University of Maryland PCC  
Program/Curriculum/Unit Proposal  

Program: Immersive Media Design (IMDM)  
Department/Unit: ARTT - Studio Art & CMSC - Computer Science  
College/School: ARHU - Arts and Humanities & CMNS Computer Mathematical and Natural Sciences  
Proposal Contact Person (with email): Brandon Morse (bmorse1@umd.edu) Roger Eastman (reastman@cs.umd.edu)  

Type of Action (check one):  
☐ Curriculum change (includes modifying minors, concentrations/specializations and creating informal specializations)  
☐ Curriculum change is for an LEP Program  
☐ Rename a program or formal Area of Concentration  
☐ Establish/Discontinue a formal Area of Concentration  
☐ Other: ☒ Establish a new academic degree/certificate program  
☐ Create an online version of an existing program  
☐ Establish a new minor  
☐ Suspend/Discontinue a degree/certificate program  
☐ Establish a new Master or Certificate of Professional Studies program  
☐ New Professional Studies program will be administered by Office of Extended Studies  

Italicics indicate that the proposal must be presented to the full University Senate for consideration.  

Approval Signatures - Please print name, sign, and date. For proposals requiring multiple unit approvals, please use additional cover sheet(s).  
1. Department Committee Chair  
   E. Brandon Morse  
   [Signature]  
   2/22/19  
2. Department Chair  
   William Richardson  
   [Signature]  
   2/22/19  
3. College/School PCC Chair  
   Alejandro Araiga  
   [Signature]  
   2/22/19  
4. Dean  
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   2/22/19  
5. Dean of the Graduate School (if required)  
   [Signature]  
6. Chair, Senate PCC  
7. University Senate Chair (if required)  
8. Senior Vice President and Provost  

Instructions:  
When approved by the dean of the college or school, please send the proposal and signed form to the Office of the Associate Provost for Academic Planning and Programs, 1119 Main Administration Building, Campus-5031, and email the proposal document as an MSWord attachment to pcc-submissions@umd.edu.  

Summary of Proposed Action (use additional sheet if necessary):  
The Colleges of Arts and Humanities (ARHU) and Computer Mathematical and Natural Sciences (CMNS) jointly propose to offer Bachelor of Science and Bachelor of Arts degrees in Immersive Media Design. The field of Immersive Media Design encompasses a broad spectrum of practices drawing from both the creative arts and computing sciences. It addresses emerging developments across both disciplines and utilizes practices in augmented and virtual reality, computer graphics and game programming, digital fabrication, software art, tangible computing and computer sensing allowing for the creation of multisensorial content which actively engages with its participants through deep interactivity in both virtual and dimensional settings.  
Continued on p 2.  

Unit Code(s) (to be entered by the Office of Academic Planning and Programs):
This proposed major represents a substantive collaboration between STEM fields and the Arts and Humanities and will prepare our students to be leaders in the production of Augmented Reality, Virtual Reality, and the aforementioned related Immersive Media Design disciplines. Students in this major will engage in a sustained interdisciplinary practice wherein groups from computer science and the arts and design collaborate over the course of several semesters to jointly study and address some of today’s most pressing questions about the role of technology as a creative medium.

The applications for augmented and virtual reality are vast and its growth as an industry and vehicle for cultural capital is imminent. The National Academy of Engineering has identified enhancing virtual reality as one of the grand challenges for the 21st century and VR and AR are on their way to evolving as the eighth mass market following print, recordings, cinema, radio, TV, the Internet, and mobile technology. Just as mobile technology has connected everyone to the world around them, immersive virtual and augmented reality is the next leap forward in the ever-expanding information revolution.

As technology increasingly becomes interwoven into the fabric of everyday life, the development of a program of study solely dedicated to this momentous shift will place the University of Maryland at the forefront of a nascent field of study and will contribute to the continued upward trajectory of this institution as it pertains to the recruiting of top-tier students, researchers and educators from not only across the state, but also from the nation and internationally.
University of Maryland PCC
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☐ Other:

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Approval Signatures - Please print name, sign, and date. For proposals requiring multiple unit approvals, please use additional cover sheet(s).

1. Department Committee Chair
   
   Michael Hicks 2/21/2019

2. Department Chair
   
   Ming Lin 2/21/2019

3. College/School PCC Chair
   
   Robert Infante 2/21/2019

4. Dean
   
   Amitabha Banerjee 2/12/2019

5. Dean of the Graduate School (if required)

6. Chair, Senate PCC

7. University Senate Chair (if required)

8. Senior Vice President and Provost

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PROPOSAL FOR
NEW INSTRUCTIONAL PROGRAM
UNIVERSITY OF MARYLAND AT COLLEGE PARK, MARYLAND
BACHELOR OF SCIENCE IN IMMERSIVE MEDIA DESIGN
BACHELOR OF ARTS IN IMMERSIVE MEDIA DESIGN

COLLEGE OF ARTS AND HUMANITIES
DEAN BONNIE THORNTON DILL
COLLEGE OF COMPUTER, MATHEMATICAL
AND NATURAL SCIENCES
DEAN AMITABH VARSHNEY
# Immersive Media Major Proposal

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Program: Bachelor of Science & Bachelor of Arts in Immersive Media Design

Date of Proposal: January 2019

Start Term for New Program: Fall 2020

Mission and Purpose

1. Describe the program and explain how it fits the institutional mission statement and planning priorities.

The Colleges of Arts and Humanities and Computer, Mathematical and Natural Sciences jointly propose to offer a new major to grant Bachelor of Science and Bachelor of Arts degrees in Immersive Media Design. The IMD major (IMDM) will prepare our students to be leaders in the production of augmented and virtual reality, as well as related immersive media. We define immersive media here as media that immerses the user, that surrounds them in a virtual world, or embeds reactive technology tangibly and seamlessly in the real world, or overlays digital information on the real world, for purposes of effective communication, data exploration, or artistic expression. This can be virtual and augmented reality (VR and AR), but is not limited to those technologies can include innovative use of mobile devices, projective displays in different environments, digitally mediated and interactive sculpture, and other emerging non-standard interfaces. This proposed major represents a substantive collaboration between STEM fields and the Arts and Humanities and a response to considerable student interest in the area.

The applications for virtual and augmented reality (VR and AR) are vast and its growth as an industry and vehicle for cultural capital is imminent. The National Academy of Engineering has identified enhancing virtual reality as one of the grand challenges for the 21st century and VR and AR are on their way to evolving as the eighth mass market following print, recordings, cinema, radio, TV, the Internet, and mobile technology. Just as mobile technology has connected everyone to the world around them, immersive virtual and augmented reality is the next leap forward in the ever-expanding information revolution. By overlaying, or augmenting, digital information on top of real-world settings, immersive augmented reality allows people from all walks of life—health care professionals, educators, industrial workers, artists, and everyday people—to see and use the information that matters most to them.

The creation of such media demands a skill set that represents a blend of training in aesthetics, media theory and formalism concatenated with technically demanding skills in programming, mathematics, and related fields such as data visualization. To answer this demand, we propose to establish an Immersive Media Design major (IMDM). This major will be offered through a unique collaboration of expert faculty members and resources at the University of Maryland (UMD). This collaboration incorporates resources and expertise from a broad spectrum of colleges and departments. It reflects the recognition that the production of works of immersive media requires that practitioners be conversant in the prominent theories, concepts and practices of both computer science and the arts and humanities and that they maintain expertise in one or more of these areas. Providing exposure to this spectrum and encouraging the development of expertise in this diverse range of disciplines is the core of this proposed major.

The proposed is a response to the changing state of the digital and immersive media industries, the academic interests of incoming students and the shifting demands of today’s collaborative workplace. Interdisciplinary teams of instructors from Computer Science and Studio Art will teach the major’s core classes. Students will work in interdisciplinary teams to complete projects based upon their interests and bolstered by expertise of the instructor pairings. Our major will also be
a catalyst for securing large, multi-institutional research and education grants from nearby federal agencies and other sources, promising to position Maryland as a leader in our nation’s new economy based on technology and innovation.

The Immersive Media Design Major combines a comprehensively collaborative structure with a rigorous theoretical underpinning conforming with the scholarly traditions of our campus. It mirrors the trends within the digital media and creative technological industries toward interdisciplinary practices. Graduates of this program will be well prepared to meet and exceed the dynamic and changing expectations of the marketplace. Interdisciplinary pairings of instructors will educate teams of students with diverse backgrounds in the arts, design, computer science and mathematics. This major is infused with courses that will provide context to these new technologies by exploring the history, culture and practices of these fields. It will cultivate students who are thinkers as well as makers and doers. The courses will challenge students to apply foundational context to research in virtual reality, visual and performing arts, and creative computational practices. Students will incorporate knowledge of software development, coding structure, mechanical functions, visual aesthetics, storytelling, resource optimization and audience considerations to produce innovative works of media technology in a rapidly emerging field.

This major will serve the University of Maryland’s mission in pursuing five strategic goals: 1) developing educational opportunities in virtual and augmented reality (VR and AR) and related media; 2) creating a new cross-campus major which offers alternate, yet high-demand academic paths for students; 3) drawing exceptional undergraduate talent with a nationally-unique program in arts and computing; 4) fostering new opportunities for research, scholarship and creativity that are interdisciplinary and will define future disciplines for the new media landscape; and 5) synergizing with key economic drivers in Maryland, including the digital media industry.

Program Characteristics

2. Provide the catalog description of the proposed program. As part of the description, please indicate any areas of concentration or specializations that will be offered.

The Immersive Media Design Major offers students an interdisciplinary, intensive experience with the concepts, theories and tools for creating innovative works in immersive and other emerging technologies. Just as mobile technology has connected everyone to the world around them, immersive virtual and augmented reality is the next leap forward in the ever-expanding information revolution. By creating an independent, virtual world, or by overlaying, or augmenting, digital information atop real-world settings, immersive virtual and augmented reality allows people from all walks of life—health care professionals, educators, industrial workers, artists, and everyday people—to see and use the information that matters most to them. The creation of such immersive environments - utilizing a balance of skills in art, design, computer science and engineering—demands a new way of thinking. To answer this demand, the Immersive Media Design Major - through a unique cross-campus collaboration of expert faculty members and resources at the University of Maryland will provide the scientific and scholarly foundations needed to advance the extraordinary potential of virtual and augmented reality applications. Immersive Media Design majors will be creative thinkers and makers who understand the impact technology has on our lives and are invested in exploring the creative potential inherent in emerging technology and media. Working in fields such as Augmented and Virtual Reality, Creative Coding, Digital Fabrication and Tangible Computing among others, the B.S. and B.A. in Immersive Media Design prepares students for professional roles through its cross-disciplinary, hands-on curriculum.

The first two years of coursework helps students develop mastery in a variety of tools and applications in computer science, art, visual communications, and related hybrid-practices. Through lecture and theory courses, they develop the
critical thinking skills necessary to create compelling and original content for immersive media. During the last two years, students apply this knowledge to content and context-specific projects in both physical and digital environments. Students work on real-world projects in collaboration with industry sponsors.

The major has different tracks of academic study to afford mastery in target areas. Track One (Computing) is focused on the implementation and creation of computer science methods used in the creation of immersive media, whereas Track Two (Emerging Creatives) focuses on content creation and concept exploration from an aesthetic and artistic standpoint. Though there are separate tracks in the major, all students in the major enroll in 'collaborative studio' courses, which foster a sustained collaborative work and study experience and which encourage students from both tracks to work together on team-based projects. Through this process students will gain a richer understanding of the field as a whole – technically-minded students in track 1 will become conversant in artistic concepts and structures, while students in track 2 will develop an understanding of, and general proficiency in, the technical concepts and practices in the field.

### 3. What are the educational objectives of the program?

IMDM graduates within 5 years of graduation will impact the local, state, national and global communities by:

- a. Becoming principals, leaders and recognized experts in the practice, theory and implementation of emerging immersive media design disciplines.
- b. Making substantive contributions to the fields of immersive media through commercial, entrepreneurial, social or artistic endeavors.
- c. Adding to the cultural landscape by adapting to and anticipating to the ever-evolving nature of the field in the pursuit of the creation of new knowledge and new digital artifacts of immersive media.
- d. Engage in lifelong learning, such as graduate school and other professional education.

A major goal of the program is to provide education and training to undergraduate students to prepare them to take positions at the forefront of the emerging visual IT workforce. Program faculty will be deeply involved in teaching undergraduate students in their labs, and the program's education and outreach programs will enrich our local communities. In this truly collaborative major, the structure of the courses mirror the interdisciplinary employment environment these students will enter by creating linkages between concepts and practices in the creative arts and STEM fields - in particular Computer Science. Working as collaborative problem-solving teams, this cohort will discover the convergence of their differing perspectives and pave the way for groundbreaking new research. These uniquely well-equipped students will emerge into Maryland’s educated workforce, able to pursue a robust array of in-demand careers, and poised to drive innovation in a broad range of industries with their hands-on knowledge of novel digital technology. These include the computer gaming industry, graphic design, fine arts, retail, real estate, education, healthcare, defense and engineering.
4. Describe any selective admissions policy or special criteria for students selecting this program.

Due to the nature of the subject matter, and the collaborative manner in which it will be taught, this major will require small classes affording students with substantive one-on-one mentorship and guidance from our faculty. Specifically, the collaborative studio courses which constitute the conceptual core of this major will require a level of individual instruction reflective of classes in the visual and performing arts, and advanced courses in computer science.

Working either individually or in collaborative teams, it is expected that students in this major will be creating works of media that are unique in their creative approach, and distinct from others in their technological underpinnings. In many substantive ways, the works being created in this major may have no precedent. As opposed to traditional Computer Science pedagogy, there are no readily available means to automatically ‘unit test’ a work of creative technology. Admittedly, it is requisite that completed work pass some low bar of simply functioning, however this major is fundamentally about the creative exploration of ideas and content. Our majors will be evaluated not simply on whether a thing can compute an answer, rather on how they effective convey concepts and ideas through technology. All this dictates that instructors dedicate greater amounts of time to individualized instruction than those relying on large lectures to convey a standardized set of knowledge to a large population. IMDM instructors will need to evaluate both the aesthetic and technical success, and to give careful feedback as to the successes and failures of those they mentor. This is an involved process requiring careful attention to cultural, artistic and technological history, theory and practice. Maintaining a tight and sustainable cohort will be essential for the success of this major.

As evidenced by a university-wide survey we anticipate a substantial number of students who will wish to pursue this major. This survey, administered in December 2016, asked UMD students about their interest in this major. Of the more than 1,100 respondents, 48% (543) said they would be interested in pursuing this major. This number well exceeds our proposed overall steady state target of 240 majors: 40 students for each of the four years in Track One and 20 students for each of the four years in Track Two. In addition, the lack of other immersive media design programs, the proliferation of immersive media in the marketplace will contribute to overall high demand for this program. The steady state number of 240 majors does not include first year and other beginning students who take the introductory courses but do not continue. We have used a figure of 60 for that population to estimate course enrollment, for a total of 300 majors.

To offer the optimal balance of faculty and resources to our majors, we propose to offer IMDM as a limited enrollment program. Given the dual-track nature of the major, the gateway process for the major will vary from track to track, though some common requirements be in place. Students intending to enroll in track 1 (computing) will be required to take a large number of courses offered in Computer Science, and therefore it is necessary that these students meet the same LEP requirements as put forth in Computer Science. In order to enroll in track 1 courses students must first meet the requirements put forth by the department of Computer Science for either incoming freshman, or for internal or external transfers to the major. Additionally, track one students must also meet the gateway requirements stipulated by Computer Science, namely: Completion of CMSC 131, CMSC 132, and MATH 140 with a minimum grade of C- at 45 credits. Given the number of upper-level computer science courses required of track one, were we to not apply these gateway requirements, IMDM would open back doors into the upper level CS courses to students who may otherwise be ineligible.

Additionally, students enrolling in either track will be required to pass a set of IMDM-specific gateway requirements, namely: In the semester in which they complete 45 credits, all IMDM majors, regardless of track must pass a portfolio review to enroll in upper-level IMDM courses. The portfolio review process will require students to submit a portfolio of pertinent work product from IMDM and related courses - the contents of this portfolio and its assessment criteria will be reflective of which track of the major they intend to pursue. The portfolio itself will be multi-valent, with some technical and some artistic elements, those largely visual in nature in order to gauge an applicant’s potential for success within the program. A secondary component of the portfolio will be an essay describing their goals and strategies for successfully completing the major. This essay will indicate areas of specific interest, speculate as to the type of work they intend to pursue in their intermediate and advanced level studies and discuss how the major aligns with their career aspirations. The criteria for a successful portfolio will vary depending on intended track of study, but will retain common means of
assessment which reflect the shared course experiences between tracks 1 and 2 - this may include an application-specific
small-scale project tailored to the expectations set forth in our learning outcomes. A minimum overall GPA of 3.0 at the
point of portfolio review will also be required. Students will upload these materials to an online application site, allowing
consideration of off-campus and transfer students. The Program Director and IMDM faculty will review and select
applicants to move forward in the program. We will strive to accept all students who meet objective standards at the
review, so the goals of 40 students in track 1 and 20 in track 1 are not hard limits, but our ability to serve students will
depend on resources.

Those students who are deemed to be making successful progress in all major course requirements, but do not pass the
portfolio review may be encouraged to re-apply one semester later, if the committee portfolio review suggests that there
are a small number of elements which, if more fully developed, would allow for successful entry/completion of the major.
However, students in track 1 must meet the gateway LEP requirements (occurring at 45 credits) put forth by the
Department of Computer Science without exception. It must also be noted that great effort has been taken to structure the
first semesters of the major in a way that closely mirrors the major requirements for Computer Science (track 1), and
Studio Art (track 2). This was done in attempts to allow unsuccessful candidates for the major to switch to majors in
CMSC or ARTT with as little disruption to time-to-degree as possible. We will also work to advise students on other
logical alternative majors, such as information systems, geographic information systems, and others.

We expect that students will add to their portfolio through the rest of their college career, in part to document their
individual contributions to the frequent group work projects in the program. Their portfolios will help faculty evaluate and
recommend each student as individuals, and help as they apply for positions in a creative field. We’ll start the
development of portfolios in the first course (IMDM101) and continue in other courses throughout their time in the major
to assist students in adding and sharpening. We expect to provide students an online portfolio system.
5. Indicate the course requirements with course numbers, titles and credits. If applicable, indicate if any course will also count for a general education requirement. In an appendix, provide the course catalog information (credits, description, prerequisites, etc.) for all of the courses.

In both IMDM tracks, Track 1 (Computing) and Track 2 (Emerging Creatives), students take a set of CMSC, ARTT and IMDM courses as part of the major, so all students are introduced to the practices of the base disciplines.

Throughout the four-year sequence both tracks take a sequence of IMDM courses that emphasize the development of skills in collaborative media design. See Appendix B: IMDM Four-Year Semester Plan (Tracks 1 & 2)

In the first year both tracks take IMDM101 (Introduction to Immersive Media) and IMDM150 (Introduction to Digital Media Theory and Culture). In the fall IMDM 101 students will be introduced to the practice of immersive media, both experiencing and creating examples, with a group project to introduce the collaborative nature of the field. This course will be self-contained for students who elect not to continue. In the spring IMDM 150 students will approach immersive media from a larger, theoretical and cultural context, to understand the historical and social aspects.

In the second year both tracks take IMDM227 (Introduction to Computational Media) and IMDM290 (Collab. Studio I: Image + Time). In the fall IMDM227 students will build more substantial immersive media projects, with an emphasis on interactive technologies and virtual/augmented reality. In the spring IMDM290 majors will take that technology knowledge, plus knowledge from ARTT and CMSC courses, and work in collaborative, cross-disciplinary groups to build projects of their own initiative and design.

This pattern repeats in the third year as in the fall the major will focus on developing specific artistic, technical and programming skills that then in the spring, they will explore in a collaborative studio course. Track 1 majors will take IMDM327 (Augmented and Virtual Reality) in the fall, and further develop skills in this technology. Track 2 majors will take a digital ARTT digital course. Then both will take IMDM390 (Collab. Studio III: Experiential Computing) in the spring to again work collaboratively on innovative projects, either of their design or chosen from projects offered by external mentors.

In the fourth, senior year majors will take electives, and IMDM490 (Capstone I) and IMDM491 (Capstone II) in which they will initiate, carry out and exhibit substantial projects of their own design, or in coordination with external mentors. The sequence of collaborative studio labs IMDM290-390-490/491 are key to the major, as majors will learn professional practice through collaborative and communication with a team of fellow majors with varying skill sets.

While taking the IMDM course sequence, Track 1 (Computing) majors will take a sequence of CMSC courses that get them into advanced courses in the CMSC major, so these students can master the algorithms and technologies on which immersive media is based.

While taking the IMDM course sequence Track 2 (Emerging Creatives) majors will similarly take a sequence of ARTT courses that take them into advanced ARTT courses.

In both tracks the four year plans are designed so majors can take more CMSC or ARTT, as appropriate, to strengthen their mastery of each field, up to completing the courses required for a major in each field.
### IMDM Course Requirements – Track 1 - Computing

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<td>CMSC 131</td>
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<td>CMSC 216</td>
<td>Introduction to Computer Systems</td>
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<td>Lecture/Lab</td>
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<tr>
<td>IMDM 491</td>
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# IMDM Course Requirements – Track 2 – Emerging Creatives

<table>
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<tr>
<th>Number</th>
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<td>ENGL elec.</td>
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<td>Elements of Drawing</td>
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<td>Studio</td>
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<td>Lab/Lecture</td>
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<td>Capstone II</td>
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6. Summarize the factors that were considered in developing the proposed curriculum.

In Fall 2014 Provost Rankin asked faculty with expertise in digital media to explore the possibility of a new cross-disciplinary major. Amitabh Varshney chaired the committee, which included faculty from multiple campus units and disciplines including Art, Art History, Computer Science, Engineering, English, Geographical Sciences, the i-School, Psychology, and MITH. In recognition of advances in immersive media technologies and related industries along with the push to transition from a STEM to STEAM curriculum, in April 2016 the committee proposed the Immersive Media Design Major. The proposed is a response to the changing digital media industries, the academic interests of incoming students and the shifting demands of today’s collaborative workplace.

In 2016, the Immersive Media Design Major committee convened to discuss development of a new major on campus in response to the changing digital and immersive media industry, the academic interests of incoming students and the shifting demands of today’s collaborative workplace.

Chair: Amitabh Varshney, College of Computer, Mathematical, and Natural Sciences-UMIACS, Computer Science; Co-Chair(2014-2018):
Audra Buck-Coleman, College of Arts and Humanities-Art; Co-Chair(2014-2018):
David Mount, College of Computer, Mathematical, and Natural Sciences-Computer Science;
Co-Chair(2018-Present):
Brandon Morse, College of Arts and Humanities – Art; Co-Chair(2017 – Present):
Roger Eastman , College of Computer, Mathematical and Natural Sciences – Computer Science.

Members: Shannon Collis, College of Arts and Humanities-Art,
Hasan Elahi, College of Arts and Humanities-Art,
Neil R. Fraistat, College of Arts and Humanities-English,
Henry Duval Gregory, College of Arts and Humanities-Art History & Archaeology,
Satyandra K. Gupta, A. James Clark School of Engineering-Mechanical Engineering,
Wendy Jacobs, College of Arts and Humanities-Art,
Matthew G. Kirschenbaum, College of Arts and Humanities-English,
Kari Kraus, College of Information Studies,
Kent Norman, College of Behavioral and Social Sciences-Psychology,
Justin Strom, College of Arts and Humanities-Art,
Paul Torrens, College of Behavioral and Social Sciences-Geography).

To help the committee assess the student demand for the major it carried out a survey of current UMD students from December 11 to December 16, 2016. The survey was administered through a Google forms interface and was shared with several departments and colleges, including Art, Architecture, Psychology, Theater, CMNS, ENGR, iSchool, Journalism, and Undergraduate Studies. We also reached out to Honors students in ACES, DCC, and Gemstone.
The survey started by stating the motivation:

*The University of Maryland is exploring the possibility of creating a new major on immersive media design that would combine studio art, digital storytelling, design, and computing, using virtual reality (VR) / augmented reality (AR) technology.*

*During its first phase, the major will include elements of game design, augmented and virtual reality, physical computing, and digital fabrication. The curricula would also provide a foundation for an artistic practice that would incorporate AR/VR technology. This new major would prepare students for a variety of AR-VR focused careers including jobs in the entertainment and computer games industry, education, healthcare, defense, journalism, and architecture.*

*Through this survey, we seek your input to help us gauge student interest in such a major.*

The main question of the survey and its responses are below:

**To what degree do you agree or disagree with this statement: If it were available at UMD, I would be interested in pursuing an immersive media design major that incorporates virtual and augmented reality technology.**

(1134 responses)

Overall, we received 1134 responses. Nearly half of the students (48%) strongly agreed (212) or agreed (333) that they had an interest in enrolling in the immersive media design major, if it were offered on our campus. Of the 212 who strongly agreed, 84 are currently in Computer Science, 25 in Art, 21 in Electrical/Computer Engineering, and 15 in Mechanical Engineering. Of the 333 who agreed, 87 are in Computer Science, 44 in Electrical/Computer Engineering, 33 in Mechanical Engineering, and 15 in Art.

After an initial report of the committee was accepted by the campus, the curriculum underwent multiple rounds of review and revision by ARTT and CMSC faculty who consulted with working professionals in relevant fields and compared the program to similar at other schools. There is no current accrediting body or agency for newer digital media undergraduate curricula such as proposed here. One of the largest professional groups in computer science, Institute of Electrical and Electronics Engineers (IEEE), is assembling an international task force under the IEEE Digital Reality Initiative to create developing an open, interdisciplinary curriculum framework for XR (VR, AR, MR) along with a set of guidelines/recommendations programs and courses for courses in this area, with this task force collaborate with the Association for Computing Machines (ACM) SIGGRAPH Education Committee, and we plan to work with this initiative as it develops. However, this curriculum will be primarily related to Track 1 of the IMDM program, and not cover the substantial collaborative elements of art and computer science.
7. Sample plan. Provide a term by term sample plan that shows how a hypothetical student would progress through the program to completion. It should be clear the length of time it will take for a typical student to graduate. For undergraduate programs, this should be the four-year plan.

See Appendix B: IMDM Four-Year Semester Plan (Tracks 1 & 2)

Since the major has two tracks that integrate courses from ARTT, CMSC and IMDM, and students may take different routes into major starting as first year majors, or transferring into the major from another on or off campus, it will be hard to expect all to follow a single, standard four year plan.. A specific issue is trying to balance keeping students progressing in ARTT, CMSC, IMDM and general education requirements in a timely fashion, balancing their interests in major courses with the need to take general education requirements early. We expect through optional plans and advising to support specific student needs.

In Appendix B we give four year plans for both tracks, and an alternative four year plan for Track 1 that accelerates General Education requirements for students who would like to finish those earlier.

8. Indicate whether the program will be offered in a non-standard delivery format, such as online delivery, off-campus, or through non-standard terms.

This program is intended for a standard delivery format with lectures, studio classes and lab sessions. Online components will supplement and enhance, but not replace, traditional delivery.

9. For Master's degree programs, describe the thesis requirement and/or the non-thesis requirement.

N/A
10. List the intended student learning outcomes. In an appendix, provide the plan for assessing these outcomes.

Upon graduation from the program, students in both tracks of the major will demonstrate:

1. Technical proficiency, skill, and contextual knowledge of immersive media technologies, products, and applications so as to produce physical and digital works that are technically proficient, aesthetically engaging, and which demonstrate conceptual sophistication.

2. Deep learned cross-disciplinary problem-solving and collaborative skills in both technical and creative arenas.

3. Knowledge and proficiency in user-centered practices as they pertain to the development and application of immersive media projects.

4. Capacity to adapt to new technologies, concepts and processes as well as anticipate new technical and conceptual developments in this emerging field.

Upon graduation from the program, students in Track 1 (Computing) will demonstrate:

1. Technical proficiency in the development of coding structures and algorithms central to the practices of immersive media.

2. Fluency in the methodologies of computer graphics programming for real-time and AR/VR contexts.

3. Ability to create and implement user-facing tools and algorithms for immersive media design.

4. Ability to critically evaluate and apply relevant areas of immersive media scholarship.

5. Ability to anticipate and adapt to the advent of new technological concepts, methods and practices in the field.

Upon graduation from the program, students in Track 2 (Emerging Creatives) will demonstrate:

1. Ability to effectively communicate ideas and concepts visually through the use of immersive media conventions.

2. Technical proficiency in common methods of content creation for immersive media such as creative coding, digital fabrication, physical computing, and 3-D modeling.

3. Ability to critically evaluate works of creative technology in terms of their formal, conceptual, historical and social impacts.

4. Ability to appropriately couple new technologies with traditional media in the creation of tangible immersive media projects.

5. Ability to market and promote one's work through portfolio development and business planning.

The degree to which the IMDM is meeting its goals will be assessed by means of the program's Learning Outcomes Assessment Plan (see: Appendix C: IMDM Learning Outcomes Assessment Plan).
11. Identify specific actions and strategies that will be utilized to recruit and retain a diverse student body.

At its core, the Immersive Media Design Major is about the production of cultural content. Though this content will be mediated through emerging technologies, the central focus of the program is the portrayal of unique and compelling concepts and content. It is our belief that this requires a diversity of voice, perspective and background in order to meaningfully occur. Whether it be through narrative storytelling, virtual interactive experience, or novel uses of experimental technology, our students’ primary responsibility will be the conveyance of ideas that resonate with diverse audiences and which have the potential to reflect on the human condition.

Currently, the populations of the two principal departments are relatively diverse in and of themselves: Underrepresented Minorities compose 30.4% (2017) of the student population in Art, an increase of 14% from twenty years ago. In Computer Science, the percentage of Underrepresented Minorities is 13.6% (2017) while the overall percentage of other minorities comprises 37.1% of its total population.

Gender diversity is less clear – In Art, there is actually a gender imbalance skewing female: in 2017, 75% of Art majors identified as female. In Computer Science, this number is just 19.6% (though this number has been trending upwards for the past 11 years).

To meet diversity standards in the IMDM, the Education Program Director will be tasked with ensuring that we effectively recruit and retain an appropriately diverse student population. Though it would be easy to state that we could rely on the gender diversity in Art to bolster the corresponding lack of diversity in this area in Computer Science, we do not wish to find ourselves in a scenario where there is a gender (or racial) disparity in population amongst the tracks. To ensure this does not happen, we will rely on model efforts already in place in Computer Science to mitigate these potential issues, in particular the Maryland Center for Women in Computing. This outreach program already has in place numerous workshops relevant to the subject matter of IMDM – previous ‘High School Computing Workshops at UMD’ have covered subjects such as ‘Virtual Reality Programming’ and ‘Creating Animations with Alice Programming’ which are directly relevant to IMDM course material. We will work closely with this and other community outreach programs to maintain appropriate diversity levels within both tracks of the major.

Relationship to Other Units or Institutions

12. If a required or recommended course is offered by another department, discuss how the additional students will not unduly burden that department’s faculty and resources. Discuss any other potential impacts on another department, such as academic content that may significantly overlap with existing programs. Use space below for any comments, otherwise add supporting correspondence as an appendix.

The IMDM structure does require courses from two departments external to the major, namely the Departments of English and Math.

In the case of English, we have consulted with the chair of the Department, Prof. Amanda Bailey as well as the Director of Undergraduate Studies, Prof. Christina Walter. As a result of this meeting, Prof. Walter was supportive of the major in general and had several suggestions as to courses within English which would be suitable for the major. Her input
explicitly led to the listing of English electives laid out in the four-year plan, specifically she recommended the following courses as suitable offerings for the major and supported their inclusion:

ENGL 143 – Visualizing Knowledge: From Data to Images - though a section of seats in this course are reserved for 'Carillon' students, once those students register, the remaining seats would open to IMDM students.
ENGL 146 – Seeing the Present: Design, Graphic Storytelling, and the Politics of Visualization - expected to have Gen Ed approval by fall 2019 – no undo pressure on seats was expected at least at the initial expected enrollment of 60 students in the major.
ENGL 245 – Film Form and Culture
ENGL 290 – Introduction to Digital Studies
ENGL 293 – Writing in the Wireless World
ENGL 294 – Persuasion and Cleverness in Social Media
ENGL 398A – Professional Writing: Writing for the Arts.

Prof. Walter has affirmed the support of the English Department in offering these courses to IMDM majors in email correspondences with both Prof. Buck-Coleman, and Prof. Morse.

In the case of Mathematics, we consulted with the chair of the department, Prof. Scott Wolpert, and corresponded with faculty interested in courses relevant to immersive media. Mathematics has traditionally offered courses required by Computer Science majors, including as CMSC140 Calculus I and CMSC141 Calculus II, along with an advanced class, CMSC431, Geometry of Computer Graphics, that would be a good elective for IMDM Track 1 majors. We did discuss a potential Mathematics course designed specifically for Track 2 majors, but have not completed the course design and are currently using CMSC115.

For Documentation of correspondence between IMDM development personnel and both ENG and MATH, see Appendix D: Affirmation of Support From External Departments.

**13. Accreditation and Licensure. Will program need to be accredited?**

N/A

**14. Describe any cooperative arrangements with other institutions or organizations that will be important for the success of this program.**

N/A
Given the interdisciplinary structure of this major, we believe that a governance structure that is independent of the principle academic units involved is necessary. To this end we intend the creation of an ‘Academy of Immersive Media’ (AIM) to provide academic direction and oversight for the program. The University of Maryland Institute for Advanced Computer Studies will initially serve as the home for this new academy. The governance structure will consist of:

**Academic Director:** The Education Program Director will be responsible for overall program development, administration, and supervision of all IMDM tracks; and develop assessment protocols to track program effectiveness and student success. The Education Program Director will also provide leadership in recruitment of new students to the program as well as review and approve new applications for admission to the program; This position will also assist in supervision of the faculty, staff and TAs related to the program.

**AIM Staff:** Advising, administration, promotion and various other duties will be undertaken by staff as outlined in section 19 of this document.

**AIM Faculty:** All faculty responsible for administering IMDM courses will share responsibility in ongoing governance, consisting of, but not limited to service duties in curricular guidance, learning outcome assessment, admission portfolio assessment, and facilities development. For a listing of faculty involved in the program, see Appendix E: Faculty and Organization: Potential Faculty Involvement in IMDM

Advising:
The academic and career advising for IMDM majors will principally be administered by IMDM academic advisors. One full-time advisor will be dedicated to each track within the major and each advisor will be housed within the Department most closely associated with the track, i.e Computer Science for Track 1, and Art for track 2. College level advising will be housed in CMNS for track 1, and ARHU for track 2. Given the LEP requirements of the major, students in the IMDM major below the 45 credit LEP threshold will be closely advised as to their potential to move forward through the LEP process and into the upper level IMDM courses. Students in the first three semesters of study will be counseled not only by the IMDM academic advisors, but also mentor faculty and staff within the program with careful attention being paid to a student’s potential routes though the major. All IMDM majors will be afforded the option of switching tracks within the major depending on individual skills and interests. For instance, if a student enrolled in track 1 be lacking in certain technical skills, yet have outstanding creative thinking potential, they may be counseled to switch tracks to the ‘Emerging Creatives’ track. Likewise a student enrolled in track 2 who perhaps exhibits higher levels of technical sophistication at the expense of creative and artistic skills may consider switching to track 1.

In addition, care was taken to ensure that those students who do not meet the LEP requirements at 45 credits may move to affiliated majors without losing time to degree. The first three semesters of both track 1 and track 2 consist of curricula which heavily overlap with relevant majors, namely Computer Science for track 1, and Studio Art for Track 2. Students not passing the LEP process would be able to move to these majors with little to no effect on time to degree.

Students who have completed the LEP process will be advised by dedicated advisors in each track on an ongoing basis, and advisors will work closely with the Program Director, as well as the IMDM faculty to ensure each student is offered...
timely and prescient academic and career advising. Advisors will report to the program director on a regular basis to aid in this process. Upon completion of the LEP process, academic advising will proceed as follows:

IMDM- Track 1 ‘Computing’. IMDM/CMNS will be the academic advising department / college for students in track 1. Students in this concentration will graduate with a Bachelor of Science in Immersive Media Design from CMNS.

IMDM- Track 2 ‘Emerging Creatives’ IMDM/ARHU will be the academic advising department / college for students in track 2. Students in this concentration will graduate with a Bachelor of Arts in Immersive Media Design from ARHU.

**Resource Needs and Sources**

16. Each new program is required to have a library assessment in order to determine any new library resources that may be required. Please contact your departmental/programmatic library liaison or Daniel Mack at dmack@umd.edu, Associate Dean of Collections, to request a library assessment that will be added as an appendix.

See Appendix F: Library Assessment.

17. Discuss the adequacy of physical facilities, infrastructure and instructional equipment.

Given the unique nature of the student work in this major, and the collaborative manner in which they will be undertaking it, assessing the adequacy of physical facilities is a complicated and multi-valent affair. Students in this major will be creating unique works of immersive media design utilizing practices and skills derived from the fields of art and design, coupled with practices in physical and creative computing. Works of this nature, i.e. works which are intended by their very name to be ‘immersive’ require a scale and flexibility in physical facilities that broadly aligns with those of traditional programs in Art, Design, Architecture, and to a lesser degree Performing Arts. Given the field, there is an additional necessity of immediate access to high-tech equipment and high-end computer labs to facilitate the work being undertaken by students in the major.

Due to the dual-track nature of this major, we expect some variance in facilities requirements between tracks, however with the focus on maintaining an ongoing collaborative experience between tracks, and emphasis on team-based teaching and learning we expect that the shared courses, i.e. the ‘IMDM’ prefix courses will carry with them the following facilities requirements:

The IMDM collaborative and studio-based courses need to facilitate a range of instructional needs: lectures and PowerPoints by instructors, class discussions, critiques of finished professional work as well as in-progress student work in a variety of media (from paper prints to screen-based versions to VR/AR to physical objects), and technical instruction. These spaces need to be outfitted with appropriate supporting technology including green screens, AR/VR headsets for testing works, and physical computing needs including 3D printers and related digital fabrication tools such as laser cutters and circuit building equipment. A lecture hall space or generic classroom will not be sufficient. The work being conducted by these students will be expansive and, in many ways, without precedent. It follows that the spaces in which they will work must facilitate this practice; they must conducive to experimentation, be open and flexible and allow for easy access to the latest technology in the field. We do expect that IMDM majors may use different spaces on campus, such as Makerspaces maintained by the Library, or other similar campus-level resources.
We are currently working with the College Park administration to identify suitable space as a core facility for the major, a central space for collaboration and specialized equipment. We do expect to use space across campus as appropriate and available, such as Makerspaces supported by the library. Currently, the Department of Computer Science has set aside a space in the Iribe Center for use by the IMDM program for primarily AR/VR, and combined with a collaborative classroom and the new Makerspace on the same floor, this may prove adequate for foundations-level offerings in IMDM (namely IMDM 101, 127, & 227). It should be noted that this space is currently slated to be shared by IMDM and other organizations within CS, and its shared-usage status, along with its limitations with regards to fabrication, projection, and exhibition leave it wanting in terms of its ability to service the collaborative and capstone courses offered at the upper level of the major. Additionally, the Department of Art has one dedicated digital media production space as well as spaces sufficiently equipped for fabrication and production needs, however these spaces are already scheduled at or near full capacity. The digital media space already services at minimum three courses in digital media per semester; leaving room for at most an additional three sections per semester. The fabrication facilities in the Department of Art are scheduled to near capacity leaving little capacity or flexibility to service the fabrication-related needs of the major. Collaborative and proximate classrooms and lab spaces will be essential for the success of this program. Given the experiential nature of the subject of the major, allowing students and faculty to easily see what others are doing and facilitating impromptu in-progress critique and problem solving is essential. To that end, we strongly advocate for a space that will accommodate the spatial needs of both Track 1 and Track 2 simultaneously. We foresee the division of these two tracks across physical spaces (such as in separate buildings) as detrimental to the overall interdisciplinary and transdisciplinary mission of the major. Without ample proximate teaching and making space, the collaborative potential of this major will be reduced. With this in mind, it is apparent that current facilities are not adequate. To effectively offer this major, we anticipate the following needs:

Collaborative studio & lab learning spaces:

Fabrication & teaching space (1): This space would be for creating physical objects and specialized VR/AR/interface construction. This space is set up for messes to be made without adversely affecting the necessary technology. This space could include electronic workbenches, vinyl cutters, 3D printers, CNC routers and other machinery as well as tables and workstations.

*Estimated square footage need: 3,000*

Technology and teaching space (1): These spaces would be dedicated to digital content creation and would have dedicated computers in the space as well as space for presentation, critique and discussion. Ideally, this space would be situated adjacent to the production and exhibition space described below. This space is available for students to test projections, wearables, and other in-progress works. Having proximity to the assigned classroom space will allow other students to keep working on computers as needed as instructors flow back and forth between spaces as needed.

*Estimated square footage need: 1,500 - 2,000 sq. ft.*

Production / Exhibition Space: A space set up with production and media capture equipment such as motion capture and a green-screen to be used for projection-based and immersive media (AR/VR, performance, animation) course work. This space will need dedicated computers with ample processing power and the corresponding hardware and software to facilitate exploration and creation of IMDM projects.

If outfitted properly, this space may also serve a dual purpose as a space to showcase and exhibit works done by students in the major. In addition to providing a venue for students to learn through doing, it will serve as a calling card and recruitment gem for the major itself. An advisor, faculty mentor, or student should be able to at any moment point to the amazing work being done in the major as a way to recruit top-level students into the program. This space would also serve as a space for symposia, visiting scholar presentations and lectures.

*Estimated square footage need: 2,000*
Studio Spaces: A series of relatively small (200-300 sq. ft) spaces in which capstone teams and students may work on their ongoing projects without having to worry about leaving works-in-progress out in an unsecured or publicly available space. These studios would be dedicated to a limited number of capstone projects determined by project needs and strengths.

Estimated square footage need: 1500

We recommend that the aforementioned facilities be located in spaces that are advantageous to both tracks involved in the major. In order to facilitate collaboration and maintain parity amongst the tracks, it is not desirable that the gravity of location swing towards one department or another. Facilities should encourage egalitarianism and be conducive to the unique collaborative nature of the major. In lieu of a purpose built home for this major, we seek spatial resources that provide balance between the disparate homes of the major, namely Computer Science and Studio Art. We will of course leverage the unique strengths of each department's facilities where necessary, i.e. large-scale installation, exhibition and fabrication in Art Studio and high-end computing environments in Computer Science.

Administrative and faculty offices (7-12): We envision that as the program grows the need to hire more staff and faculty members will as well. Thus, the space needs to be able to accommodate this growth. We anticipate a need for 5-8 faculty offices. The lower end would be needed at the beginning of the program, and the higher end would be needed as the program develops. We would also 2-5 administrative office spaces. We foresee needing the more spaces as the program expands and thus so would the need for more administrative positions. These positions would include a program director, course advisor, recruitment and marketing position and an administrative assistant.

18. Discuss the instructional resources (faculty, staff, and teaching assistants) that will be needed to cover new courses or needed additional sections of existing courses to be taught. Indicate the source of resources for covering these costs.

Faculty (10)

Studio-based courses in subjective, creative fields like the arts require an approach to instruction which involves substantial time working with students individually or in small teams. The nature of the field is such that no two outcomes are ever the same – each student, or group of students bring their own creativity, aesthetic and conceptual training, and personal history to a project. This requires carefully tailored feedback from instructors which address the unique qualities of any given project. To facilitate this level of instruction, faculty will need to be brought on in both CMSC, and ARTT to accommodate the course offerings. It is important to note that the hiring of these faculty may be staggered over the course of the first four years of the major's existence: As students matriculate to upper-level courses, faculty may be hired in anticipation of this cohort reaching yearly benchmarks. For a detailed breakdown of faculty requirements and timeline, see: Appendix G: Instructional Resources - Faculty timeline.

Teaching Assistants (14.5): Integral to accommodating the instructional workload of the IMDM program develops are an appropriate compliment of dedicated Graduate Teaching Assistants (TAs). TAs are, first and foremost, graduate students pursuing an education. The opportunity to work closely with faculty members and undergraduate students in teaching, research, or administrative environments is an integral part of that education. Graduate students who hold assistantships gain further expertise in their field; enhance their research skills and develop pedagogical skills; acquire experience in leadership, interpersonal effectiveness, and performance evaluation; acquire academic administrative experience; and enjoy collegial collaborations with advisors that may result in joint publications and other professional activities. For IMDM TAs, duties include assuming teaching responsibility for a laboratory or discussion session of a course; assisting a faculty member in the grading, advising, and administrative duties necessary for a course(s); and assisting in general departmental administrative duties, such as advising or the administration of community programs, workshops and other projects. All
TAs serving in any capacity are under the direction and close supervision of a member of the faculty. For a detailed breakdown of requirements and timeline, also see: Appendix G: Instructional Resources - Faculty timeline.

19. Discuss the administrative and advising resources that will be needed for the program. Indicate the source of resources for covering these costs.

**Educational Program Director (1):** The Education Program Director will: provide leadership for the recruiting of new students for the program; review and approve new applications for admission to the program; review and assess overall diversity benchmarks for the program; be responsible for overall program development, administration, and supervision of all IMDM tracks; and develop assessment protocols to track program effectiveness and student success. This position will also assist in supervision of the coordinator and GAs.

**Advisors (2):** The IMDM’s two full-time advisors will help students to appropriately shape and target their coursework to meet their academic and professional interests. They will: assist with review and approval of new applications for admission; meet with incoming advisees for orientation to the program and its tracks; and will subsequently meet at least once each semester with continuing students to plan for the coming semester and to review/revise long-range academic program schedules. They will also monitor student progress toward educational/career goals and meet at least once each semester to review the progress toward completing the proposed academic program and to discuss grades and other performance indicators.

**Coordinator (1):** We include full-time effort for a coordinator position for the proposed major. This kind of intensive campus-wide activity, which pulls together 12 faculty, 8 staff members and 16 teaching assistants from across colleges and departments will require significant administrative support. As such we have identified a need for one full-time staff position to serve as the IMDM administrative coordinator. This position will be responsible for: working with IMDM faculty, advisors and students as program develops; identifying and securing meeting venues; coordinating with vendors; assisting in the development of printed and electronic publicity material; managing the IMDM website; responding to general email or telephone questions from the public; and assisting educational and research program directors with other tasks as necessary.

**Content Production Assistant (1):** AR/VR promises to fundamentally transform how we educate and train across all age groups and a diverse array of disciplines. The key to realizing this potential in the IMDM program is virtual content creation; to this end, we believe that a content production assistant will provide vital assistance to the faculty, staff and students in the major. This person will work in tandem to with faculty, staff and students to design compelling VR environments and create frameworks for educational experiences in key thrust areas that we’ll develop with corporate partners and stakeholders which will dramatically enrich students’ educational experiences, and improve their portfolios. For example, we imagine modules that allow a student to grasp the spatial relationship amongst the atoms of a protein through an interactive 3D model; modules that allow physics students to explore 3D projectile motion in AR to see what path an infinitely bouncing ball would take when thrown against the wall of the classroom, or thrown in the gravitational fields on the Moon or Mars; or modules that are in essence virtual field trips that show students how their own carbon footprints contribute to ocean acidification and the eventual destruction of coral reefs. The potential for embodied cognition inherent in this content will allow us to create lessons that go far beyond text, but will depend on the expertise and support of the content production assistant.
Lab Technician/IT (2): Technology support will be vital to the smooth and efficient operation of the Academy. Lab technicians will be responsible for: providing and maintaining online account access, backup and storage for students and faculty; implementing and maintaining lab hardware and software upgrades; implementing and maintaining security measures to safeguard both information and equipment; and providing network maintenance, research computing support, and general technology support and training.

Marketing (0.5): We note that there are several similar digital media design programs nationwide; in order to quickly and competitively establish a presence on the national stage, we will require marketing support, at the level of one-half FTE, for both student recruitment efforts, and for outreach to potential corporate partners. This position’s duties will include: assistance with the design of comprehensive program marketing plans; development and support of communications strategies; assurance of quality and appropriateness of marketing activities; and coordination of surveys, evaluations and assessments of external communications activities in order to determine the effectiveness of the program’s marketing and communications plans.

Finance/Budget (0.5): To maintain fiscally-responsible operations, we advise finance/budget support at the level of one-half FTE. This position’s duties include: analysis of a variety of financial information (e.g. revenues, expenditures, cash management, and cost projections) for the purpose of providing financial direction, maximizing use of funds, and ensuring overall operations are within budget.
20. Use the Maryland Higher Education Commission (MHEC) commission financial tables to describe the program's financial plan for the next five years. Add these tables as attachments. Use the space below for any additional comments on program funding. DRAFT ONLY

<table>
<thead>
<tr>
<th>Expenditure Categories</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
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<tr>
<td>1. Full-time Faculty (b+c below)</td>
<td>$478,800</td>
<td>$772,624</td>
<td>$1,269,897</td>
<td>$1,307,994</td>
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<td>c. Total Benefits</td>
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<td>$315,087</td>
<td>$324,540</td>
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<td>0.4</td>
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<tr>
<td>b. Total Salary</td>
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<td>$60,000</td>
<td>$60,000</td>
<td>$60,000</td>
</tr>
<tr>
<td>c. Total Benefits</td>
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<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
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<tr>
<td>3. Admin. Staff (b+c below)</td>
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<td>c. Total Benefits</td>
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<td>4. Total Support Staff (b+c below)</td>
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<tr>
<td>b. Total Salary</td>
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<td>5. Graduate Assistants (b+c)</td>
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<td>7. Library</td>
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<td>$5,000</td>
<td>$5,000</td>
<td>$5,000</td>
<td>$5,000</td>
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<tr>
<td>8. New or Renovated Space</td>
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<td>$125,000</td>
<td>$100,000</td>
<td>$100,000</td>
<td>$100,000</td>
</tr>
<tr>
<td>9. Other Expenses: Operational Expenses</td>
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<td>$80,000</td>
<td>$80,000</td>
<td>$80,000</td>
<td>$80,000</td>
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</table>

The university is not anticipating overall enrollment growth as a result of this major (more so a shift in major selection by matriculating students), so no new tuition revenue is assumed in identifying resources. Resources will come from redirection of tuition revenue at the campus level, redirection of instructional resources from the collaborating colleges, from enhancement funding, and from other reallocated resources within the university.
21. **Explain how there is a compelling regional or statewide need for the program. Argument for need may be based on the need for the advancement of knowledge and/or societal needs, including the need for “expanding educational opportunities and choices for minority and educationally disadvantaged students at institutions of higher education.”**

With the advent of the Internet and related technologies, we have witnessed a substantial and necessary turn towards the STEM fields at academic institutions the world around. Researchers working in computer science and related fields have opened doors and democratized information in a manner that was previously unimaginable. Though this process, scientists have solved countless problems and paved the way towards a society empowered with commonplace technologies that would have seemed impossible only a few years ago.

As this technological landscape matures, focus increasingly turns towards how these tools are being used to affect our cultural and societal landscape. Increasingly, those in the STEM fields look to incorporate the creative problem-solving and inventiveness often associated with those in the arts as a means to contextualize and enliven advances in technology. Likewise, artists and creatives in the twenty-first century must take into account ubiquitous technology as they address the cultural landscape around them. Indeed, it has become impossible to effectively function as an artist, designer or creative entrepreneur without mastery of numerous technical skill sets ranging from simple image manipulation to advanced generative and reactive creative computation practices.

The concatenation of STEM practices with the arts within the academy has come to be known as STEAM (Science Technology Engineering Arts and Math). The Immersive Media Design Major represents a substantive union of the STEM fields and the creative practices. It is a concrete example of STEAM curriculum in practice; one which has the potential to engender unique ways of navigating both fields for a new generation of thinkers, makers and doers. Students in computing, art, education, engineering, behavioral and social sciences, information and business—working together—will discover the convergence of their differing perspectives and pave the way for groundbreaking new research. These uniquely well-equipped students will emerge into Maryland’s educated workforce in three to five years able to pursue a robust array of in-demand careers and poised to drive innovation in a broad range of industries with their hands-on knowledge of novel digital technologies.

The State of Maryland and greater Washington region are poised to capitalize on the virtual and augmented reality industry. The region has many startups, including Machine Elf (program for developers, architects and engineers to better communicate building plans via a virtual reality headset), Agora VR (software that lets users attend seminars, university lectures or business meetings with the help of a virtual reality headset), VisiSonics (hardware and software designed to bring life-like audio to gaming, virtual-reality environments, movies and music), Brightline Interactive (created virtual reality gaming experience for Toyota to accurately illustrate the dangers of distracted driving), and Sensics (builds open-source virtual reality headsets and software).

By training students to be thinkers as well as makers and doers, we can incentivize them to transition their study into practice. Specifically, our major will coordinate with an annual programming and building contest (VR Camp), bringing together hundreds to thousands of student attendees, where students take what they love, fuse it with technology, and build something the world has never seen. Unlike other “hackathons,” these events will bring together students that are exclusively focused on VR and AR, but from an interdisciplinary point of view, including computer scientists, engineers, psychologists, and artists. Through significant collaboration with the local and national digital media industry, we anticipate at least 10 startups will arise from this initiative over a period of five years, further showcasing Maryland as a unique location for entrepreneurial and innovative business opportunities in the country.
Further, Maryland has one of the largest clusters of computer gaming companies on the East Coast, with over 50 companies involved in games and games-related ventures. Our links to this growing industry remain strong, including a steady flow of graduates to both established companies and startups. Oculus VR co-founders and their families committed $38 million to UMD in September 2014 to help establish our leadership in virtual and augmented reality. UMD is also strongly supported by NVIDIA, a leading vendor of visual computing processors, through the company’s Center of Excellence program. According to a 2010 report prepared by Sage Policy Group for the Maryland Department of Business and Economic Development, “Digital media is a $5.5 billion industry in Maryland. Once one considers multiplier effects, the industry is associated with $15 billion in economic activity in Maryland each year; in fiscal year 2008, Maryland’s digital media industry contributed more than $1 billion to State and local government revenue.” We are uniquely positioned to catalyze this rapidly growing segment of the local and national economy.

The Immersive Media Design Major also addresses several goals put forth in the Maryland State Plan for Postsecondary Education. The State Plan identifies ‘Innovation’ as one of six primary goals. In particular, it defines innovation as “the use of new, transformative approaches to delivering and evaluating postsecondary institutions’ offerings, instructional methods, and training models and systems as a way of facilitating student success.” It goes on to state: “The State encourages the development of new, diverse, creative, and collaborative practices that enhance the quality, effectiveness, and adeptness of offerings and services provided by postsecondary institutions.” The Immersive Media Design Major was envisioned from the beginning as a model of interdisciplinary collaboration bringing together disciplines from across campus. The comprehensive collaborative nature of the major, which involves team teaching with faculty from different colleges and departments, along with the expectation that students from disparate fields collaborate to find success seems uniquely prescient to this goal of the State Plan. In addition, it should be obvious from the content of this proposal that this program itself addresses a newly emerging high-tech field which is poised to become ubiquitous in daily life. The State Plan specifically outlines trends which underscore the need for educational innovation to include:” the need for more high-tech, cyber security, health and education workers.” The IMDM specifically addresses this need for more high-tech workers in the state workforce.

In addition, Goal 5 of the State Plan: ‘Economic Growth and Vitality” the plan goes on to put emphasis on partnerships with industry: “Collaboration among postsecondary institutions and business and industry is essential to the development and adoption of innovative approaches and strategies that can address the changing needs of the workplace and workers.” A required component of the capstone year of the IMDM program is that each and every student work with an ‘External Mentor’ though that mentor can come from the campus community, it is explicitly encouraged that this mentor be a professional from a relevant industry or field, thus ensuring input and feedback from relevant business and industry.

The IMDM also addresses several challenges put forth in the state plan, among them, collaboration: “Collaborative efforts can reduce burdens on individual institutions, agencies, and businesses, and enhance the coordination of strategies to better identify and respond to student and workforce needs.” The collaborative nature of this major speaks directly to this challenge. Indeed, IMDM envisions a scenario where collaboration is the defining characteristic of the curriculum. It recognizes intrinsically that collaboration fosters a synergetic scenario in which complementary disciplines work together to better serve our student population.
Broadly speaking, the field of Immersive Media Design encompasses a constellation of industries from computer science, entertainment, game design, graphic design, industrial design, the fine arts, architecture, and other related fields. Specifically, Virtual & Augmented Reality as a field unto itself is in its infancy, and as such, employment and market data is sparse. It is precisely this nascence which makes this major so promising; It situates the University of Maryland as a forerunner in the field and, in doing so, positions the program in an aspirational position for top-ranked students from around the world and as exemplar for other institutions across the country. We expect to graduate 60 students a year at steady state.

Projections indicate that AR/VR as a field is set to expand rapidly over the next five to ten years: A five-year projection of total AR/VR spending by Digi-Capital suggests a growth in revenue in AR/VR markets which will grow from $2B in 2016 to nearly $110B in 2021. Govini – a government spending analysis firm shows that DoD spending alone on AR/VR grew at a 16.9% compound annual growth rate between 2012 and 2017. A January, 2017 report by TechCrunch anticipates that by 2021, AR/VR fields could command a market of $108B annually, and a recent International Data Corporation (IDC) study shows that spending on AR/VR services will reach $27B in 2018, a 92% increase over spending in 2017. Further, the IDC study expects a five year compound annual growth rate of 72% (2017-2022). In a January 2016 report, Goldman Sachs predicted that by 2025, virtual and augmented reality technologies will command an addressable market of $85B. The Goldman Sachs analysis goes on to discuss the breadth and potential of the AR/VR landscape – it estimates the following spending across the enumerated fields:

- Video Games: $11.6 Billion by 2025 with an estimated 216 million users
- Live Event Production: $4.1 billion by 2025 with an estimated 95 million users
- Video Entertainment: $3.2 billion by 2025 with an estimated 79 million users
- Retail: $1.6 billion by 2025 with an estimated 32 million users
- Real Estate: $2.6 billion with an estimated 300,000 users
- Healthcare: $5.1 Billion with an estimated 3.4 million users
- Education: $700 million with an estimated 15 million users
- Military: $1.4 billion with an estimated 700,000 users
- Engineering: $4.7 billion with an estimated 3.2 million users

Further, in 2017, Citi Research predicted that by 2035, that market could grow to $2T. The potential for disruption in the job market in the near future is clearly massive.

For sources and graphs, see: Appendix H: AR/VR Market Analysis
23. Identify similar programs in the state. Discuss any differences between the proposed program and existing programs. Explain how your program will not result in an unreasonable duplication of an existing program (you can base this argument on program differences or market demand for graduates). The MHEC website can be used to find academic programs operating in the state: http://mhec.maryland.gov/institutions_training/pages/HEPrograms.aspx.

In public institutions in the state of Maryland, the following offer programs which may be considered similar to the IMDM proposal:

1) University of Maryland, Baltimore County – Degrees Offered: BA, BFA Visual Arts with a Concentration in Animation/Interactive Media
2) Bowie State University – Degrees Offered: BS in Visual Communication and Digital Media Arts (VCDMA) with a Concentration in Animation & Motion Graphics, Digital Cinema & Time-Based Media, and Digital Media Arts
3) University of Maryland, Baltimore County – Game Development track in the Computer Science BS degree
4) Notre Dame of Maryland University Digital Media Arts BA
5) Maryland Institute College of Art - Degrees Offered: BFA Animation, Interaction Design and Art; MFA Illustration Practice
6) Salisbury University - Degrees Offered: BA, BFA Art with a New Media Track. Note: Video, Audio, Animation, Web Design, and Screen Graphics are all components of the New Media Track.
7) Towson University - Degrees Offered: BFA Art and Design with Concentration in Digital Art and Design, Illustration; MFA Studio Art; Post-Baccalaureate Certificate in Interactive Media Design
8) University of Baltimore, BS. in Simulation and Game Design

The listing above represents an exhaustive listing of institutions in the state which have degree programs which explore to varying degrees the overlap of technology and the arts. An examination of the curricula of said programs indicates that the IMDM will not replicate the curricula or learning outcomes of any of these programs in any substantive manner. This is due primarily to several defining characteristics of the IMDM curriculum that are not present in any of the aforementioned programs:

1. The programs listed above all exist as siloed programs within singular academic homes; they do not offer the sustained collaborative curriculum between Computer Science and the Arts as defined in the IMDM curriculum. Though the 'Gaming Arts and Interactive Media' program at UMBC does in fact contain both an 'arts track' and a 'computing track' there are no courses listed in which students from both tracks are asked to work collaboratively. IMDM seeks to maintain a semester-to-semester collaborative experience and reinforces this with numerous courses in which the subject matter explicitly demands successful collaboration between the technically and artistically-minded.

2. None of the programs enumerated above explicitly prepare students for careers in Immersive Media Design. Though the curriculum of the programs above deal with the intersection of technology and the arts, none of the aforementioned programs explicitly cover Augmented or Virtual Reality – they place primacy in several realms, be it game design, 3-D modeling and Animation, or Screen-based Creative Coding, however none of these programs are described as approaching computing as a field that can be physically experienced and as encompassing of all of the senses as Immersive Media Design with its focus on AR/VR, tangible computing, digital fabrication and physical interactivity.

3. The IMDM curriculum is written as a ground-up standalone major which draws on the strengths of our faculty in Art, Design, and Computer Science. It consists of a four-year curriculum which builds skills and critical-thinking capacity year-over-year from the freshman year though graduation. In contrast, the programs above by and large consist of two-year (junior and senior) addenda to existing majors, or as major-elective tracks consisting entirely of 400-level courses taken only in the student's junior and senior years.
24. Discuss the possible impact on Historically Black Institutions (HBIs) in the state. Will the program affect any existing programs at Maryland HBIs? Will the program impact the uniqueness or identity of a Maryland HBI?

Of programs in the state at Historically Black Institutions, the 'Visual Communications & Digital Media Arts' concentrations at Bowie State University appears to be the sole program with meaningful overlap in curriculum with the IMDM proposal. This comes in the form of several courses within the Digital Media Arts concentration, namely: ART 342 – New Media Public Art Installation, ART 230 – Introduction to Computer Graphics, and ART 470 – Self-Promotion & Marketing in the Arts, ART 479 Animation and Modeling II.

Though these courses overlap in subject matter with several courses in the IMDM proposal, these courses cover subject matter which may be said to be foundational practices within the media, and therefore overlap is expected. The Visual Communications and Digital Media Arts concentrations at Bowie State University are offered entirely within the context of a 'Department of Fine and Performing Arts.' They do not offer a program with a similar interdisciplinary bent as that which is put forth in this proposal. Further, there is no mention of software development, tangible computing, digital fabrication, and related Immersive Media Design fields within the curriculum at Bowie State University. With this in mind, we do not anticipate that the IMDM program will adversely affect the existing program at Bowie State University.

25. For new Post-Baccalaureate Certificates derived from existing master’s programs only, include the complete curriculum of the existing master’s program.

N/A
Appendix A: Course Descriptions and Prerequisites

Course Descriptions: IMDM course listings (tracks 1 & 2)

IMDM 101 – Introduction to Immersive Media
Credits: 3
Prerequisite: N/A
Course Description:
IMDM 101 is an introduction to the basic practices, concepts and issues in the field of Immersive Media Design. This course is a hybrid studio / lecture course in which students will work collaboratively in teams to complete both research and practical projects related to the field. Topics covered include: creative labs with software and interactive hardware, surveying the contemporary and historic works of Immersive Media Design, and speculative project design.

IMDM 127 – Creative Coding for Digital Media
Credits: 3
Prerequisite: N/A
Course Description:
An introduction to program supported by exercises in creative coding, creating code for algorithmic and interactive art. Students will use a problem-driven approach to design and build software for the visual and auditory arts. The course also includes an introduction to a wide variety of issues relating to computational including software design and construction, supporting mathematics, and how computational approaches impact artistic choice. The course assumes no background in programming and is targeted to students with a broad diversity in backgrounds and interests.

IMDM 150 – Introduction to Digital Media Theory and Culture
Credits: 3
Prerequisites: N/A
Course Description:
IMDM 150 is an introduction to the fundamental structures and themes of digital culture in contemporary society as related to immersive media. This course will provide examples of contemporary works of Immersive Media Design, New Media Art, and emerging cultural technologies to demonstrate pathways towards becoming active producers, critics, and consumers of digital culture. It will explore the dynamic interplay between culture and emerging digital technologies and examine the many ways in which they influence our lives.

IMDM 227 Intro to Computational Media.
Credits: 3
Prerequisites: IMDM 127 or CMSC 131
Course Description:
IMDM 227 is an introduction to practices in computational media as they pertain to the implementation and creation of virtual and augmented reality applications. This course will cover this subject matter from both technical and aesthetic viewpoints. Students are introduced to basic programming constructs, digital asset creation processes, algorithms, and data structures associated with Augmented and Virtual Reality (AR/VR) production pipelines.
IMDM 290 – Collaborative Studio I: Image + Time  
Credits: 3  
Prerequisites: IMDM 101, IMDM 150, ARTT255, IMDM 227, Candidate Portfolio Review  
Course Description:  
IMDM 290 is concept-driven team-taught studio course in which you will work together in groups to create intellectually engaging and technically innovative works of time-based media. It bridges the technical and creative tracks of the major to expose students to the process of working collaboratively on team-based projects in a manner that reflects contemporary practices in the fields of art, design, and creative technical industries. Topics include: image manipulation, audio/video production, generative and procedural image manipulation processes, as well as effective teamwork, exhibition, installation and presentation design.

IMDM 327 – Augmented and Virtual Reality  
Credits: 3  
Prerequisites: IMDM227, CMSC132  
Course Description:  
Introduction to mechanisms and programming for virtual reality, augmented reality, and related technologies. Covers elements of a standard VR system, including creating, managing and rendering visual and audio VR content, tracking orientation and positions of head mounted display (HMD) and controller, rendering stereo imagery for VR headsets, and implementing approaches for user interactivity.

IMDM 350 – Advanced Digital Media Theory  
Credits: 3  
Prerequisites: IMDM 290  
Course Description:  
IMDM 350 is an lecture course covering advanced theories and concepts in the fields of immersive media design, new media art, design, and cultural technology. Building on the foundation of IMDM 150, this course looks at ways in which contemporary societal norms are being shaped by game culture, social and mobile media, AR/VR escapism, network aesthetics, hacktivism, open-source culture, neural networks, artificial intelligence, and machine learning, among others. This course addresses the broad range of ways in which the accelerating pace of technological advances influence how we mediate the world around us and examines the environmental, social, political, and ethical implications of its use.

IMDM 351 – Digital Innovation Marketing and Business  
Credits: 3  
Prerequisites: IMDM 290  
Course Description:  
IMDM 351 is a lecture course in which students research and learn how to implement best practice strategies in building support for wide ranging projects in the fields of applied creativity (such as entrepreneurial ventures, media startups, public media arts and design projects). Students in IMDM 310 will learn how to effectively build a modern promotional portfolio that supports their entrepreneurial, creative, emerging technology, new-media, and artistic endeavors. Topics include: portfolio building, grant writing, social media public relations, oral presentation and promotion.

IMDM 358 – Experiential Learning  
Credits: 2-6  
Prerequisites: IMDM 290  
IMDM 358 supports those students wishing to seek out professional experience in relevant Immersive Media Design fields. This course is an elective open to students from all tracks of the major who wish to participate in
internships in a position or at an organization which will offer real-world experience, knowledge and feedback from mentors working in a relevant field.

IMDM 390 – Collaborative Studio II: Experiential Computing  
Credits: 3  
Prerequisites: IMDM 290, ARTT37x or IMDM 327  
Course Description: 
IMDM 390 is an intermediate-level concept-driven team-taught studio course wherein students work in groups consisting of students across both tracks of the major. The objective of the course is to create multi-sensorial works of art, design, and cultural technology through the use of inventive digital processes such as 3-D modeling, procedural animation, audio synthesis, and interactivity. Emphasis is placed on the development of works which envelop the viewer or participant and exhibit a physicality which manifests from the ephemera of digital media. Topics covered include: 3-D modeling, digital cinematography and lighting design, digital fabrication, projection design, sound design and electronics.

IMDM 470 – Performative Computing  
Credits: 3  
Prerequisites: IMDM 390  
Course Description: 
IMDM 450 is a studio course which introduces intermediate and advanced level practices and theories of designing physically interactive immersive media experiences. Through the use of emerging systems of interaction design, digital sensing, fabrication, and display, students explore the methods and processes involved in the creation of materialized media for a broad range of multi-sensorial applications. Topics include: technology-augmented live performance, audio and visual responsive environments, data responsive design, media architecture, site specific new-media installation.

IMDM 490 – Capstone I  
Credits: 4  
Prerequisites: IMDM 390  
Course Description: 
The first in a two-semester series of courses (with IMDM 491), this team-taught studio course examines the generative process of creating a large-scale immersive media design project. Students will commence pre-production and early-stage production processes for a large-scale capstone project. Topics covered include: project ideation, feasibility studies, computational tool-building and pipeline logistics, external mentorship, and in-class peer critiques of in progress work.

IMDM 491 – Capstone II  
Credits: 4  
Prerequisites: IMDM 490  
Course Description: 
The second in a two-semester series of courses (with IMDM 490), in this team-taught studio course you will complete the process of creating and publicly exhibiting a large-scale immersive media design project. Topics covered include exhibition design, exhibition venue research, public relations, and team-based collaboration.

Course Descriptions: ARTT Course listings required in tracks one or two:
ARTT 100 – Two-Dimensional Design Fundamentals
Credits: 3
Prerequisites: N/A
Course Description:
Principles and elements of two-dimensional design. Introduction to visual communication.

ARTT 110 – Elements of Drawing I
Credits: 3
Prerequisites: N/A
Course Description:
Fundamental concepts, media, and processes of drawing. Emphasis on observation and representation in combination with individual expression. Subject matter includes still life, human figure, nature, the built environment, and conceptual projects.

ARTT 200 – Three-Dimensional Art Fundamentals
Credits: 3
Prerequisites: ARTT 100, ARTT 110
Course Description:
Fundamental concepts of three-dimensional form and space examined through the manipulation and organization of various materials.

ARTT 210 – Elements of Drawing II
Credits: 3
Prerequisites: ARTT 110
Course Description:
Continuation of ARTT110 with additional emphasis on color, figure drawing, and contemporary issues.

ARTT 255 – Introduction to Digital Art and Design Processes
Credits: 3
Prerequisites ARTT 100, ARTT 110
Course Description:
Introduction to basic software and principles of digital imaging, and how they are applied to art and design. Topics covered: Digital image construction and manipulation, Vector-Based digital techniques layout, typography, etc, time-based digital techniques (video and audio composition and manipulation), and basic interactivity (web-design). Digital media used to explore visual principles established in ARTT100.

ARTT 370 – Elements of Digital Media
Credits: 3
Prerequisites: ARTT 255 or permission of ARHU-ARTT
Course Description:
Exploration of creativity through code and software development, image creation and manipulation, interactivity, and linkages between digital audio and video. Emphasis on issues in contemporary digital art.

ARTT 371 – Digital Video and Sound Installation
Credits: 3
Prerequisites: ARTT 255
This course focuses on the acquisition of practical and theoretical skills integral to digital video and sound installation as an evolving form that extends beyond the screen and into site-specific, immersive, and multiple-channel environments. Through technical demonstrations, individual projects, assigned readings, and class
discussions, students will develop and extend their understanding of time-based media and installation practices, learn the historical/cultural significance of the medium, and discuss the work of various artists.

ARTT479A – Advanced Digital Media Studio: Code and Form  
**Credits:** 3  
**Prerequisites:** ARTT 370  
**Course Description:**  
Advanced level course in Digital Media emphasizing contemporary practices and theories in the area of Digital Fabrication. 3-D modeling, 3-D printing and related digital fabrication techniques are covered.

ARTT 479D – Advanced Digital Media Studio: Immersive and Virtual Environments.  
**Credits:** 3  
**Prerequisites:** ARTT 370  
**Course Description:**  
Introduction to the uses of game development software in an artistic context. Practical examination of interactive, immersive and installation art as mediated through the context of real-time computer generated imagery and game engine methodologies.

**Course Descriptions: CMSC Course listings required in tracks one or two:**

CMSC122 Introduction to Computer Programming via the Web  
**Credits:** 3  
**Prerequisites:** None  
**Restriction:** Must not have completed any courses from CMSC131-499 course range; and must not be concurrently enrolled in CMSC131. Credit only granted for: CMSC106, CMSC122, or INST126.  
**Course Description:**  
Introduction to computer programming in the context of developing full featured dynamic web sites. Uses a problem solving approach to teach basics of program design and implementation using JavaScript; relates these skills to creation of dynamic web sites; then explores both the potential and limits of web-based information sources for use in research. Intended to help relate a student's major to these emerging technologies.

CMSC131 Object-Oriented Programming I  
**Credits:** 4  
**Corequisites:** MATH140; and permission of CMNS-Computer Science department  
**Course Description:**  
Introduction to programming and computer science. Emphasizes understanding and implementation of applications using object-oriented techniques. Develops skills such as program design and testing as well as implementation of programs using a graphical IDE. Programming done in Java.

CMSC132 Object-Oriented Programming II  
**Credits:** 3  
**Prerequisites:** Minimum grade of C- in CMSC131; or must have earned a score of 5 on the A Java AP exam. Or permission of the department based on satisfactory performance on the department placement exam; and minimum grade of C- in MATH140; and permission of CMNS-Computer Science department  
**Course Description:**  
Introduction to use of computers to solve problems using software engineering principles. Design, build, test, and debug medium-size software systems and learn to use relevant tools. Use object-oriented methods to create
effective and efficient problem solutions. Use and implement application programming interfaces (APIs). Programming done in Java.

CMSC250 Discrete Structures
Credits: 3
Prerequisites: Minimum grade of C- in CMSC131; or must have earned a score of 5 on the A Java AP exam. Or permission of the department based on satisfactory performance on the department placement exam; and minimum grade of C- in MATH140; and permission of CMNS-Computer Science department
Course Description: Introduction to use of computers to solve problems using software engineering principles. Design, build, test, and debug medium-size software systems and learn to use relevant tools. Use object-oriented methods to create effective and efficient problem solutions. Use and implement application programming interfaces (APIs). Programming done in Java.

CMSC330 Organization of Programming Languages
Credits: 3
Prerequisites: Minimum grade of C- in CMSC250 and CMSC216; and permission of CMNS-Computer Science department.
Course Description: The semantics of programming languages and their run-time organization. Several different models of languages are discussed, including procedural (e.g., C, Pascal), functional (e.g., ML, LISP), rule-based (e.g., Prolog), and object-oriented (e.g., C++, Smalltalk). Run-time structures, including dynamic versus static scope rules, storage for strings, arrays, records, and object inheritance are explored.

CMSC351 Algorithms
Credits: 3
Prerequisites: Minimum grade of C- in CMSC250 and CMSC216; and permission of CMNS-Computer Science department.
Course Description: A systematic study of the complexity of some elementary algorithms related to sorting, graphs and trees, and combinatorics. Algorithms are analyzed using mathematical techniques to solve recurrences and summations.

Course Descriptions: CMSC Course listings recommended in track one

CMSC420 Data Structures
Credits: 3
Prerequisites: Minimum grade of C- in CMSC351 and CMSC330; and permission of CMNS-Computer Science department. Or must be in the (Computer Science (Doctoral), Computer Science (Master's)) program.
Course Description: Description, properties, and storage allocation of data structures including lists and trees. Algorithms for manipulating structures. Applications from areas such as data processing, information retrieval, symbol manipulation, and operating systems.
CMSC425 Game Programming
Credits: 3
Prerequisites: Minimum grade of C- in CMSC420.
Course Description:
An introduction to the principles and practice of computer game programming and design. This includes an introduction to game hardware and systems, the principles of game design, object and terrain modeling, game physics, artificial intelligence for games, networking for games, rendering and animation, and aural rendering. Course topics are reinforced through the design and implementation of a working computer game.

CMSC426 Computer Vision
Credits: 3
Prerequisites: Minimum grade of C- in CMSC330 and CMSC351; or must be in the (Computer Science (Doctoral), Computer Science (Master's)) program.
Restriction: Permission of CMNS-Computer Science department.
Course Description:
An introduction to basic concepts and techniques in computervision. This includes low-level operations such as image filtering and edge detection, 3D reconstruction of scenes using stereo and structure from motion, and object detection, recognition and classification.

CMSC427 Computer Graphics
Credits: 3
Prerequisites: MATH240; and minimum grade of C- in CMSC420; and permission of CMNS-Computer Science department. Or must be in the (Computer Science (Doctoral), Computer Science (Master's)) program.
Course Description:
An introduction to the principles of computer graphics. Includes an introduction to graphics displays and systems. Introduction to the mathematics of affine and projective transformations, perspective, curve and surface modeling, algorithms for hidden-surface removal, color models, methods for modeling illumination, shading, and reflection.

CMCS434 Introduction to Human-Computer Interaction
Credits: 3
Prerequisites: Minimum grade of C- in CMSC330 and CMSC351; and permission of CMNS-Computer Science department. Or must be in the (Computer Science (Doctoral), Computer Science (Master's)) program.
Course Description:
Assess usability by quantitative and qualitative methods. Conduct task analyses, usability tests, expert reviews, and continuing assessments of working products by interviews, surveys, and logging. Apply design processes and guidelines to develop professional quality user interfaces. Build low-fidelity paper mockups, and a high-fidelity prototype using contemporary tools such as graphic editors and a graphical programming environment (eg: Visual Basic, Java).
Appendix B: Four Year Plan with Benchmarks

The follow three pages show four-year plans for the IMDM major.

The central thread of the major is the sequence of IMDM courses, and most specifically the collaborative studio series IMDM290, 390 and 491/491. We hope to develop cohorts of majors that proceed through these as a group.

However, students come to majors with many backgrounds. They may have coursework from high school, they may be an internal transfer from another major, they be an external transfer from another school, they may have started in ARTT or CMSC and wish to switch. We expect to work on different routes through the major for students of different backgrounds and interests. The major already accommodates artistically minded students in Track 2, and technically minded students in Track 1. We expect to accommodate other variations in the sequence in which students take CMSC and ARTT courses.

Specifically, to accommodate students who wish to emphasize CMSC courses in Track 1, we have a four-year plan “Track 1: Computing – Accelerated Computer Science”. For Track 1 students who wish to extend their CMSC sequence over more semesters, we have “Track 1: Computing – Extended Computer Science.” The latter allows students to complete more General Education (Gen Ed) courses earlier.
## Track 1: Computing – Accelerated Computer Science

<table>
<thead>
<tr>
<th>Year</th>
<th>Fall</th>
<th>Spring</th>
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<tbody>
<tr>
<td><strong>Year 1</strong></td>
<td><strong>Fall</strong></td>
<td><strong>Spring</strong></td>
</tr>
<tr>
<td>CMSC 131 - Object Oriented Programming I (4)</td>
<td>MATH 141 - Calculus II (4)</td>
<td></td>
</tr>
<tr>
<td>MATH 140 - Calculus (4) FSAR</td>
<td>CMSC 132 - Object-Oriented Programming II (4)</td>
<td></td>
</tr>
<tr>
<td>ARTT 100 - Two-Dimensional Design Fundamentals (3) DSSP</td>
<td>ARTT 200 - Three-Dimensional Art Fundamentals (3)</td>
<td></td>
</tr>
<tr>
<td>IMDM 101 - Intro to Immersive Media (3)[NEW]†</td>
<td>IMDM 150 - Intro to Digital Media Theory and Culture (3)[NEW]† DSHU</td>
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</tr>
<tr>
<td>ENGL 101 - Academic Writing (3) FSAW</td>
<td>Credits: 17 (semester 1)</td>
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</tbody>
</table>

| **Year 2** | Benchmark Requirements - Semester three: | Completion or enrollment in: | CMSC 216, 250, IMDM 227, ARTT 255 |
| Successful completion of portfolio review process between 31-47 credits | Electronic Media (3) [NEW] | IMDM 227 - Intro to Computational Media (3) [NEW] |
| CMSC 216 - Intro to Computer Systems (4) | CMSC 310 - Programming Languages (3) |
| CMSC 250 - Discrete Structures (4) | CMSC 351 - Algorithms (3) |
| ARTT 255 - Intro to Digital Art and Design Practices (3) | IMDM 290 - Collaborative Studio I: Image + Time (3) |
| COMM 107 - Oral Communication (3) FSOC | Gen Ed (3) DSHS |
| | ENGL Elective (143/245/255/290/294) (3) DSHU |
| Credits: 17 / 48 (semester 3) | Credits: 15 / 63 (semester 4) |

| **Year 3** | Benchmark Requirements - Semester five: | Completion or Enrollment in: | IMDM 390, Professional Writing, COMM 107 |
| Successful completion or enrollment in: | | | |
| CMSC 4xx Elective (3) | IMDM 390 - Collaborative Studio II: Experiential Computing (3) |
| IMDM 327 - Augmented and Virtual Reality (3) | Professional Writing (3) FSPW |
| GEN Ed (3) DSHS | Gen Ed (3) DSHS |
| GEN Ed (4) DS NL | Open Elective (3) |
| GEN Ed (3) DSSP (non-major) | Open Elective (3) |
| Credits: 16 / 79 (semester 5) | Credits: 15 / 94 (semester 6) |

| **Year 4** | | | |
| IMDM 490 - Capstone I (4) | IMDM 491 Capstone II (4) |
| ARTT 37X / 47X elective (3) | CMSC 4XX Elective (3) |
| Open Elective (3) | Open Elective (3) |
| Open Elective (3) | Open Elective (3) |
| Credits: 13 / 107 (semester 7) | Credits: 13 / 120 (semester 8) |

* - must fulfill I-Series requirements  | ** - must fulfill Understanding Plural Societies requirement  | † - offered every semester
## Track 1: Computing – Extended Computer Science

<table>
<thead>
<tr>
<th></th>
<th>Fall</th>
<th>Spring</th>
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</thead>
</table>
| **Year 1** | CMSC 131 - Object Oriented Programming I (4)  
MATH 140 - Calculus (4) FSAR  
ARTT 100 - Two-Dimensional Design Fundamentals (3) DSSP  
IMDM 101 - Intro to Immersive Media (3)[NEW]†  
ENGL 101 - Academic Writing (3) FSAW | MATH 141 - Calculus II (4)  
CMSC 132 - Object-Oriented Programming II (4)  
ARTT 200 - Three-Dimensional Art Fundamentals (3)  
IMDM 150 - Intro to Digital Media Theory and Culture (3)[NEW]† DSHU  
Credits: 17 (semester 1) |}

|          | Semester 2:  
IMDM 227 - Intro to Computational Media (3) [NEW]  
CMSC 250 - Discrete Structures (4)  
Gen Ed (3) DSNS  
ARTT 255 - Intro to Digital Art and Design Practices (3)  
COMM 107 - Oral Communication (3) FSOC | CMSC 216 - Intro to Computer Systems (4)  
IMDM 290 - Collaborative Studio I: Image + Time (3)  
Gen Ed (3) DSHS  
ENGL Elective (143/245/255/290/294) (3) DSHU  
Gen Ed (4) DSNL | Credits: 16 / 47 semester 3) |}

*Must also meet Limited Enrollment Criteria of Computer Science Major

**Year 2**

**Benchmark Requirements - Semester three:**

Successfully complete portfolio review process between 31-47 credits
Completion or enrollment in:
CMSC 216, 250, IMDM 227, ARTT 255

<table>
<thead>
<tr>
<th></th>
<th>Credits: 17 / 64 (semester 4)</th>
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<tbody>
<tr>
<td></td>
<td><strong>Year 3</strong></td>
</tr>
</tbody>
</table>
|          | Rotation Correction:  
CMSC 330 - Programming Languages (3)  
CMSC 351 Algorithms (3)  
IMDM 327 - Augmented and Virtual Reality (3)  
Gen Ed (3) DSHS  
Gen Ed (3) DSSP (Non-major) | Credentials: 15 / 79 (semester 5) |}

|          | Rotation Correction:  
IMDM 390 - Collaborative Studio II: Experiential Computing (3)  
Professional Writing (3) FSPW  
CMSC 4xx Elective (3)  
Open Elective (3)  
Open Elective (3) | Credits: 15 / 94 (semester 6) |}

**Year 4**

<table>
<thead>
<tr>
<th></th>
<th>Credits: 13 / 107 (semester 7)</th>
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</thead>
</table>
|          | **Rotation Correction:  
IMDM 490 - Capstone I (4)  
ARTT 37X / 47X elective (3)  
Open Elective (3)  
Open Elective (3) | Credits: 13 /120 (semester 8) |}

* - must fulfill I-Series requirements   | ** - must fulfill Understanding Plural Societies requirement | † - offered every semester
### Track 2: Emerging Creatives

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Fall</th>
<th>Spring</th>
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</thead>
<tbody>
<tr>
<td>ARHU 158 (3)</td>
<td>Gen Ed (3) ENGL101 FSAW • IMDM 127 - Creative Coding for Digital Media (3) [NEW]</td>
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</tr>
<tr>
<td>MATH 115 - Precalculus (3) FSMA •</td>
<td>IMDM 170 - Three-Dimensional Art Fundamentals (3)</td>
<td></td>
</tr>
<tr>
<td>CMSC 122 - Intro to Programming via Web (3)</td>
<td>IMDM 150 - Intro to Digital Media and Theory &amp; Culture (3)† DSHU</td>
<td></td>
</tr>
<tr>
<td>ARTT 100 - Two-Dimensional Design Fundamentals (3)</td>
<td>ARTT 110 - Elements of Drawing (3)</td>
<td></td>
</tr>
<tr>
<td>IMDM 101 - Intro to Immersive Media (3)† DSSP</td>
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</tbody>
</table>

Credits: 15 (Semester 1)

<table>
<thead>
<tr>
<th>Year 2</th>
<th>Benchmark Requirements - Semester three: Successfully complete portfolio review process between 30 &amp; 45 credits</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gen Ed (3) FSAR COMM 107 - Oral Communication (3) FSOC ARTT 210 - Drawing II (3) ARTT 255 - Intro to Digital Art and Design Practices (3) IMDM 227 - Intro to Computational Media (3) [New]</td>
<td>ENGL Elective (143/245/255/290/294) (3) DSHU Gen Ed (3) DSNS Gen Ed (3) DSHS Gen Ed (3) ** IMDM 290 - Collaborative Studio I: Image + Time (3)[NEW]</td>
<td></td>
</tr>
</tbody>
</table>

Credits: 15 / 45 (Semester 3)

<table>
<thead>
<tr>
<th>Year 3</th>
<th>Benchmark requirements - Semester five: ARTT 34x, 37x IMDM 350</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gen Ed (3) DSHS Gen Ed (4) DSNL Open Elective (3) ARTT 37X elective (3) IMDM 350 - Advanced Digital Media Theory (3) [NEW]IS</td>
<td>Professional Writing (3) PW Open Elective (3) Gen Ed (3) DSSP (Non-major) IMDM 351 - Digital Innovation Marketing and Business (3)[NEW] IS IMDM 390 - Collaborative Studio II: Experiential Computing (3) [NEW]</td>
<td></td>
</tr>
</tbody>
</table>

Credits: 16 / 76 (Semester 5)

| Year 4 | Open Elective 3xx/4xx(3) Open Elective (3) Open Elective(3) IMDM 470 - Performative Computing (3)[NEW] IMDM 490 - Capstone I (4)[NEW] | Open Elective 3xx/4xx (3) Open Elective 3xx/4xx (3) ARTT 37X / 47X elective (3) IMDM 491 - Capstone II (4)[NEW] |  |

Credits: 16 / 107 (Semester 7)

| Year 5 | Open Elective 3xx/4xx(3) Open Elective (3) Open Elective(3) IMDM 470 - Performative Computing (3)[NEW] IMDM 490 - Capstone I (4)[NEW] | Open Elective 3xx/4xx (3) Open Elective 3xx/4xx (3) ARTT 37X / 47X elective (3) IMDM 491 - Capstone II (4)[NEW] |  |

Credits: 13 / 120 (Semester 8)

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* - must fulfill I-Series requirements  | ** - must fulfill Understanding Plural Societies requirement | † - offered every semester | • must complete by 30 credits

All students must complete two Distributive Studies courses that are approved for I-Series courses. The Understanding Plural Societies and Cultural Competence courses may also fulfill Distributive Studies categories.

Track 2 students must fulfill ARHU global engagement requirements.
Appendix C: IMDM Learning Outcomes Assessment Plan

The IMDM program will work to set, monitor, and maintain high standards for the program under a shared vision of an excellent student learning experience leading to outstanding educational outcomes. The program will apply these standards to courses, activities, advising, faculty effectiveness, administrative services and technical support for students, and regular assessment under the standards will be used to guide the development and revision of curriculum and services for continual improvement.

The program goals, outcomes, courses and services will be assessed regularly under an Assessment Plan developed and monitored by the Undergraduate Programs Committee (UPC), and consistent with UMD Undergraduate Program Learning Outcomes Assessment Plan. The program plan will lay out responsibilities, metrics, timelines and procedures for assessment. Performance of the overall curriculum will be assessed by two factors: direct evaluation of student mastery of program learning outcomes during the senior year, and indirect evaluation by tracking of alumni career performance over time. To assess senior year mastery, selected senior projects and portfolios will be evaluated by faculty and external partners under metrics developed by the UPC. To evaluate professional success, the UPC will work with the Career Center to appropriately track initial placement and mid-career status, and survey graduate and employers.

Performance of individual courses and course outcomes will be regularly assessed on a rotating basis, with a subset of courses assessed in detail each year and all courses assessed every four years. The focus will be on IMDM courses for which the program has primary responsibility, with coordination with assessment processes in departments (notably CMSC and ARTT) which support the program with required courses. Mastery of course material will be assessed by performance on examinations or projects as appropriate for the course. The Undergraduate Program Committee will direct assessment of the curriculum and courses, with assessments conducted annually in the spring semester, beginning in the first year of the program. The Undergraduate Program Committee will direct the assessment process. Assessments will be conducted annually in the spring semester, beginning in the first year of the program. The assessment report to the Provost each fall will include the results of the assessment and recommendations for program improvement that are based on these results.

Performance of administrative and technical support services will be evaluated regularly by the program administration in consultation with the UPC to insure high quality delivery to students of services such as course technology, learner support, advising and accessibility.

In addition to ongoing internal assessment, formal program review will follow the University of Maryland’s policy for Periodic Review of Academic Units. This entails a review of the academic programs offered by, and the research and administration of, the academic unit (http://www.president.umd.edu/policies/2014-i-600a.html). Program Review is conducted following the guidelines of the campus-wide cycle of Learning Outcomes Assessment (https://www.irpa.umd.edu/Assessment/LOA.html). Program faculty will be reviewed according to the University’s Policy on Periodic Evaluation of Faculty Performance (http://www.president.umd.edu/policies/2014-ii-120a.html).
Email correspondence between Prof. Morse (ARTT/IMDM) and Prof. Walter (Director of Undergraduate Studies, ENGL):

Immersive Media Design Major - ENGL course offerings
5 messages

Brandon Morse <ebmorse@gmail.com>

To: Christina Walter <cmwalter@umd.edu>

Hello Prof. Walter,
My name is Brandon Morse from the Department of Art. As you might be aware, I have taken on some of the responsibilities in seeing the new Immersive Media Design Major through the PCC process. I wanted to touch base with you quickly to reaffirm some information about our suggested ENGL electives for the major.

According to notes given to me by Audra Buck-Coleman, she met with you at some point last year to discuss English classes that would fit the major. You made a number of recommendations and I have added them to our current four-year plan for the IMDM major. Currently each of the two tracks of the major has an 'English Elective' and we ask that they take one course from the following list:

ENGL 143 / 146 / 245 / 290 / 293 / 294 as well as Professional Writing 398a

So, as we put the PCC document together, I want to make sure what was given to me is accurate. Do these courses accurately align with your recollection of your meeting with Prof. Buck-Coleman? In her notes, you had suggested a number of 400-level courses as well which we haven't listed.

If this is accurate, can we get affirmation that you support this roster of courses as a part of the IMDM major?

If you'd like to meet in person I'm available before July 11, and after the 18th. If you would like to speak on the phone, I'm available anytime that's convenient.

best,
Brandon

http://coplanar.org
ebmorse@gmail.com

Christina Walter <cmwalter@umd.edu>

To: Brandon Morse <ebmorse@gmail.com>

Hi Brandon,
That list of 200- and 300-level courses is accurate. You could also consider including:
ENGL275 Scriptwriting for Theater, Film, and Television (3 Credits)
Introduction to the theory and practice of scriptwriting with an opportunity to read, view, evaluate, write, and revise texts meant to be performed. Students will practice writing for the stage, film, and television and also examine selected scripts, performances, and film and television clips as models for their own creative work. Students will complete frequent writing exercises, participate in workshops, and learn to apply scholarship to the analysis and critique of scripts. Also offered as: ARHU275.
Credit Only Granted for: ENGL278D, ENGL275, ARHU319B, or ARHU275.
Formerly: ENGL278D; ARHU319B.

ENGL329 Special Topics in Film Studies (3 Credits)
Studies in various periods and genres of film.
Prerequisite: ENGL245, FILM245, FILM283, or SLLC283; or permission of ARHU-English department.
Repeatable to: 9 credits if content differs.

ENGL387 Visual Rhetoric (3 Credits)
Investigation of the persuasive power of visuals based on how they construct and communicate their content and predispose viewers to an interpretation or attitude. "Iconic" images and other modes of visual representation including diagrams, graphs, and page or screen design. Most attention given to a grammar and rhetoric of visuals. Also the elements of images and their arrangement and consideration of historical and generic contexts and the "affordances" of various media. Not a course in "high art" or in video, TV, or film. Emphasis on visuals that accompany or replace verbal texts.
Credit Only Granted for: ENGL387 or ENGL488F (Spring 2013 only).
Formerly: ENGL488F (Spring 2013 only).

There are a number of 400-level courses that would also be pertinent and non-majors can take 400-level courses if they have had 1-2 prior English courses OR if they get permission from the department. I won't, however, list out the 400-level courses for the moment; just let me know if you would like that list (which would include, for example, ENGL 467: Critical and Creative Approaches to Digital Texuality). I would also note that we will be developing some additional courses over the next year or so, so you can check back next spring about whether there's anything new of interest.

In any case, I support the courses you listed as part of the roster of courses for the IMDM major. Let me know if you need anything else.

Best,
Christina

Christina Walter
Associate Professor of English
Director of Undergraduate Studies in English
Coordinator of ARHU Graduate Certificate in Critical Theory
University of Maryland
Office: 1128 Tawes Hall  Ph: 301-405-3825
Pronouns: She/Her/Hers
One more course of interest at the 300-level would be:

ENGL 321 American Comics (3 Credits)
Survey of the long and vibrant history of the American graphic novel, from its origins in newspapers, through the underground comix movement of the 1960s, to its present moment of cultural ascendency. Exploration of the representational possibilities of comics, the graphic novel, and graphic narrative more broadly as well as the history of its incorporation into high culture.

Best,
Christina

Christina Walter
Associate Professor of English
Director of Undergraduate Studies in English
Coordinator of ARHU Graduate Certificate in Critical Theory
University of Maryland
Office: 1128 Tawes Hall  Ph: 301-405-3825
Pronouns: She/Her/Hers
Brandon Morse  
http://coplanar.org  
ebmorse@gmail.com

Christina Walter  
To: Brandon Morse <ebmorse@gmail.com>

Sounds good. Thanks, Brandon.

Best,
Christina

Christina Walter  
Associate Professor of English  
Director of Undergraduate Studies in English  
Coordinator of ARHU Graduate Certificate in Critical Theory  
University of Maryland  
Office: 1128 Tawes Hall    Ph: 301-405-3825  
Pronouns: She/Her/Hers
APPENDIX E: Faculty and Organization: Potential Faculty Involvement in IMDM:

<table>
<thead>
<tr>
<th>Faculty Name</th>
<th>Title/Expertise</th>
<th>Credentials</th>
<th>Potential courses taught in program:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brandon Morse</td>
<td>Associate Professor, ARRT Digital and physical instantiation of generative systems, video and installation works</td>
<td>MFA, Art &amp; Technology from The Ohio State University</td>
<td>ARTT37x/47x IMDM 470 IMDM390 IMDM490 IMDM491</td>
</tr>
<tr>
<td>Shannon Collis</td>
<td>Associate Professor, ARTT Digital installations and interactive environments</td>
<td>MFA, University of Alberta with post-graduate work in Digital Media and Computation Arts</td>
<td>ARTT255 ARTT37x IMDM290 IMDM490 IMDM491</td>
</tr>
<tr>
<td>Hassan Elahi</td>
<td>Associate Professor, ARTT Interdisciplinary media artist with emphasis on technology and surveillance</td>
<td>MFA, Cranbrook Academy of Art</td>
<td>IMDM150 IMDM350</td>
</tr>
<tr>
<td>Justin Strom</td>
<td>Associate Professor, ARTT Mixed-media print, digital imaging</td>
<td>MFA, University of Wisconsin-Madison</td>
<td>ARTT34x IMDM290 IMDM490 IMDM491</td>
</tr>
<tr>
<td>Cy Keener</td>
<td>Assistant Professor, ARTT Digital fabrication and media</td>
<td>MFA, Stanford University M.Arch, University of California, Berkeley</td>
<td>ARTT37x ARTT47x IMDM390 IMDM490 IMDM491</td>
</tr>
<tr>
<td>David Jacobs</td>
<td>Professor, CMSC AI and Robotics, Computer Vision and Machine Perception</td>
<td>Ph.D., Massachusetts Institute of Technology</td>
<td>CMSC 426</td>
</tr>
<tr>
<td>David Mount</td>
<td>Professor, CMSC Algorithms and Theory, Information Retrieval and Geographic Information Systems (GIS)</td>
<td>Ph.D., Purdue University</td>
<td>CMSC 425</td>
</tr>
</tbody>
</table>

2/23/2019
<table>
<thead>
<tr>
<th>Faculty Name</th>
<th>Title/Expertise</th>
<th>Credentials</th>
<th>Potential courses taught in program:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matthias Zwicker</td>
<td>Professor, CMSC Graphics Visualization and VR AR</td>
<td>Ph.D., ETH Zurich</td>
<td>IMDM 327 CMSC 427</td>
</tr>
<tr>
<td>Dinesh Manocha</td>
<td>Professor, CMSC AI and Robotics, Graphics Visualization and VR AR, High Performance and Scientific Computing</td>
<td>Ph.D., University of California at Berkeley</td>
<td>CMSC 427</td>
</tr>
<tr>
<td>Larry Davis</td>
<td>Professor, CMSC Computer vision, Artificial intelligence, High performance computing</td>
<td>Ph.D., University of Maryland</td>
<td>CMSC 426</td>
</tr>
<tr>
<td>Cornelia Fermuller</td>
<td>Assoc. Research Scientist, CMSC Bio-inspired solutions for active vision</td>
<td>Ph.D., Technical University of Vienna</td>
<td>CMSC 426</td>
</tr>
<tr>
<td>Huaishu Peng</td>
<td>Asst. Professor, CMSC Human Computer Interaction, IoT and Wearables Technology</td>
<td>Ph.D., Cornell University</td>
<td>IMDM101 IMDM227 CMSC434</td>
</tr>
<tr>
<td>Roger Eastman</td>
<td>Professor of the Practice, CMSC AI and Robotics, Computer Vision and Machine Perception, Graphics Visualization and VR AR</td>
<td>Ph.D., University of Maryland</td>
<td>IMDM 101 IMDM 227 IMDM 327 CMSC 425 CMSC 426 CMSC 427</td>
</tr>
<tr>
<td>Evan Golub</td>
<td>Senior Lecturer, CMSC Human Computer interaction, ubiquitous computing, computer science education, information technology and non-majors</td>
<td>Ph.D., University of Maryland</td>
<td>IMDM 101 IMDM 227 IMDM 327 CMSC 427 CMSC 434</td>
</tr>
</tbody>
</table>
Appendix F: Library Assessment:

DATE: 8/27/18
TO: College of Arts and Humanities/College of Computer, Mathematical & Natural Sciences
FROM: On behalf of the University of Maryland Libraries:
Patricia Kosco Cossard, Art/Sociology Librarian
Nevenka Zdravkovska, Head of STEM Library
Maggie Saponaro, Head of Collection Development
Daniel Mack, Associate Dean, Collection Strategies & Services
RE: Library Collection Assessment

We are providing this assessment in response to a proposal by the Immersive Media Design Major (IMDM) Committee in the College of Arts and Humanities – Art and the College of Computer, Mathematical and Natural Sciences – Computer Science to create Bachelor of Sciences and Arts in Immersive Media Design (BASI). The IMDM asked that we at the University of Maryland Libraries assess our collection resources to determine how well the Libraries support the curriculum of this proposed program.

Library Technology
The University of Maryland Libraries currently provide access to a number of technologies that will support this major. The following Library spaces/units have been outfitted with appropriate supporting technology including AR/VR headsets for testing works, and physical computing needs including 3D printers and related digital fabrication tools such as laser cutters. These spaces evolve rapidly to keep up with user demands.

- Library Media Services (LMS) (http://www.lib.umd.edu/lms) supports access to and the creation of audio/visual media as data and information. The services are: general and research audiovisual collections, media-centric learning and teaching spaces, multimedia production facilities, and staff, including a Production Specialist. Consult the webpage for up-to-date information. (https://www.lib.umd.edu/lms/learn-more/equipment-information-copy)
- John and Stella Graves Makerspace (https://www.lib.umd.edu/tlc/makerspace) provides access to equipment to experiment with emerging technologies, create models and prototypes. Resources for Virtual/Augmented Reality include: HTC Vive & Hand Controllers, Oculus Rift with Touch Controllers either as a kit that includes a gaming laptop or with a laptop hook up, Microsoft HoloLens headset and the Google Tango phone. The Graves Makerspace is part of McKeldin Library’s second floor Terrapin Learning Center which is described below in the “Additional Resources” section.
- STEM Library (https://www.lib.umd.edu/stem/equipment-and-technology/3d-printing) is complementing the John and Stella Graves Makerspace to respond to the needs of the STEM community on Campus. Currently they are 3D printers, and additional equipment is expected, like laser cutter. Its Equipment for Loan service includes: a Ricoh Theta S 360-degree camera and a Knox V2 Cardboard

Serial Publications
The University of Maryland Libraries currently subscribe to a large number of scholarly journals—almost all in online format—that focus on studio art, digital storytelling, design, computing, and using virtual reality (VR) / augmented reality (AR) technology.

The Libraries subscribe to several of the top ranked journals that are listed in the [Arts and Humanities Edition/Science Edition/Social Sciences Edition of Journal Citation Reports.]*

It is noteworthy, that this is a new field and new titles will be forthcoming. The Libraries will make every effort to purchase these, however, articles in journals that we do not own likely will be available through Interlibrary Loan/Document Delivery.

*Note: Journal Citation Reports is a tool for evaluating scholarly journals. It computes these evaluations from the relative number of citations compiled in the Science Citation Index and Social Sciences Citation Index database tools.

Databases
The Libraries’ *Database Finder* (http://www.lib.umd.edu/dbfinder) resource offers online access to databases that provide indexing and access to scholarly journal articles and other information sources. Many/some/few of these databases cover subject areas that would be relevant to this proposed program. Databases that would be useful in the field of Immersive Media Design are Web of Science, IEEExplore, ACM Digital Library, and ScienceDirect, especially for Track I. Artbibliographies Modern, Art Abstracts, and Art Full Text would be useful for Track II. In many-and likely in most-cases, these indexes offer full text copies of the relevant journal articles. In those instances in which the journal articles are available only in print format, the Libraries can make copies available to graduate students through either the Libraries’ Scan & Deliver Program (http://www.lib.umd.edu/access/scan-deliver) or via Interlibrary Loan. (Note: see below.)

**Monographs**

The Libraries regularly acquire scholarly monographs in studio art, digital storytelling, design, and computing, using virtual reality (VR)/augmented reality (AR) technology, game design, augmented and virtual reality, physical computing, and digital fabrication and allied subject disciplines. Monographs not already part of the collection can usually be added upon request.

A search of the University of Maryland Libraries’ WorldCat UMD catalog was conducted, using a variety of relevant subject terms. This investigation yielded sizable lists of citations of books that we own such as over 1,000 books on digital storytelling, and over 3,000 on digital game design. A further search revealed that the Libraries’ membership in the Big Ten Academic Alliance (BTAA) dramatically increases these holdings and citations three-fold (3,000 on digital storytelling and 10,000 on game design).

**Scan & Deliver and Interlibrary Loan**

These services offer online delivery of bibliographic materials that otherwise would not be available online. As a result, remote users who take online courses may find these services to be helpful. Scan & Deliver and Interlibrary Loan are available free of charge.

The Scan & Deliver service scans and delivers journal articles and book chapters within three business days of the request—provided that the items are available in print on the UM Libraries’ shelves or in microform. In the event that the requested article or chapter is not available on campus, Scan & Deliver will automatically refer the request to Interlibrary Loan (ILL). Interlibrary Loan is a service that enables borrowers to obtain online articles and book chapters from materials not held in the University System of Maryland.

**Additional Resources**

In addition to serials, monographs and databases available through the University Libraries, students in the proposed program will have access to a wide range of media, datasets, software, and technology. Library Media Services (http://www.lib.umd.edu/lms) houses media in a variety of formats that can be utilized both on-site and via ELMS course media. GIS Datasets are available through the GIS Data Repository (http://www.lib.umd.edu/gis/dataset) while statistical consulting and additional research support is available through the Research Commons (http://www.lib.umd.edu/rc) and group study rooms, technology/printing support and equipment loan services are available through the Terrapin Learning Commons (http://www.lib.umd.edu/tlc). The subject specialist librarians for the disciplines also serve as an important resource to programs such as the one proposed.

**Other Research Collections**

Because of the University’s unique physical location near Washington D.C., Baltimore and Annapolis, University of Maryland students and faculty have access to some of the finest libraries, archives and research centers in the country vitally important for researchers. These include the Library of Congress, the National Archives, the Folger Shakespeare Library, the Smithsonian, and other institutions.

**Conclusion**

With our substantial journals holdings and index databases, as well as additional support services and resources, the University of Maryland Libraries have resources to support teaching and learning in Studio Art and Computer Science. These materials are supplemented by a strong monograph collection. Additionally, the Libraries Scan & Deliver and Interlibrary Loan services make materials that otherwise would not be available online, accessible to
remote users in online courses. As a result, our assessment is that the University of Maryland Libraries are able to meet the curricular and research needs of the proposed Immersive Media Design Major.
Appendix G: Instructional Resources - Faculty timeline.

Given a nominal initial enrollment of 60 students a year enrolled per year in the Immersive Media Design Major (IMDM), plus assuming we have about 50% more or 90 in the first year and not all continue, we anticipate the need to hire 10 faculty and to provide 14 Graduate Assistantships over the course of the initial four years of the major offering. These faculty will have academic homes in each of the two principal departments and colleges supporting this major, namely the departments of Computer Science and Studio Art and the College of Computer Mathematical and Natural Sciences and College of Arts and Humanities. Given the structure of the major, a staggered hiring of faculty in targeted areas over the course of the initial four years of the major offering is recommended:

Art Studio Instructional Resource Requirements - Initial Four Years of Degree Offering:

**Year 1:**
**Faculty Requirement:** 0  
**Instructor Requirement:** 1  
**GA Requirement:** 1.5
In their first year, incoming majors will impact a number of currently offered Studio Art Foundations courses, including: ARTT100, ARTT110, and ARTT 200. ARTT 100 and 110 are frequently taught by graduate assistants or PTK instructors; provided support for new graduate assistant lines, it is not anticipated that new faculty will be necessary to support this component of the major. However, all students in the major will be enrolled in ARTT 200 as well as two IMDM courses; IMDM 101 and IMDM 150. ARTT 290 is a studio course in which students learn foundational concepts and practices related to sculpture and physical making - students are often using equipment and tools which require close supervision, and therefore section sizes must be smaller to maintain safety. To accommodate the influx of students from both tracks of the IMDM major in a responsible manner, we anticipate the need for four additional sections of this course per year requiring the addition of one PTK instructor and one-half of GA position to monitor student safety during shop hours outside of class. The subject matter of IMDM 150 is such that it will require administration from the Studio Art contingent of faculty. We currently have faculty in place who have expressed interest in offering this course, so we do not anticipate an initial need to hire new faculty or instructors for this course, however GA support will be necessary to aid in discussion sections.

**Year 2:**
**Faculty Requirement:** 2  
**Instructor Requirement:** 0  
**GA Requirement:** 0.5
Second year students within the major will encumber the Department of Art with enough additional seats to require additional sections of ARTT 210 (2 sections) and ARTT255(2 sections). ARTT 210 can be supported through instructors and graduate assistants, however
given that ARTT 255 covers subject matter central to the major, it is imperative that a full-time tenure-track faculty member be committed to the instruction of these sections. In addition, year 2 is where students from both track 1 and track 2 formally converge to collaborate and work in teams via IMDM 201. IMDM 201 is envisioned as a team-taught course involving one faculty member from Art Studio and one faculty/instructor from Computer Science. ARTT255, and IMDM 201 are each anticipated to require two sections per year. We anticipate the need for two additional faculty in the areas of Digital Foundations (1) and Digital Media (1). To facilitate student research across disciplines, IMDM 290 will have GA support from the home departments of both tracks necessitating and ARTT 255 requires GA support as well. Put together, an additional one-half GA support for Studio Art (course support as well as lab facilities monitoring) will be necessary in year 2 of the program.

**Year 3:**
**Faculty Requirement:** 1  
**Instructor Requirement:** 0  
**GA Requirement:** 1  
The third year of the major represents the most substantial exposure to practice-specific courses in the series; students in both tracks will enroll in intermediate and advanced level digital media courses offered by the Department of Art, specifically ARTT 370, ARTT371, and ARTT479A, ARTT 479C, ARTT 479D, and ARTT 479E. In addition, IMDM course offerings directly involving faculty from Studio Art include: IMDM 390 (2 sections) IMDM 350 (1 Section), and IMDM 351 (1 Section). We anticipate again the need for 1 new faculty line to service additional sections of existing courses as well as the proposed IMDM offerings. Additionally, GA support will need to be provided from Studio Art for IMDM 390, IMDM 350, and IMDM 351 as well as to support the increased burden on all of the digital production facilities within the Department of Art.

**Year 4:**
**Faculty Requirement:** 1  
**Instructor Requirement:** 0  
**GA Requirement:** 1.5  
A major component of the final year of the major is a two-semester capstone series (IMDM 490 & IMDM 491). We anticipate the need to offer two sections of IMDM 490 in the fall semester, and two sections of IMDM 491 in the spring semester. These courses are the culmination of the major and are collaborative experiences which are team-taught between faculty in Studio Art and Computer Science. IMDM 470 is solely a component of track 2, and it is anticipated that we will have faculty in place at this point to service these courses. In addition to the IMDM course requirements, students enrolled in track 2 are required to take two advanced or intermediate level digital media courses throughout the year. We anticipate the need for one additional faculty line in Digital Media to facilitate the offering of these courses (coupled with the two additional faculty from the previous year). Again, sufficient GA support will be required to assist in the
IMDM courses, but also to offer supervision, and technical support during off-class open-studio hours.

**Computer Science Instructional Resource Requirements:**

**Year 1**  
**Faculty Requirement:** 0  
**Instructor Requirement:** 1  
**GA Requirement:** 3

In the first year the major is offered we assume track 1 and track 2 students will take the introductory CMSC and IMDM courses. The forty track 1 students will take CMSC131/132 and effectively add an additional section of 32 requiring a graduate assistant or equivalent undergraduate assistants. The twenty track 2 students will take IMDM 127, requiring an instructor and a graduate assistant, and all students will take CMSC-taught IMDM101 when the major starts, with 90 students for the year and three sections. In total, this requires a net of 6 instructor slots or one new instructor, with three graduate assistants at two sections each.

**Year 2:**  
**Faculty Requirement:** 1  
**Instructor Requirement:** 0.5  
**GA Requirement:** 2

In the second year track 1 students will continue to take introductory CMSC courses 216, 250, 330 and 351, requiring additional sections of each with corresponding teaching assistants. Track 1 and 2 students will both take IMDM 227, adding two additional courses with required instructors for two course instructors. The spring will have studio course IMDM290 as a team-taught course involving one faculty member from Art Studio and one faculty member from Computer Science, with two sections, and we assume a tenure track faculty is needed to provide leadership for 290. The net requirements are instructors for four courses.

**Year 3:**  
**Faculty Requirement:** 1  
**Instructor Requirement:** 0.5  
**GA Requirement:** 3

In the third year the enrollment of Track 1 students in CMSC courses becomes more complex as the 40 students will start taking electives and potentially be scattered through 400 level courses, making the impact harder to predict. However, we can assume that in net, the department may need to add an additional section of a CMSC42x course (420, 425, 426, 427, and a potential 400 level VR course), so would require one course instructor, best provided by a tenure track hire. Track 1 and 2 students continue the studio sequence with IMDM390 and therefore require one
faculty member from Art Studio and one faculty member from Computer Science, with two sections. CMSC will be responsible for one section for IMDM327 in the fall. The net requirements are instructors for about five courses, one of which we assume we will cover through an adjunct so four need to be covered by full time faculty, with 3 graduate assistants.

**Year 4:**

**Faculty Requirement: 1**

**Instructor Requirement: 0**

**GA Requirement: 2**

Again, Track 1 students will take CMSC400 level electives, and we can assume that in net, the department may need to add an additional section of a CMSC42x course (420, 425, 426, 427, and a potential 400 level VR course), but we assume this can covered by the tenure track hire in year or an adjunct. A major component of the final year of the major is a two-semester capstone series (IMDM 490 & IMDM 491). We anticipate the need to offer two sections of IMDM 490 in the fall semester, and two sections of IMDM 491 in the spring semester, some of which can be covered by adjuncts. These courses are the culmination of the major and are collaborative experiences which are team-taught between faculty in Studio Art and Computer Science. Providing leadership in 490/491 would require a TT hire.
Appendix H: AR/VR Market Analysis Data Sources and Charts

Use cases and software market detail

We believe VR and AR have the potential to not only create new markets but also disrupt existing ones. We’ve identified 9 use cases for VR/AR technology which we see currently emerging: videogames, live events, video entertainment, retail, real estate, education, healthcare, engineering, and military.

For each of these use cases, we assess the following:
1) The potential market reach in terms of users
2) The current challenges to execute on this use case
3) The existing revenue pool that VR/AR adoption could disrupt
4) Revenue drivers and estimate the software/subscription revenue potential through 2025

The following exhibit summarizes our software estimates by use case and key data points to gauge the market.

### Exhibit 13: Our base case user and software revenue assumptions

<table>
<thead>
<tr>
<th>Use Case</th>
<th>Current market size</th>
<th>Datapoints on the population that could use VR/AR</th>
<th>2020 Base case assumptions</th>
<th>2025 Base case assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>To gauge the magnitude, the population that VR/AR could sell into</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Users</td>
<td>Software revenue</td>
<td>Users</td>
</tr>
<tr>
<td>Videogames</td>
<td>$106bn videogame market</td>
<td>70mn</td>
<td>$6.8bn</td>
<td>216mn</td>
</tr>
<tr>
<td>Live events</td>
<td>$44bn live sports ticketing revenue</td>
<td>28mn</td>
<td>$0.8bn</td>
<td>95mn</td>
</tr>
<tr>
<td>Video entertainment</td>
<td>$60bn online video TAM</td>
<td>24mn</td>
<td>$0.8bn</td>
<td>79mn</td>
</tr>
<tr>
<td>Real estate</td>
<td>$107bn total real estate commission market in US, Japan, UK, and Germany</td>
<td>0.2mn</td>
<td>$0.8bn</td>
<td>0.3mn</td>
</tr>
<tr>
<td>Retail</td>
<td>$3bn in ecommerce software market (impacting $1.3tn e-commerce market)</td>
<td>9.5mn</td>
<td>$0.5bn</td>
<td>31.5mn</td>
</tr>
<tr>
<td>Education</td>
<td>Education software market: $5bn for K-12, $7bn for higher education</td>
<td>7mn</td>
<td>$0.3bn</td>
<td>15mn</td>
</tr>
<tr>
<td>Healthcare</td>
<td>$16bn patient monitoring devices market</td>
<td>0.8mn</td>
<td>$1.2bn</td>
<td>3.4mn</td>
</tr>
<tr>
<td>Engineering</td>
<td>$20bn engineering software market</td>
<td>1.0mn</td>
<td>$1.5bn</td>
<td>3.2mn</td>
</tr>
<tr>
<td>Military</td>
<td>$50bn defense industry training and simulation market</td>
<td>6.9mn military personnel in &quot;high income countries&quot; (World Bank)</td>
<td>20mn</td>
<td>$0.5bn</td>
</tr>
</tbody>
</table>

The Ecosystem
Virtual Reality / Augmented Reality

Total Addressable Market
2025 Base Case VR/AR Estimates

VIDEOGAMES
$3.6bn
- Estimated users: 216mn
- Markets disrupted: videogames

LIVE EVENTS
$4.1bn
- Estimated users: 95mn
- Markets disrupted: live ticket sales

VIDEO ENTERTAINMENT
$3.2bn
- Estimated users: 70mn
- Markets disrupted: online streaming

RETAIL
$1.6bn
- Estimated users: 32mn
- Markets disrupted: e-commerce

REAL ESTATE
$2.6bn
- Estimated users: 0.3mn
- Markets disrupted: commissions

EDUCATION
$0.7bn
- Estimated users: 15mn
- Markets disrupted: K-12 and higher-ed software

HEALTHCARE
$5.3bn
- Estimated users: 3.4mn
- Markets disrupted: patient monitoring

MILITARY
$1.4bn
- Estimated users: 0.7mn
- Markets disrupted: defense training and simulation

ENGINEERING
$4.7bn
- Estimated users: 3.2mn
- Markets disrupted: CAO/CAM software

SOFTWARE
$35bn
- 60% of VR/AR software revenue will be driven by the consumer (vs. enterprise/public sector)
- Videogames will be the first consumer market to develop
- Beyond videogames, we see real estate, retail and healthcare among the first markets disrupted

HARDWARE
$45bn
- 4 main devices used to experience VR/AR: HMDs, host systems, tracking systems and controllers
- Our forecast is specific to HMDs
- Our base case assumes 125mn annual shipments by 2025

Data Source: Digi-Capital Augmented/Virtual Reality Report Q3 2018:

Data Source: Citi GPS: Are You Sure It Isn't Real?:

2/23/2019
Market Size and Growth

Based on the aforementioned classifications, we believe the VR/AR market will expand to $7.6 billion in 2016, $18.2 billion in 2017, $80 billion in 2020, and $569 billion in 2025. We forecast the market for headsets and other hardware will expand from $3.6 billion in 2016 to $130 billion in 2025 (a compound annual growth rate, or CAGR, of 49%), and the market for software, contents, and services will expand from $3.9 billion in 2016 to $276 billion in 2025 (61% CAGR). In the next chapter, we introduce technologies and systems for VR/AR hardware and software, content, and services.

Figure 11. VR/AR Market Scale Forecasts

Source: Citigroup

© 2016 Citigroup