.

**MATH-111, Fundamentals of Geometry and Measurement**, is intended for, but not limited to, students in the education major. Topics covered include plane and solid geometry, as well as standard and non-standard measurement. Geometry topics include circles, polygons, triangle congruence and similarity, coordinate geometry, and transformations. Measurement topics include metric and English systems, dimensional analysis, and constructions. Emphasizes problem solving, educating elementary, middle, and high school students. Appropriate use of technology includes calculators and computers. Prerequisite: eligibility for ENGL-101, plus a satisfactory placement test score or MAT-099, MAT-095 or MAT-092 with a C grade or better. Credit by exam not available. Calculator with arithmetic functions, a compass, straight-edge, and ruler are required. Four hours lecture each week. Four credits. Four billable hours.