AN INTERDISCIPLINARY FOUNDATIONS CURRICULUM FOR MEDIA, COMPUTING AND ENGINEERING TECHNOLOGIES

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Abstract

The New York City College of Technology, City University of New York, is offering a new Bachelor of Technology program in Emerging Media Technologies. The program is highly interdisciplinary, integrating 1) media design theory and practice, 2) computational media models and principles, and 3) engineering methodology and implementation. The program identifies five meta-level skill sets: teamwork as a discipline; rapid prototyping; formulative thinking skills, integration skills, and software skills. The first year Creative Media Foundation courses provide surveys with hands-on experiences in emerging media technology. Second year students choose Concentration areas and begin to develop specializations through career track sequences. In the third and fourth years students from all concentrations converge into collaborations through Interdisciplinary Team Projects, where they work in large and small teams on production and design.

Keywords - Innovation, technology, research projects, etc. [Arial size 10, left alignment].

1 INTRODUCTION

The New York City College of Technology, City University of New York, is offering a new Bachelor of Technology program in Emerging Media Technologies. The program is highly interdisciplinary, integrating 1) media design theory and practice, 2) computational media models and principles, and 3) engineering methodology and implementation. Emerging Media Technologies refer to the technologies in an experimental stage prior to industrial adaptation. Emerging Media concerns the process of specifying message protocols, device interoperability, and the transmission and display of information. In this new discipline students learn to develop skills such as rapid prototyping, integration, teamwork, software knowledge, and the skills for evaluating the long-term viability of media technologies in multiple application domains.

This paper highlights the unique structure of the Interdisciplinary Foundations experience drawing upon courses in other programs. The Creative Media Foundation 1) helps students discover their strength and their orientation to select their future concentration area by exposing them to a gallery of possibilities; 2) increases their understanding of plasticity by providing them with hands-on experiences in designs and experiments across multiple modalities; 3) prepares students to favor cooperative and collaborative learning by providing an open laboratory environment; 4) facilitates their capacity to participate in interdisciplinary projects with proper communication skills with fluent media literacy.

In this paper we analyze the challenges to this approach in institutional and educational contexts. We assess the strength of orientation of curriculum design around three Concentrations supporting an extended and comprehensive capstone project structure. The paper focuses on development of a model of Interdisciplinary pedagogy that aims for coherence by creating collaborations in classrooms where students with diverse technical backgrounds work together.

1.1 Regional context

The New York City metropolitan area is populated with design firms and entertainment industries equipped with up-to-date media technology. The urban environment comprises an ecosystem of unique economic development opportunities dependent upon a knowledgeable, media-fluent workforce. The descriptions for new job opportunities call for expertise both with specialized problem solving and integrated cognitive skills [1]. Demands for new talent require that student be prepared in specific disciplines, at the same time they have to be well-informed of interdisciplinary production models incorporating engineering, computing, and design creativity.

It may be assumed that students are required to pay expensive tuitions to pursue media related careers. An informal survey of digital-media related programs in the area turned up most programs in private institutions carrying fees of $32,000-35,000 annually, not including housing costs. Digital media programs are popular as an income source at many private institutions due to two factors: 1) the relatively low infrastructure costs of desktop computers and consumer grade media software, and 2) the proliferation of digital media courses that are designed to teach the use of a individual commercial applications. Our public college full time tuition and fees are currently less than $6000 annually, and the college provides a range of engineering technology hands-on laboratories that represent a substantial investment and carrying cost for the college, as well as significant facilities commitments in the dense urban environment where the college is located.

There are no comparable undergraduate 4-year programs in the NYC area. NYC industries rely upon imported talent or secondary training at the post-graduate level, rather than undergraduate foundations training in emerging media technology.

1.2 Generational context

The generation entering higher education in the new millennium is heavily exposed to powerful media and computing technologies. In large part, their competence with media devices is developed from an early age, their action judgments are spontaneous and intuitive, and their expectation assumes rich media experiences. Devoted to fun seeking and socialization, their engagement tends to be voluntary. The profile of this generation is well-suited for emerging media industrial tasks; the proposed program responds to this generation. The program will endeavor to guide and cultivate new talents, not only to provide a dynamic work force for emerging media industries, but also to mobilize the new generation’s intelligence to shape future technology and lifestyle.

1.3 Institutional context

The Program initiatives recognize the lack of formalized education framework to account for practices emerging in the entertainment and creative media industry. While this gap misses the opportunity to accommodate diverse students’ talents with common interests in innovative media careers, it also mirrors unfilled job opportunities. The emerging job descriptions demand integrated skills and interdisciplinary approaches in the field. Situated in the midst of versatile engineering, computing, and design academic departments, the School of Technology and Design at City Tech is an ideal environment to implement the program to address the situation and to provide the proper educational hosting structure to produce graduates with forward looking perspectives and technical skills.

A review of national trends in related programs can be summarized as follows.

1. *Digital Media Programs*: instruction utilizes existing media software and offers small-scale media and web productions.
2. *Art and Technology Interdisciplinary Programs:* art and design intensive training incorporates tools to serve artistic productions.
3. *Art and Science Interdisciplinary Programs*: art and media theory intensive education with media study topics.
4. *Game-related Concentrations in Computer Science Programs*: recent flexibility to include applications, often as part of efforts to reverse downward trends in enrolments.

While the classes of related programs described above do not explicitly address emerging media, it is possible to seek out interdisciplinary programs addressing emerging media in research centers and universities. These projects are often featured under the auspices of externally supported postgraduate research contingent upon fluctuating funding levels. These conditions are not suitable for hosting regular curriculum for undergraduates.

To establish a pedagogically sustainable model, the Emerging Media Technologies program is positioned between research programs and digital media programs, with the scale appropriate to media industry demands. The program discussed here expands the scale and depth with an interdisciplinary structure, specifically focused on the Baccalaureate degree. The program also embraces diverse faculty expertise and coursework from the departments of Architectural Technology, Advertising Design and Graphic Arts, Computer Systems Technology, Computer Engineering Technology, and Mechanical Engineering and Industrial Design Technology; through collaborative teaching and uniquely designed pedagogy for interdisciplinary projects.

1.4 Industry context

We are increasingly facing industry and creative niches where needs are not met by graduates from existing programs; most educational environments to this date do not know how to address this issue [1, 2]. Industries face problems of educating a workforce to have intuitive grasp of relationships that can only be acquired from perspectives of working knowledge of more than one field. The need for cross-disciplinary structure is also reflected in application-oriented engineering education, where students' professional contexts have much in common with those in the media technologies.

Housing the program within the Entertainment Technology Department entails three main merits to this need: 1) Instructional topics inherently cover multiple disciplines; 2) problems and methods concerning entertainment require creative thinking; 3) the project scope ranges from individual scale to institutional scale. These merits target students who wish to pursue engineering, computation, and creative design with an entertainment focus.

Due in part to the historical lack of support and practice for undergraduate interdisciplinary training, there resides a strong assumption in academic approaches that an undergraduate degree is not sufficient to gain access to careers in emerging media technologies. This assumption often has the effect of delaying or bypassing interdisciplinary roles and team-based learning at a critical stage in students' pre-professional identity formation. We have taken a novel approach to enforce the immediacy of professional identity in teams, while preserving flexibility of roles in working groups for students to "audition" different identities to discover a good fit with their best talents and interests. Emerging industries tend to minimize professional hierarchy based upon formal education and maximize effective resource management and production efficacy. They seek fresh talent and are receptive to career-ready college graduates.

2 CHALLENGES FOR INTERDISCIPLINARY FOUNDATIONS CURRICULUM

The simple and immediate challenge to an interdisciplinary foundations curriculum is the implied oxymoron of the term "interdisciplinary foundations." Foundations-based learning in practitioners' fields, including engineering and creative fields such as media and arts, focus on mastery of material related to a particular medium. Crossing disciplinary boundaries creates challenges in planning the alignment of prerequisites, and challenges in securing shared resources such as laboratory access. In section 3.1 we address these challenges with an alternative curriculum model that defines and encourages teamwork as a discipline, and introduces interdisciplinary Concentrations.

Traditional degree programs are often designed for supporting a uniform course of study where all students reproduce uniform assignments, rather than a diversified course of study model where students work on select topic areas anticipating other students in the program are working on complementary topics. The model of interdisciplinary Concentrations resists the trend of programs that aim to teach all students everything about a field. Interdisciplinary concentrations go against the model of limiting specialization and topical individuality among students to the final stages of their course of study. Many traditional programs require students to apply themselves to predominantly identical assignments for the majority of the course, a practice that may encourage direct competition among students rather than encouraging complementary project skills and teamwork.

A related challenge we can report is that available faculty talent is not a good fit with an interdisciplinary foundations model, because faculty are trained in the legacy context. It is most challenging to establish a comprehensive pedagogy as interdisciplinary instead of relying on isolated projects to teach interdisciplinary thinking. Assumptions prevail that simply by putting students together from different disciplines something will happen. We argue this is not a sufficient design. .

A further challenge is that Concentrations must be limited in total credits so that they do not require accreditation as separate degree programs. Each concentration in our program is a mix of several existing programs but duplicates none of them. Concentrations in our program represent highly selective paths; they cannot be comprehensive in their coverage of each discipline, in the way a single department tries to be exhaustive to provide basic learning coverage through uniform course of study.

3 INTERDISCIPLINARY FOUNDATIONS CURRICULUM CONCEPT

The program is created with the assumption that an undergraduate degree is sufficient for entering a professional career. We provide requisite job-related experience during undergraduate education and bypass traditional academic assumptions to the contrary. Continuation in a graduate program is possible and the program is designed to facilitate a graduate degree path; at the same time graduate study is not assumed as a requirement for professional success. The program prepares students for advanced study in computational media while recognizing that in a rapidly transforming industry, professional performance is grounded by experiencing and understanding practitioners' orientation. We may say this program's philosophy is that of extreme long range workforce development, recognizing contemporary work environments where professionals having undergraduate and graduate training participate in design and production decisions based upon their shared perspective toward production and performance practices.

3.1 Curriculum design criteria

Bypassing several assumptions discussed in Section 1.4, the new curriculum requires new design criteria to prepare necessary skill sets for next generation workforce. The design challenge is to shape the curriculum to cover both breadth and depth in students' skill sets called for in next generation analyses such as *Educating the Engineer of 2020* [3, 4]. It is very important for students to deepen their focused knowledge and skill sets in depth in their concentration areas, as in the example in Section 5. It is also important for students to be able to apply what they know well to varying contexts with broad perspectives [5, 6, 7]. For the students' expertise and concentration areas we can leverage on the traditionally well founded and stable courses offered from the traditional computing, engineering, and design related departments. For the new curriculum we needed to identify and abstract a set of meta-level skill sets that all students must acquire from the early stage of their college career and keep developing through to graduation. Once we have identified these meta-level skills, we can use them as design criteria for the curriculum and as pedagogical approaches that give a signature to the program. In this section we discuss the five meta-level skill sets: teamwork as a discipline, rapid prototyping, formulative thinking skills, integration skills, and software skills. We believe these are essential to the transformation of specialized skills and knowledge to contextual skills and knowledge.

A. Teamwork as a discipline

Teamwork as a discipline describes a foundation based upon defined learning roles among students on an ongoing basis. This meta-level skill applies to the following first and second processes: 1) self regulated learning and 2) project based learning and production. In the first process, self regulated learning, teamwork as a discipline not only applies to individuals also to a team as a collaborative learning entity. This approach is well-structured from course to course, and provides consistency of student learning process. The self regulated team learning processes can be further informed and enforced by the second process. In the second, the project based learning and production process, teamwork as a discipline not only applies to facilitate individuals to cooperate and collaborate in a team; teamwork also applies to facilitate individuals to develop the skills to establish their identity in a team. Students must learn and develop their individual expertise and then bring this into the team environment where others perform complementary assignments showing complementary skills. This method is intended to cultivate students' internalizations of mutually dependent responsibilities. The identity in a team is a function of the social context, the collectives of knowledge and skills, and the peer to peer recognition based upon individuals' contributions. Therefore identity is something constructible, revisable, and even correctable. We must also acknowledge this concept of teamwork as a discipline goes beyond the traditionally hierarchical and corporate organizational models. The intended goal is to enable more reliable assessment of individuals in group work, avoiding assignments where students are merely thrown into a social setting by requiring multiple hands. Team roles are differentiated in most production courses, and adopted as to be expected and encountered in multiple professional settings.

B. *Rapid prototyping*

The program encourages *rapid prototyping* as an instructional and learning methodology for converting conjectures and hypotheses into feasibility studies. The path from research to design and implementation is iterative and hands-on. This design is intended to reduce the conceptual distances that theory and practice sometimes develop in media and computing fields. Working notebooks of tests of project prototypes are given twofold credit: 1) for enabling clear presentation of project results to team members and to other teams; 2) to aid the student in reconnecting observations and feasibility results with theoretical writings and perspectives. Rapid prototyping as a meta-level skill enforces students to rapidly experiment with the application of theory with working knowledge to arrive at various possible configurations to increase their contextual competence.

C. *Formulative thinking skills*

Students must be able to not only solve the problems given, known, and identified, also be able to identify the problems and articulate them. The pedagogical use of rapid prototyping facilitates program emphasis on *formulative thinking skills* in emerging problem areas. As students acquire rapid prototyping exercises they encounter emerging problem areas. Immediate or short-term feedback is relatively common and instructors can review in each lab how students' first efforts indicate their basic grasp of lesson materials. Transitions from foundation tutorials to team projects are expected to be facilitated by establishing feasibility-based conversations in lab activities. Formulative thinking skills are also a means to measure students' role in verbal presentation and communications skills regarding their interpretations and creative ideas.

D. *Integration skills*

Integration skills are also supported by rapid prototyping and feasibility study assignments. The direct challenge is to bring together diverse media in complementary roles, where these media are not merely co-located in a project but co-dependent. This requires an understanding and integration of diverse data types that flow in and out of computational media supporting multiple modalities and formats. This data in turn provides a learning opportunity to introduce a functional grasp of the underlying engineering principles. For example mobile phone communication is now accompanied by accelerometer data to determine aspects of the orientation of the phone and user movements. Diverse sensor subsystems and their data types are an increasingly standard complement to communications platforms and media displays. Integration will move from mechanical and electronic tasks of sharing data streams to interpretive and creative tasks of designing systems that will use these data sources meaningfully and ethically.

E. *Software skills*

Software skills are considered a normative mode of written communication and expression of both scholarship and design competence. Software includes a range of technical skills from writing simple scripts to programming in object oriented languages. As a form of technical writing, software skills have a dual role as direct production of text—the code or script, and indirect production of a computational result—the automated operation of the code as a *program*. The written software may be interpreted both in terms of a text in a well defined language, and as an intended communications with a machine interpretation.

The concept of *software as writing* has pedagogical linkages: 1) Software expressions must be rigorously formulated in a well defined language. 2) Software is written to express the intention of the programmer. 3) The effectiveness of software expression can be assessed both according to the writing itself and the functional performance when the software is run. 4) Written software demands *style* and *etiquette* which can be evaluated according to industry standards, including both annotation and documentation required to describe structures and intended functions. 5) Software that does not function properly must be *debugged*: the writing must be corrected as to syntax and grammar, also as to intended function. Software scripts and code are introduced in graded levels of complexity. The emerging media technologies program assumes software skills may be taught as a formalization of natural language acquisition learned early in life, and that incoming students will have exposure to examples of programming computational devices in the environment. Software skills are available to be brought into many professional disciplines that are connected through computational media.

3.2 Interdisciplinary relationships

Fig. 1 illustrates the relationship between computational media disciplines and the formal concentrations of the program. The collection of terms at the bottom of the diagram represents relevant fields that provide learning opportunities and require some level of foundational support in the program. The design challenge is how to bring these fields into a working relationship at the foundations level of the curriculum.

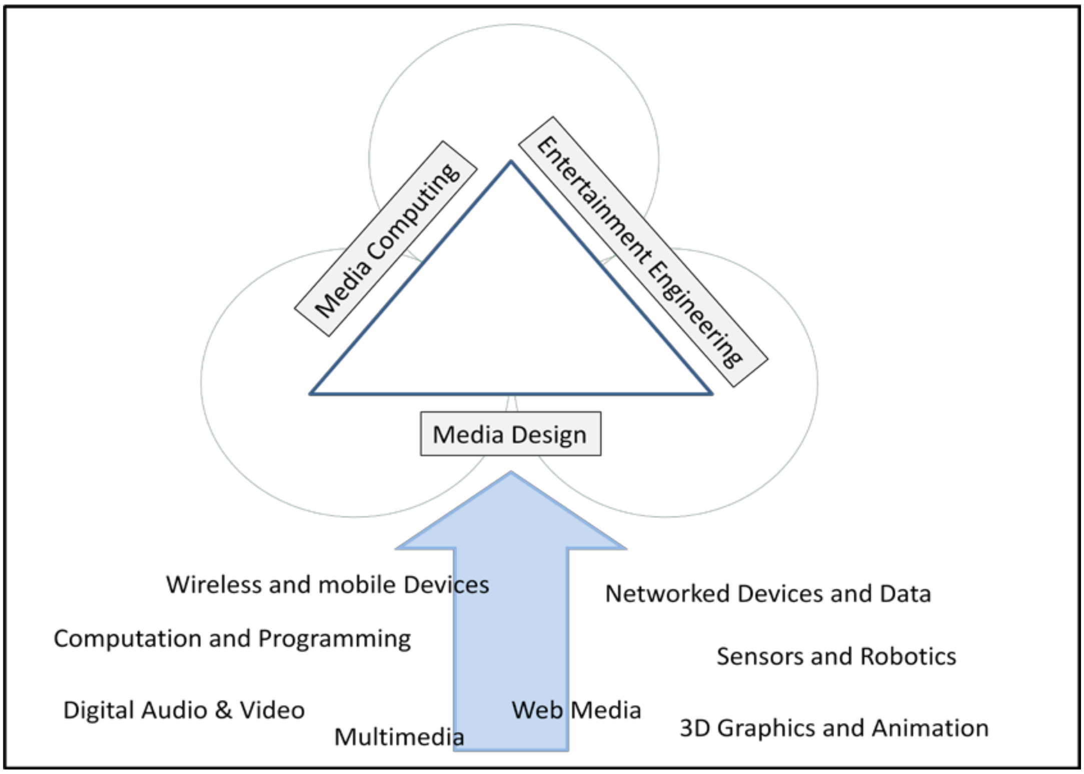

Figure 1: The triangle's sides represent program Concentrations. Below the triangle are technologies that contribute to emerging media platforms. Their convergence creates new media professions.

The sides of the triangle in the diagram present the three program concentrations: Media Design, Media Computing, and Entertainment Engineering. The radius around each vertex represents convergence of related technologies. These convergences are embodied as technology platforms that host combinations of technologies drawn from the contributory fields below. The curriculum assembles technology combinations following those that are provided by industry as integrated platforms.

Fig. 2 represents the structure of interdisciplinary relationships, with integrated technology platforms clustered at each vertex. The spatial proximities of the terms in the diagram represent the relative associative strengths of potential integration of these technologies. The center of the diagram represents the integration function that is embodied by emerging platforms and reflected in the integration of fields of study in the program. The curriculum integrations have been designed in response to the industry platform integrations, and reflect similar design principles of awareness of technology compatibility and complement.

Fig. 3 shows the Career Tracks that encapsulate contributory technologies and integrated platforms. Career Tracks subdivide each Concentration. These career tracks provide guidelines for the selection of courses from contributing engineering and media-related departments. In practice these interdisciplinary relationships are realized by selective combinations of course sequences from multiple technical departments, securing prerequisites within the credit limits of the program. A career track course sequence example is discussed in Section 5.

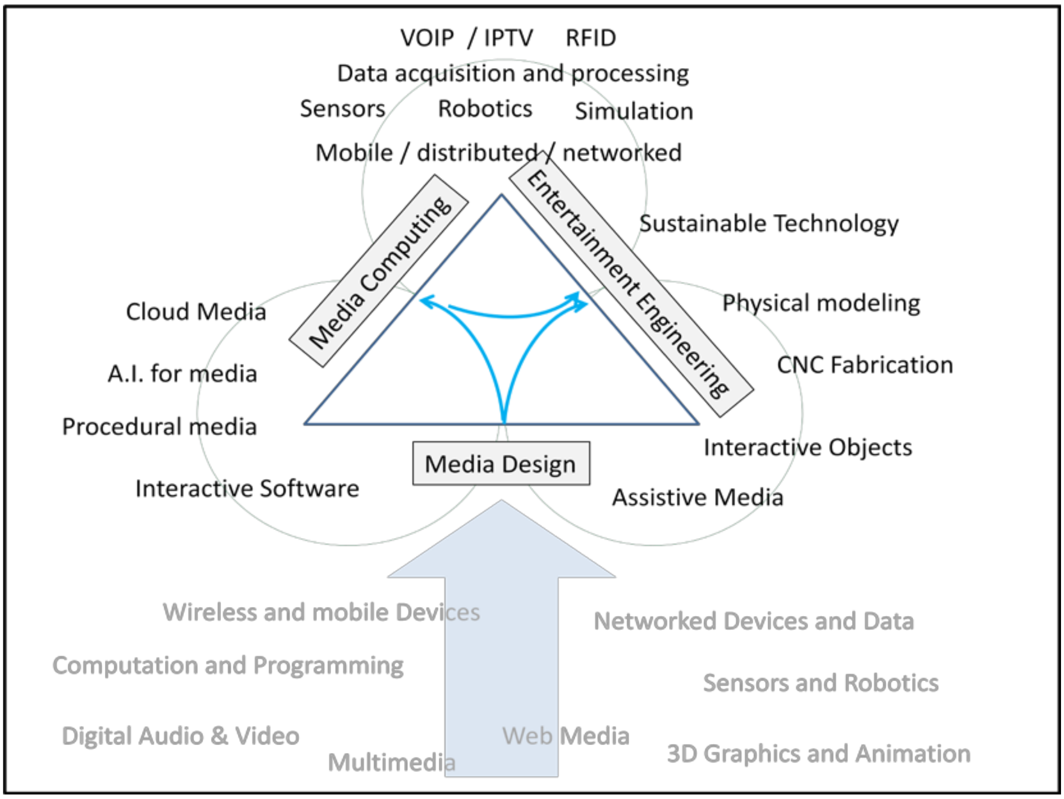

Figure 2: New media platforms are created by convergence. These platforms represent the formation of integrated media systems across intersections of traditional professional boundaries.

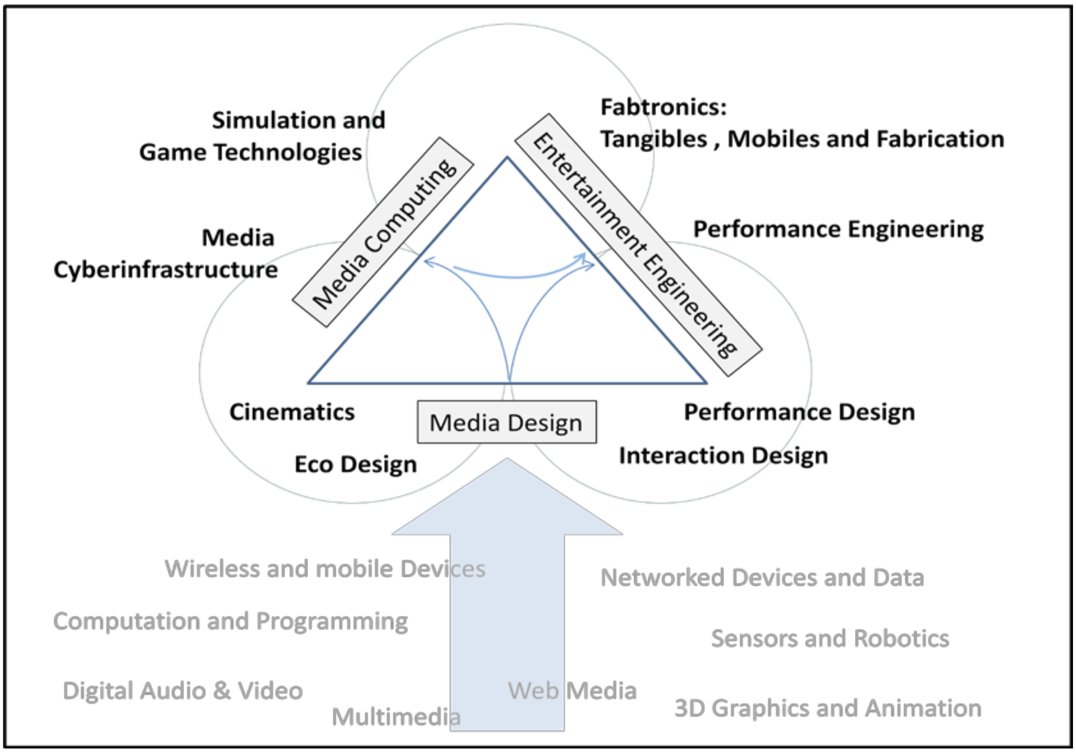

Figure 3: Concentrations and Career Tracks represent media systems professions.

4 CURRICULUM STRUCTURE

In order to keep the curriculum and graduates relevant as technology rapidly changes, students must develop a passion for their discipline and achieve learning independence. Our instructional design methodology aims to provide a structure that supports teamwork, experimentation, and self-learning by pairing collaborative, project-based courses with technology skills workshops. The interdisciplinary effort will be led by Emerging Media Technology, partnering with faculty from multiple departments within the School of Technology and Design. Instructional experiences will be shared and adapted, which will in turn strengthen the individual department curricula. The Program embraces this interdisciplinary exchange and incorporates courses from design, entertainment, engineering, architecture, and computer systems departments into the fabric of the curriculum

4.1 Cohort progression summary

Fig. 4 presents a schematic illustration of the cohorts moving from common foundations to selected concentrations, and then working together after specialized coursework. Each student begins the first year with Creative Media Foundation courses to acquire comprehensive overviews and hands-on experiences in emerging media technology. In the second year students will choose their concentration areas and begin to develop specializations through career track sequences, which provide indirect involvement in integrated projects. In the third and fourth years students from all concentrations converge into collaborations through Interdisciplinary Team Projects, while they continue courses in their concentration area. Students will be encouraged to take their internships in the third year to bring their experiences back to the program and to sharpen their portfolio directions. Seniors are required to complete portfolios of their project collaborations, while they are assigned leadership roles to guide third year students through Interdisciplinary Team Projects. In the 120 credit Baccalaureate program, Creative Media Foundations fulfill about 20 credits, Concentrations fulfill 40 credits, advanced courses fulfill about 20 credits, and general education fulfills about 40 credits.

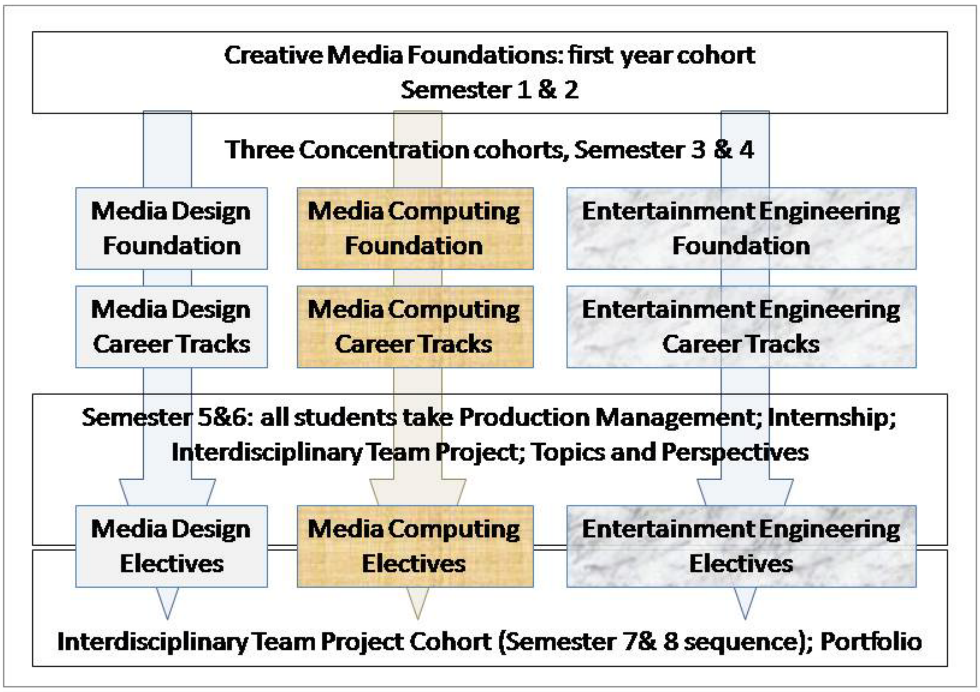

Figure 4: Cohort Progression Model: Horizontal groups indicate students in a common cohort by semester. Smaller boxes indicate subgroups in Concentrations and Career Tracks.

4.2 Creative Media Foundation

Creative Media Foundation consists of six courses. It is mandatory for all students to complete them during freshman year. The goals of Creative Media Foundation are (1) to help students discover their strength and their orientation to select their future concentration area by exposing them to a gallery of possibilities; (2) to increase their understanding of plasticity by providing them with “messy” hands-on experiences in designs and experiments across multiple modalities; (3) to prepare students to favor cooperative and collaborative learning by providing an open laboratory learning environment; (4) to facilitate their capacity to participate in interdisciplinary projects with proper communication skills with fluent media literacy. The courses include introductions to design process and production practices, site visits to media design and media technology firms, skills workshops to introduce detailed user orientation to a number of software tools, an introduction to tangible media and electronics, an introduction to pre-programming and programming patterns using computer scripting in a graphics environment, and an introduction to computer-aided technical drawing.

4.3 Concentrations

To accommodate the diverse orientations in emerging media fields the program facilitates three areas of concentration. Each concentration is divided into focused career tracks to provide students with clearly defined areas of specialization.

A. Media Design Concentration

Media Design will consist of four tracks: Interaction Design, Cinematics, Performance Design and EcoDesign . Interaction Design studies systems, cybernetics, and social interaction through computer and device mediated life activities. Cinematics focuses on interactivity in 2D and 3D graphics, video, and narrative. Performance Design studies multimodal performance and staging in terms of process analysis and design practice, including motion capture data applications, covering a variety of performance configurations. EcoDesign addresses the development of interactive media, products, and systems using ecological design considerations and theories, such as biomimicry, pattern language, and cradle-to-cradle design process. In the future the program may include a Sound Design track to account for new practice in areas such as sound for games and interactive products.

B. Media Computing Concentration

Media Computing will consist of two tracks: Simulation and Games, and Media Cyberinfrastructure. Simulation and Games will concentrate on the building blocks of virtual environment technology, artificial life algorithms, 3D camera path planning, immersive experience design, data driven modeling and simulation, and the mathematics of games, with pedagogical and assistive applications. Media Cyberinfrastructure will study multimedia database storage and retrieval, media device networking, media streaming, integrated media architecture, VoIP[1], IPTV[2] webcasts and live distributed events, and large-scale multi-participant systems.

C. Entertainment Engineering Concentration

Entertainment Engineering will consist of two tracks: FabTronics and Performance Engineering. FabTronics is comprised of Tangibles, Mobiles, Fabrication and Mechatronics. Students will integrate sensors and actuators, robotics and small devices with processors, fabrication of mobile props for stage and for installations. Objects with embedded processors are networked and distributed. Performance Engineering covers automation and live media technology and practices through computer modeling, pattern recognition, performance gesture analysis, and performance space instrumentation. Topics include motion capture data acquisition and conditioning, and wearable interface engineering, covering a variety of stage sensing technology and integration into larger presentation systems.

4.4 Career Tracks

Following 20 credits of Creative Media Foundations, each Concentration provides 40 credits of coursework divided into Concentration Foundations and Career Track courses. Each Concentration has a Foundations sequence of 9-12 credits that combines Emerging Media courses and courses from other departments. For the remaining Concentration credits students must select a Career Track from

[1] Voice Over Internet Protocol
[2] Internet Protocol Television

those described in Section 4.3. Each Career Track provides a sequence of required courses and elective courses. Career Track courses are comprised from other programs, with each Career Track combining complementary coursework from multiple programs. For example Computer Systems and Graphic Design in the Simulation and Games track; or Industrial Design and Computer Engineering in the Fabtronics track. The ratio of required and elective credits in Career Tracks varies depending upon the depth of technical prerequisites. Media Design tracks average almost 20 elective credits; the other tracks range from 10 to 15 elective credits, as they have more specific course sequences required for technical proficiency, drawn from other majors.

The selection of courses for Concentrations and Career Tracks required extensive discussion with the related departments. The first goal was to find the courses that fit best with the Concentration area. The second goal was to identify course sequences that developed progressions of technical prerequisites or substituted courses from another department to provide prerequisites, given the limited number of credits available. Concerns for student preparedness and technical quality were addressed by the use of ABET accreditation criteria [8] that are in place for the engineering technology programs participating in the Concentrations. Selection of complementary courses from multiple departments provides a window onto convergences of emerging technology platforms related to multiple technical professional areas. The process of creating Concentrations elevated awareness of emerging media technologies in each of the participating programs. It has also created opportunities for students in technical majors to find relevant electives related to emerging media applications. We anticipate the informal exchanges among students in shared courses will foster a range of informal learning and professional benefits. Section 5 provides an example of a Concentration and related Career Track sequences.

Select options in the general education curriculum provide liberal arts and science offerings suitable for students entering various subfields of emerging media. The general education options are tailored for each Concentration, to meet the requirements of Career Track courses from other programs. For example, students in the Entertainment Engineering concentration are required to take two semesters of Calculus-based Physics whereas the Media Design students take Algebra-based Physics with an option to substitute the higher math coursework.

4.5 Advanced project courses

There are considerable limits to the range of courses from multiple programs that can be combined in the coursework of a single student. The program objective is not to create super-disciplinary achievers, but to establish expectations of team relationships for professional endeavors of scale. The Concentrations are designed to cultivate a balanced distribution of talents, interests, and perspectives that will meet in the advanced project courses where students will perform in multiple team roles. Advanced professional coursework includes multiple semesters of an Interdisciplinary Team Projects course; also Topics and Perspectives in Emerging Media, a theory-based analytics course; also Project Management, Professional Portfolio, and Internship courses. The curriculum is further enhanced with a media literacy course, Media Research and Documentation, developed in collaboration with the Library and English departments to provide a targeted communication and digital documentation research course for our students and others interested in media technology.

5 EXAMPLE CONCENTRATION AND CAREER TRACK IMPLEMENTATION

The Entertainment Engineering Concentration is comprised of 9 credits of Foundations. These include an introductory Java programming course from the Computer Systems department, and two courses from Emerging Media Technologies: Physical Computing and Interaction Design. The Fabtronics track adds 13 required credits: 5 credits of 3D modeling, simulation and CNC fabrication from the industrial design and mechanical engineering technology programs, and 8 credits of circuits and control systems from computer engineering technology. Additional 18 elective credits enable the student to focus further on fabrication or on embedded systems. In either direction the students will build upon fundamentals of fabricated forms and fundamentals of computational processing and control embedded in fabricated forms. Both tracks support the basic professional orientation of Fabtronics to provide students with understanding of smart personal devices and interactive applications that have a tangible form factor.

The Performance Engineering track adds 20 required credits: A Show Control course from Entertainment Technology, a C++ programming course from Computer Systems, a Linear Algebra course, and digital control and robotics courses from Computer Engineering Technology. Nine elective credits support additional focus on actuated and robotic systems for performances and interactive installations, alternatively on computational modeling of performance media resources. This track represents a streamlined introduction to robotic design and control, bypassing a comprehensive robotics and embedded system curriculum, while providing reliable groundwork for use of production-based robotics in emerging media applications.

6 PROGRAM ASSESSMENT

Program outcomes are assessed at two levels, an overall assessment of general outcomes and assessment of outcomes specific to each concentration. Both direct and indirect measures are applied, based upon individual course outcomes and also summative reviews of students' interactions in teamwork settings, on interdisciplinary projects, during internships, and through professional advisory commission recommendations, job placements and graduate and employer feedback. The program tests for broad skills development measures used across the college to assess critical thinking, analytic reasoning, oral communications, listening skills, and written communications with a focus on technical writing.

Comprehensive outcomes assessment for all courses in the program reviews a common set of emerging media technology skills: production management, collaborative production (teamwork), cooperative project design skills (collaborative design), and a basic understanding of each concentration area. Additional outcomes assessment for all students includes basic competencies in general media and production technology including computer aided drafting and design software, simulation software, 3D modeling software, and digital media production competencies in audio, video, and web-based media. All students are expected to master basic competencies in interaction design.

Media Design Concentration outcomes assessment will focus on advanced levels of performance in video production, audio production, lighting production, web-based media, tangible media, and application of interaction design principles. Outcomes will include a mastery of best practices in the above areas. Technical competencies will include a mastery of computer scripting and a basic understanding of object-oriented computer programming and networked communications of media devices. In addition, competencies in the design and planning of communications media and successful methodologies for producing communications across diverse media will be measured.

Table 1: Competencies for Entertainment Engineering and Media Computing Concentrations

Competency	Entertainmt. Engineering	Media Comp.
Object-oriented programming in Java	X	X
Computing hardware and operating systems including Linux and Macintosh as well as Microsoft environments	X	X
Networking techniques for computers and other digital devices	X	X
Engineering Graphics for 2D layout and 3D modeling	X	X
Use of computer modeling for automated fabrication	X	
Experience with a variety of sensor technologies	X	
Computer control of electromechanical devices.	X	
Embedded computing using programmable microchips	X	
Familiarity with applications of wireless, mobile and handheld devices for performance and social media	X	
Web back-end programming and web server media configuration		X
Software development best practices; documentation; version control		X
Digital Media Database configuration and management techniques		X
3D modeling and animation focusing on procedural animation		X
Computational simulation and visualization of parametric models		X

Entertainment Engineering and Media Computing Concentrations' outcomes assessment will measure repertoires of technology competencies across hardware and software applications, represented in Table 1. Assessment of these concentrations is conducted using ABET-defined outcomes assessment methods, applied in the contributing programs that are ABET accredited [8].

7 CONCLUSIONS

We anticipate that project distribution across teams of students will prove to be an effective methodology to foster broad knowledge in groups, and to provide maximum awareness of and learning through complementary skills sets. This meta-skill set instructional model informs students from their first semester that they will be in company of multiple talents and multiple areas of expertise among fellow students. With this knowledge and a structured learning environment to investigate their interests, students will be moved steadily toward selecting their preferred expertise. This approach requires planned diversification of assignments, for truly interdisciplinary foundations pedagogy. It cannot be accomplished with all students in a uniform course of study. Our goal is to grow students' expectations and participation in an inter-talented culture from their first semester, rather than mixing separate cultures later in students' learning careers. Mixing later is prone to limited success and could demand ongoing high overhead to manage relationships at too many levels.

The program goal is to create a meta-culture in which multiple disciplines can coexist. The ultimate focus of this approach is the students' orientations to their learning; their expectations of relationships in study and production teams. Creative Media Foundations is designed to provide the impetus for students' early discovery of themselves in the context of creative and design projects, by giving them at an early stage the production context where they can integrate projects into a larger scope. From then on they discover what they are really good at and what they really want to spend time on. This perspective will impact their experiences in the traditional engineering technology and computing courses of their Concentrations, where they will be working with future professionals of those fields. The program defines through project assignments how to orient and guide students to focus their expertise toward emerging media technologies in that context.

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