PROPOSAL FOR AN UNDERGRADUATE PROGRAM LEADING TO A

Bachelor of Arts (B.A.) Degree in

Management of Innovation, Sustainability and Technology

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Proposed Major in Management of Innovation, Sustainability and Technology

1. Program Description and Rationale

1.1 Program Focus

The Department of Management of Complex Systems (MCS) is submitting a proposal for an undergraduate B.A. major in *Management of Innovation, Sustainability and Technology* (MIST). Coursework integrates *Technology and Innovation Management* studies (involving leadership, management, and innovation and data analytics) with applications tailored to broad cross-cutting themes encompassed by *Sustainability* studies (i.e., knowledge of coupled human and natural sustainability issues, and critical thinking and skills relating to the innovative application of technology for developing innovative solutions to both local and global sustainability challenges). As such, the program aligns with the following two CIP codes: *52.0216 – Science/Technology Management* and *30.3301 – Sustainability Studies*.[1]

The proposed MIST (B.A.) program provides a broad and multi-disciplinary perspective on how people, organizations, information, technology, and the natural world interact, resulting in dynamic systems that both challenge and help society. The MIST major will address how to identify and execute the management of these systems by employing innovation and technology to balance social justice, environmental resources, and economic welfare. By monitoring the three complex system outcomes of people, the planet, and profit, we will train future managers, technology developers, and innovators to facilitate sustainable organizations and relationships.

The proposed MIST major supports the campus' *Sustainability Vision* which highlights the potential of technology and adaptive resource management to reach Triple Net Zero, Net Zero energy use and greenhouse gas emissions and waste targets. These and other examples where technology management leads to innovative solutions that satisfy sustainable "boundary conditions" – such as the emerging domain of AgTech, which has yielded innovative technology-oriented solutions, e.g. coupling solar panels with agricultural canals[2] – will be used through case-based education and scholarship to provide situationally relevant examples of *MIST* for promoting the *triple-bottom line* [3] *(*people, planet and profit, *PPP*) mindset to 21st century individual and collective decision-making. In this way, the proposed program conceptually and pedagogically aligns with the graduate Master of Management professional degree program offered by the MCS faculty (which for sake of comparison, is a streamlined and condensed 1-year version of the proposed undergraduate major).

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[1] Since a program can only be classified by a single CIP, and because Sustainability defines the scope of the application of Science/Technology Management, we believe the most appropriate is "Science/Technology Management" [CIP code 52.0216], which is also appropriate to the present school (School of Engineering) and potential future school (Gallo School of Management) that will administer the program.

[2] See *Energy and water co-benefits from covering canals with solar panels* (Nat. Sustainability, 2021) and related press in the New York Times (4/2023).

[3] Savitz, A. (2013). The triple bottom line: how today's best-run companies are achieving economic, social and environmental success-and how you can too. John Wiley & Sons.

The proposed MIST major will be delivered primarily by existing MCS faculty and consists of 15 required courses (52 units) oriented around contemporary problem domains and methodologies for real-world problem-solving in such a way that aligns with skilled workforce demand. Students who strategically select upper-division electives can obtain a concentration in one of three *Emphasis Tracks* in: *Innovation Management*; *Sustainability Management*; or *Technology Management*. According to such intersectional design, the program supports interdisciplinary educational pathways in support of the campus' stated mission to "foster and encourage cross-disciplinary inquiry and discovery".

As such, we strongly believe the MIST program will contribute to the campus' timely degree-completion and enrollment growth objectives according to two anticipated growth channels. [4] First, we believe the composition of contemporary problem domains, toolsets and experiential learning will be attractive to a wide range of candidate students that are not solely interested in the technical aspects of technology and innovation, but also appreciate intersections with human/social, organizational and sustainability dimensions of management. Given the dearth of similar multidisciplinary technology management programs in California and the UC system, we believe this major will increase the number of students applying to UCM.

Second, the curriculum is flexible and customizable, making it feasible to complete in a normative 4-year period – in particular for students changing major or transferring from community college, since upper division required courses have few if any pre-requisites. By design, the proposed major aligns with the common structure of the first and second-year School of Engineering curriculum, so that students who are either challenged by the inflexibility or technicality of upper-division coursework, can change major to the MIST major and receive significant credit for coursework completed in their first two years. To be specific, the MIST major accommodates SOE students changing major by crediting for up to 7 lower-division required courses[5] (28 units), which reduces their course load to just 8 courses (24 units) over their third and fourth years of undergraduate study. In other words, the proposed MIST curriculum accommodates students changing majors from several of the impacted programs in SoE that feature a high student-to-faculty ratio (e.g. CSE and ME) after the first and second years with no anticipated impact on normative time-to-degree. More generally, this major accommodates retaining the roughly 1 in 2 declared SoE majors (corresponding to ~ 250 students) who do not return after their third year. Following similar arguments as above, the program also accommodates 3rd year CA community college transfers, thereby attracting altogether new students.

We envision launching the MIST major in Fall 2025 with advising and other undergraduate education staff support resources provided by the School of Engineering. The undergraduate program will migrate to the E & J Gallo School of Management in the case that the proposed new school is approved and launched. For full clarity, this MIST proposal and the Gallo School proposal should not be considered as contingent.

[4] These two growth channels are reflected in the enrollment projections provided by IRDS, which include complementary estimates based upon both SSHA and ENG parameters.

[5] See **Tables 5-9** which illustrate the straightforward course pathway for major changes (e.g., from another SoE major) and external (e.g., a 3rd-year from Merced Community College) transfer student pathways.

1.2 Program Rationale

The basic conceptualization of the management of innovation, sustainability and technology (MIST) is that present and future problems will require a systems-thinking approach that integrates across diverse teams and expertise to achieve solutions that are environmentally sustainable and socially just. Many such problems and solutions will necessarily draw on the *innovative* development and deployment of technological capabilities to achieve the target objective while also satisfying the boundary conditions imposed by principles of sustainability and social justice.

As such, this major will develop a valuable skillset that combines soft skills (communication, teamwork, entre/intrapreneurship, design thinking) with marketable technical skills (in data analytics, GIS, finance, project management) and real-world problem-solving skills developed through the study of organizations, management and innovation through the lens of sustainable and ethical development achieved by way of technological application.

The net result is a potent digital and systems thinking mindset for understanding how technology can be developed and deployed to address grand societal challenges. As the solution space to such broad problems is frequently constrained by the need for sustainable and just outcomes, the approach to such problems is rarely direct, and requires a wholistic systems thinking.

1.2.1 Workforce and programmatic demand

The range of professions dealing with these types of complex and multi-disciplinary PPP problems is quite broad, including but not limited to: sustainability officer, policy analyst, resource management, think tanks, economic analyst, science communication. Hence, we imagine that students and employers will value this major because it develops a flexible generalist toolkit that can be deployed in a myriad of professional scenarios.

1.2.2 Programmatic novelty in support of campus' mission to deliver cross-disciplinary education and research

In order to carry forward the University of California's mission to lead in education and research in this direction, the MCS department and MIST graduate group have developed a multi-disciplinary faculty joined around a common interest in how arrangements of people, organizations, information, technology and the natural world give rise to complex adaptive phenomena that pose difficult — often grand — challenges to society.

The proposed undergraduate major complements the terminal MM and PhD/MS degree programs offered by the MCS department. Together, these programs address the need for professionals who can identify and execute management strategies that seek balance and alignment among social justice, environmental resources and economic welfare — i.e. toward the long-term sustainability of people, planet *and* profit (PPP), instead of the conventional approach in business and government that have historically prioritized profit and growth over people and planet.[3]

As such, the aim of this program is to train the next generation of PPP managers and scholars by way of a distinctive multidisciplinary approach. Curricula provide a wide range of opportunities to gain management training via case studies, field exercises, internships and development of information-driven decision-making skills — all of which are required for successful

administration of public and private resources, as well as service- and innovation-oriented enterprises, in the 21st century. Coursework stresses innovation, engineering and vigilance for emerging technologies that open the way for alternative sustainable and renewable approaches to institutional operations, resource management and service delivery.

Coursework also emphasizes cross-disciplinary collaboration, thereby encouraging students and faculty to work across traditional academic boundaries to solve complex problems. For example, students in this program would have various avenues to work (as is already the case at the graduate level) with scholars in engineering and environmental science to develop sustainable business practices or collaborate with social science researchers to explore the social impact of business decisions via their capstone projects. By fostering interdisciplinary approaches, the MIST program would contribute to the university's broader mission of promoting cross-disciplinary inquiry and discovery.

The novel composition of coursework is also supported by a diverse MCS faculty, in terms of not only disciplinary expertise, but also gender and ethnic background. Such diversity is befitting of the proposed coursework, providing an interdisciplinary blend of perspectives (e.g. on organizations, leadership, design thinking, systems thinking) and technology-oriented methods (service systems, data science and data analytics, cognitive engineering, remote sensing, web and app-based decision-support tools) that are crucial for real-world problem solving.

1.2.3 Value Proposition

The proposed program calls for 1 replacement senate faculty line (contingent on reaching an enrollment target of 150 students) and one teaching faculty line, which would together offset two tenured MCS faculty in 2023 entering an unpaid leave of absence. If approved, the senate faculty would be strategically aligned with the areas of technological applications, project and operations management; and the teaching faculty would serve to increase instructional support for the Data Science and Analytics major, which shares a number of courses. Otherwise, the proposed MIST program does not require staff or specialized space, facilities or equipment, and requires just 5 new courses to be developed: MIST 001 “Intro to MIST: Leadership, Organizations and Communications” (4 units); MIST 011 “Climate Justice” (4 units); MIST 070 “Innovation Management” (4 Units); MIST 080 “Systems Thinking” (4 units); MIST 180/181 Capstone 1/2; and MIST 182 “MIST Seminar”. Only MIST 001 is needed for the 1st cohort.

The resource requirements are also relatively small owing to the low material cost of delivery (leveraging students’ personal laptops as primary computing device for accessing open-source coding platforms and free data repositories, which aligns with new School of Engineering policy that is also being considered for the campus; see Sec. 4.4 for more elaboration on instructional computing resource needs, which are marginal).

The proposed degree plan is relatively flexible and customizable, making it attractive to students who might not otherwise enroll in a School of Engineering program, but who are essential to integrating social science and humanities perspectives and considerations into real-world challenges in STEM[6]. At the same time, the program offers a technology-oriented option for

[6] Marcoci, A., Thresher, A.C., Martens, N.C., Galison, P., Doeleman, S.S. and Johnson, M.D., 2023. Big STEM collaborations should include humanities and social science. *Nature Human Behaviour*, pp.1-2.

students in Engineering majors seeking to change majors or drop out altogether - a choice possibly attributable to relatively high student-to-faculty ratios in certain majors, or more generally, trouble making progress to degree due to the rigid and technical course load in all SoE majors.

Importantly, if all SoE students leaving UCM or switching out of SoE majors after their second year were to instead switch to this MIST major, this could retain roughly 1 in 2 SoE students, totaling ~250 students annually.[7] As such, the MIST major is designed in order to support student retention and graduation rates that aligned with campus enrollment growth and degree completion objectives, in addition to making fundamental contributions to undergraduate education and the overall mission of UCM .

Notably, because most UCM SoE majors take common coursework in their first two years, students switching from SoE (respectively, CSE in particular) majors are eligible for up to 5 (resp., 7) required course substitutions, including Calc. I/II and ENGR 057/096. Hence, third-year SoE students switching majors have significantly fewer required courses in their junior and senior years to graduate on time.

1.3 Contribution to undergraduate education at UCM

School of Engineering: While a Bachelor of Arts program being offered by an engineering school may appear nontraditional, we believe this distinction signals two important aspects of the proposed major. First, as is the case with various other Technology Management and Sustainability programs, the B. A. designation connotes a focus on non-technical aspects of technological design, development, deployment and management in such a way that effectively complements all existing SoE majors. Second, the B.A. designation identifies with the fundamental boundary spanning nature of problem-solving in the engineering discipline, which increasingly calls on convergent ethical and sustainability perspectives.[6] The prioritization of the public good by embracing humanist values into design thinking and problem solving, which in the real world tends to be achieved by way of cross-disciplinary collaboration, is a core principal reflected by 3 of the 5 program learning outcomes (namely PLOs 3,4,5 – see section 2.3 for their elaboration).

Indeed, undergraduates at UC Merced are innately interested in issues such as diversity, inclusion, and sustainability, and so this proposed major caters to this demand, and in this regard aligns with existing programs and the campus at large. In particular, MIST formalizes education in diversity and inclusion through leadership and change management coursework that, among other learning outcomes, teaches principles of cross-cultural communication and organizational management theory highlighting the advantages of workplace diversity. Similarly, an interdisciplinary degree that emphasizes sustainability principles also appeals to students who are passionate about environmental stewardship. In summary, the MIST major equips students with the knowledge, skills and intellectual environment that supports the development of a sustainable and just future that is the biproduct of collaboration between engineers and socio-technologists.

[7] UCM IRDS data for 3rd year retention rates – source data from UCOP [dashboard weblink]. Roughly 1 in 3 freshman enrolled in SoE majors are not retained by UCM in their third year; An additional 1.8 in 10 students change majors or schools after their 2nd year.

Campus at large: The proposed major not only contributes to the university's missions of promoting cross-disciplinary inquiry and discovery, but also helps to further contextualize this broad mission by highlighting the role of diversity, inclusion, and sustainability through coursework and practice. By preparing students to succeed in a rapidly changing business world while also promoting the values and principles of the university, we believe the major would make valuable contribution to the local UC Merced community, as well as serving as a "shiny object" that attracts external attention. In particular, the MIST major represents a distinctive major that has both regional and international appeal, as it horizontally integrates management, leadership, digital and systems-thinking perspectives against the backdrop of real-world decision-making confronted with the challenges of satisfying the constraints imposed by the need to balance across *People, Planet and Profit* (PPP) values.

Distinctive interdisciplinary identity and curriculum: Graduates of the program would be equipped with a multidimensional toolkit, allowing them to identify and pursue problems in a number of distinct disciplines spanned by the program faculty, including human behavior, agriculture, environment, law, innovation, management, economics and political science. Another distinguishing feature of the proposed curriculum is the integration of data ethics, data-services entrepreneurship, and problem-driven data challenges encountered in areas like climate change or social justice. The resulting T-shaped skillset emerges organically from the convergence of faculty delivering the program.

To identify candidate major names, we implemented an in-class survey of UCM students taking ENGR 091 "Professional Development: People in an Engineered World" (Fall 2022 and Spring 2023) and SPARK 010 "Inclusive Innovation" (Spring 2023). Students were provided a brief description of the MCS department research and teaching activities, and were then provided with the prompt "MCS Major: What degree name appeals to you the most?" **Figure 1** shows the percentage of respondents voting for one of the candidate names. The left panel shows the percentage of student responses, independent of major school, which indicates that there are not overwhelming preferences for any single option. The right panel shows the percentages decomposed by major school; notably, within the subset of 40 SSHA/SNS student responses, there is a strong preference for "Management of Innovation, Sustainability and Technology".

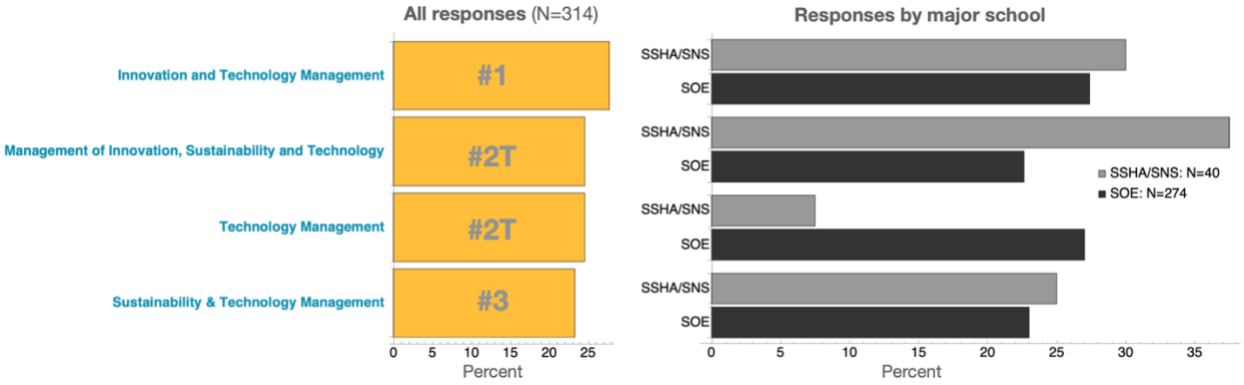


Figure 1: *Left panel:* Ranking of the candidate major names according to the responses across "All" students, independent of their major. There is a slight preference for "I &TM" over "MIST" and "TM" (tied). *Right panel*: Percentage of responses calculated according to the

student's declared major school. SOE students show a slight preference for "I & TM" and "TM"; SSHA/SNS students show a dominant preference for "MIST".

1.3.1 Contribution to Technology Management education across the UC and CSU systems

Within the UC, the proposed program contributes to the limited availability of technology management programs, including only one undergraduate major:

- UC Santa Cruz: Technology and Information Management terminating in a B.S. or Minor, offered by the Baskin School of Engineering;
- UC Santa Barbara: Technology Management programs terminating in a Masters, PhD, and undergraduate certificate program, offered by the School of Engineering;
- UC Davis: Technology Management program terminating in a Minor, offered by the Graduate School of Management.

And based upon the CSU degree-search portal (link), a search for "Technology Management" returns two results:

- CSU East Bay offers both an in-person and online (extension) degree in Business Administration with focus on Information Technology Management;
- CSU Fullerton offers an online MS in Information Technology with focus on IT Management.

The proposed MIST major thus casts a more traditional approach to technology management, which tends to be focused within the context of information systems, against the diverse set of problems and contexts encountered in the engineering discipline. In particular, with a focus on sustainability – which represents a boundary condition that narrows the space of candidate solutions – the MIST major is aligned with 21st century challenges embodied by 17 distinct Sustainable Development Goals of varying multidisciplinary context. Because the innovative application of technological advancements represents our best hope in achieving many of these goals, the multidisciplinary configuration of MIST is aligned with the supply of problems and demand for solutions and skilled workforce at the nexus of technology management and sustainability studies.

1.3.2 Contribution to Technology Management education more broadly

In California and more broadly across the nation there are several other highly interdisciplinary undergraduate degree programs that bear similarities to the proposed undergraduate degree. For example, Stanford's School of Engineering offers a Bachelor of Science in Management Science and Engineering (MS&E) program that combines coursework in engineering, business, and social sciences to prepare students for careers in technology management, operations research, and more. Students in the MS&E program take courses in topics like product design, data analysis, decision-making, and innovation.

Given the multiple entry points to technology management, not all these programs are housed in a traditional school of management or engineering. One example is the Bachelor of Arts and Sciences (BAS) degree offered at the University of Pennsylvania. This degree program allows students to design their own curriculum by combining courses from multiple disciplines within the College of Arts and Sciences and other schools at the university, such as the School of Engineering and Applied Science or the Wharton School of Business. Students can choose

courses from a variety of fields, including technology, social sciences, humanities, natural sciences, and more, to create a unique and highly interdisciplinary course of study.

Another example reflecting the cross-disciplinary aspects of MIST is the Bachelor of Science in Global Health and the Environment program at the University of California, Berkeley. This degree program combines coursework in environmental science (e.g., ecology), public health (e.g., toxicology), social sciences (e.g., policy analysis) to prepare students for careers in fields such as environmental health, global health, and sustainability.

1.3.3 Alignment with PPP graduate education at UC Merced

The triple-bottom-line (People, Profit, Planet) framework for the core electives aligns with the existing Master of Management (M. M.) and the Management of Complex Systems (Ph.D.) programs offered by faculty from the Management of Complex Systems department. While the M. M. would provide redundant coursework and perspective, the MCS PhD program would offer a research-based graduate pathway fitting to graduates of the MIST major.

1.3.4 Alignment with existing undergraduate education delivered by the MCS department

The proposed curriculum is designed to provide cross-bracing support for the approved (implementation in 2024) Data Science and Analytics (B.A.) major and the existing Management Analytics and Decision-Making (MAD) minor, as these programs share a common set of MCS faculty and a significant number of courses are required of both programs, e.g. MIST 050, 060 and 070. Also, to further reinforce principles of team diversity and efficiency of programmatic delivery, we envision conjoining the senior year capstone between the DSA and MIST majors.

Students in the DSA program would also likely be able to double-major in MIST, as both programs feature relatively low course requirements and a sufficient amount of overlap in required and elective courses to make a double major feasible within the normal time to degree.

1.3.4 Complement to existing management major: Management and Business Economics (MBE)

The proposed program complements the other existing management major on campus, the Management and Business Economics (MBE) offered by faculty from the Economics department. The MBE program has more emphasis on traditional economics, business management, finance and accounting with target career paths leading in the direction of actuary, financial analyst, investment banking, real estate broker, accounting, and treasurer. Also, as a result of the technical quantitative coursework, the MBE major terminates with a B.S., whereas the proposed MIST terminates with a B.A. By comparison, the MIST major instead focuses on the design and systems thinking approaches to problems constrained by PPP principles and values, and the role of technology in identifying candidate solutions that respect the boundary conditions imposed by sustainability and social justice values.

1.4 Job market

According to the Bureau of Labor Statistics (BLS), management occupations are projected to grow 5% from 2019 to 2029, adding more than 500,000 new jobs. Additionally, the BLS reports that employment of environmental scientists and specialists is projected to grow 8% from 2019 to 2029, much faster than the average for all occupations. Similarly, employment of

sustainability specialists is projected to grow 6% from 2019 to 2029, also faster than the average for all occupations. These projections suggest that there will be job opportunities available in these fields in the coming years.

Moreover, graduates of a program that specifically emphasizes diversity and inclusion at the curricular level may be highly sought after by employers who prioritize a diverse and inclusive workplace culture. Graduates may find employment opportunities in industries such as human resources, marketing, public relations, and consulting, among others. Additionally, graduates may be interested in pursuing careers in the nonprofit sector, where they can apply their knowledge of diversity and inclusion to advocate for marginalized communities and promote social justice.

1.4.1 Job types and skills required

UC Merced's Office of Institutional Research & Decision Support (IRDS) compiled a job market analysis using the *Lightcast™* data platform (result of a merger of Burning Glass and EMSI) based upon the following two relevant CIP codes: "Science/Technology Management" (CIP 52.0216) and "Sustainability Studies" (CIP 30.3301). The full report is provided in the Appendix Documents folder, document titled "**08.15.For MIST job section.pdf**", and the most relevant results are summarized below.

Results indicate a flourishing market for graduates in these two areas, in particular for Science/Technology Management which features roughly 230,000 jobs in this area in California in 2022, demand that was 16% above the national average, and which has nearly doubled over the last decade, and are expected to grow another 13% over the next decade. The IRDS report provides an indication of job types and skill areas that align with the proposed MIST major. [8]

Accordingly, we anticipate that graduates of this program will address regional workforce development needs, especially in the area of "green jobs" which tend to have a significantly lower unemployment rate (3%) than the aggregate rate for all civilian occupations combined (3.5%-5.7%) – labor factors explored in the following section. And by reflecting the campus' diverse student body, graduates will provide underappreciated perspective[9] to the nation's increasingly data-intensive workforce.[10]

1.4.2 Professional Industry prospects

This program will prepare students for both existing and emergent professions in management of sustainability, technology and innovation in the private sector, international organizations, and governmental agencies, both in the Central Valley and across the globe. Given the increasing rate

[8] See *Appendix II - IRDS* where we point to the relevant IRDS reports provided as Appendix documents constructed around the Classification of Instructional Programs (CIP) queries "*52.0216- Science/Technology Management*" and "*30.3301—Sustainability Studies*". Notably, the latter CIP belongs to 30 - "Multi/Interdisciplinary Studies", defined as "Instructional programs that derive from two or more distinct programs to provide a cross-cutting focus on a subject concentration that is not subsumed under a single discipline or occupational field.", which is consistent with and provides support for this multi-disciplinary program design.

[9] National Academies of Sciences, Engineering, and Medicine, 2018. Minority serving institutions: America's underutilized resource for strengthening the STEM workforce. National Academies Press.

[10] Information technology and the US Workforce: Where are we and where do we go from here?. National Academies Press, 2017; Promising practices for strengthening the regional STEM workforce development ecosystem. National Academies Press, 2016; Strengthening Data Science Methods for Department of Defense Personnel and Readiness Missions. National Academies Press, 2017; Future US workforce for geospatial intelligence. National Academies Press, 2013.

of job turnover and career change in the 21st century[11], and in particular during and after the pandemic which accelerated the shift to remote work, this major will provide new entrants to the modern workforce with an adaptable mindset combined with a broad understanding of problem-solving.

This major provides fundamental quantitative, data literacy, communication and innovative problem-solving skills required of managers and analysts in a broad range of industry, education, and public institutions. Given the global focus on sustainability initiatives, the number of jobs that call for a fundamental understanding of sustainable and ethical best practices is increasing – according to a recent 2023 analysis, there is "a tenfold increase in the number of jobs with 'sustainability' in the title over the last decade, reaching 177,000 in 2021" (Boone & Seto, The Conversation, 2023)[12]. So too is the need increasing for higher-educational programs to train the workforce in this domain.[13]

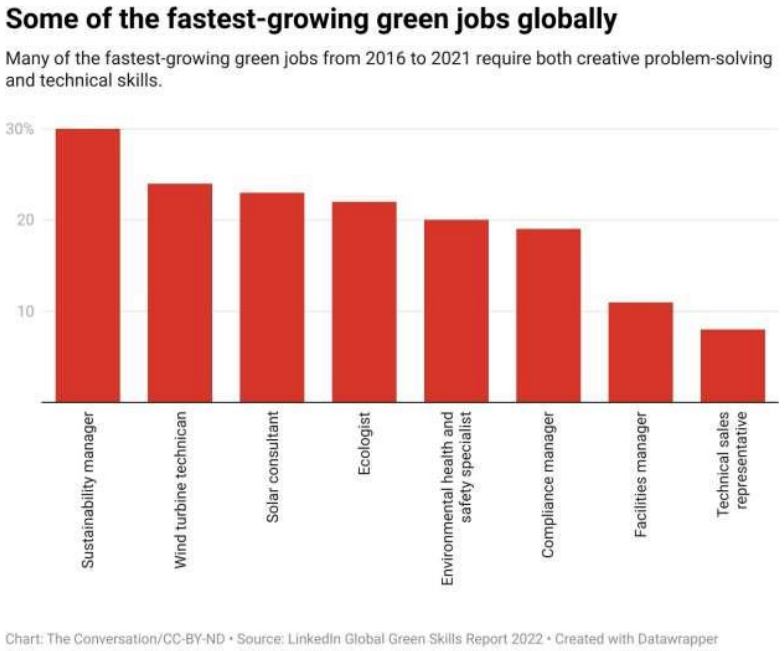


Figure 2: Image sourced from: (C. Boone, K. C. Seto, The Conversation, 2023)

1.4.3 Graduate education and professional school prospects

The interdisciplinary composition of the curriculum develops a broad T-shaped knowledge and skillset combination by way of core technical coursework combined with social, economic, and environmental application/contexts via PPP electives. This composition is complemented by a highly multi-disciplinary faculty.

[11] https://www.bbc.com/worklife/article/20220720-the-case-for-job-hopping
[12] "Green jobs are booming, but too few employees have sustainability skills to fill them – here are 4 ways to close the gap" (C. Boone, K. C. Seto, The Conversation, 2023)
[13] National Academies of Sciences, Engineering, and Medicine. Strengthening sustainability programs and curricula at the undergraduate and graduate levels. National Academies Press; 2020 Dec 2

As such, graduates of this interdisciplinary program emphasizing sustainability principles will be well-suited for careers in fields such as environmental science, sustainability consulting, renewable energy, or corporate sustainability. Graduates may also be interested in pursuing advanced degrees in related fields, such as environmental law or public policy.

Graduates of the program would also be prepared to continue onto interdisciplinary graduate programs at UC Merced, such as the Environmental Systems, Management of Complex Systems and Cognitive and Information Science PhD programs.

1.5 Expected student enrollment

The undergraduate major is closest to the Technology Management major, which is a widespread major. Hence, there are limited available data sources to draw upon regarding long-term enrollment growth at public universities of similar size and mission as UC Merced.

1.5.1 University of California

The only undergraduate major in the management domain of the proposed MIST major within the UC system is the "Technology & Information Management" (TIM) B.S offered at UC Santa Cruz. The enrollment data snapshot obtained from the UCSC Institutional Research, Assessment and Policy Studies portal is provided below and also accessible at this (link). **Figure 3** showing student demand for the TIM major shows steady growth from 2012-13 with 81 combined proposed and declared majors, and peaking at 298 students in 2018-19; as with many programs in the UC and across the country, demand for the major appears to have stalled due to the pandemic. And **Figure 4** shows the number of degrees conferred, which closely tracks the numbers tracking declared majors, indicating a high degree of retention and completion for this major.

Also of note, the UCSC multiple major co-occurrence matrix identifies "Business Management Economics" (the analog to MBE at UC Merced) as a common double-major choice, indicating the distinction between those two programs, as well as the complementarity that could support a new channel for double majors at UCM (link).

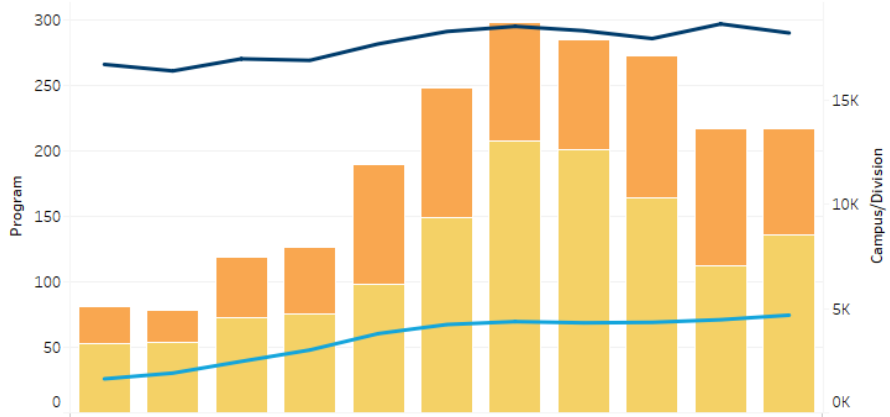
Major Demand Trends: Fall Major Count

Select Major: Technology & Info Mgmt | Display Fall or 3-Quarter Avg: Fall | Display Major Count or Major Fraction: Major Count | Split By: Major Type | Student Level: Multiple values

Major Type: All | Admit Type: All | Gender: All | URG Status: All | First Generation Status: All | Pell Grant Status: All | Race/Ethnicity: All | EOP Status: All

Breakout Selection: Proposed, Declared

Comparison Lines: BSOE Division, Campus



Split	Major Name	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23
Proposed	Technology & Info Mgmt	28.0	24.0	46.0	51.0	91.0	99.0	91.0	84.0	108.0	105.0	81.0
	BSOE Division	621.0	845.0	1,553.0	1,981.0	2,376.0	2,608.0	2,358.0	2,160.0	2,504.0	2,612.0	2,602.0
	Campus	7,951.0	7,801.0	8,398.0	8,644.0	9,180.0	9,475.0	9,206.0	8,387.0	8,992.0	9,560.0	8,585.0
Declared	Technology & Info Mgmt	53.0	54.0	73.0	75.0	98.0	149.0	207.0	201.0	164.0	112.0	136.0
	BSOE Division	1,008.0	1,060.0	913.0	1,031.0	1,424.0	1,626.0	2,016.0	2,156.0	1,835.0	1,854.0	2,082.0
	Campus	8,762.0	8,599.0	8,582.0	8,263.0	8,516.0	8,816.0	9,332.0	9,941.0	8,961.0	9,093.0	9,637.0
Total	Technology & Info Mgmt	81.0	78.0	119.0	126.0	189.0	248.0	298.0	285.0	272.0	217.0	217.0
	BSOE Division	1,629.0	1,905.0	2,466.0	3,012.0	3,800.0	4,234.0	4,374.0	4,316.0	4,339.0	4,466.0	4,684.0
	Campus	16,713.0	16,400.0	16,980.0	16,907.0	17,696.0	18,291.0	18,538.0	18,328.0	17,953.0	18,653.0	18,222.0

Figure 3: Student demand (enrollment) data for the most similar UG major (at UCSC).

Degree Major Count

Division: All | Department: All | Major: Technology & Info Mgmt | Summer Leading/Summer Trailing: Summer Leading

Academic Year(s): All | Career: Undergraduate | Admit Type: All | Display Major Count or Major Fraction: Major Count

Gender: All | URG: All | First Generation Status: All | Pell Grant Status: All | Race/Ethnicity: All | EOP Status: All | NRT Payer Status: All | Domestic/International: All

Division	Department	Major	Deg. Type	Split: All Split	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
School of Engineering	School of Engineering Reporting Org	Technology & Info Mgmt	BS	All	24.0	42.0	44.0	45.0	66.0	95.0	132.0	123.0	74.0
		Total			24.0	42.0	44.0	45.0	66.0	95.0	132.0	123.0	74.0
	Total				24.0	42.0	44.0	45.0	66.0	95.0	132.0	123.0	74.0
Grand Total					24.0	42.0	44.0	45.0	66.0	95.0	132.0	123.0	74.0

Figure 4: Graduation rates (degrees awarded) for the most similar UG major (at UCSC).

1.5.2 Anticipated UC Merced Enrollment

To estimate anticipated enrollment in the MIST major, we consulted with the campus' Academic Planning and Assessment Support Center and Institutional Research & Decision Support Center to obtain an external projection of initial enrollment and growth. The full report is provided in the Appendix Documents folder, document titled "**2023.08.17.MIST Data Sheet.pdf**", and the most relevant results are summarized below.

Notably, the report starts by noting that there are not many comparable programs with CIP *52.0216: Science/Technology Management*, as this is a relatively new category introduced in 2020. Along similar lines, in the case of the CIP *30.3301: Sustainability Studies,* there are not many programs offered by universities of comparable size to UCM. Hence, estimates are based upon appropriate scaling of available data to approximate according to the 10-15k undergraduate target population of UC Merced. Accordingly, three estimates of present student enrollment in the MIST major, if it already existed, are between 45 to 130 students for a program based upon data for CIP 30.3301 alone, and 95 students based upon data for CIP 52.0216 alone[14]. Notably, these two present-day CIP estimates are consistent in order of magnitude, corresponding to ~100 students.

To estimate enrollment growth in 2031 (after 7 years from launching in 2025), IRDS accounted for the differences in CIP by mapping these onto the two distinct enrollment channels we believe this program will support, in particular attracting students who would naturally gravitate towards either a social sciences major offered by SSHA or a technology-focused major offered by SoE. Consequently, IRDS produced six total 2031 enrollment projections, with 3 scenarios (corresponding to three different university type comparisons) produced using enrollment and retention data for SSHA; and 3 scenarios also produced using data for SoE.

To summarize, IRDS projects that if students enroll in the MIST major along the lines of students enrolling in a SOE major at a R2 University (i.e., smaller on average than R1/R2 combined, more closely resembling UCM SoE), this estimate corresponds to 25 MIST students by 2031 (see "Scenario 1" in the IRDS report). Similarly, the IRDS "Scenario 2" projects 110 MIST students by 2031 assuming that the program tracks like a SSHA sustainability studies major at a Carnegie R1/R2 research university. These projections place MIST admissions applications roughly on par with the Environmental Engineering major in SoE, and between the Global Arts and Cognitive Science majors offered in SSHA at UCM. Combined, these two distinct enrollment channels suggest 135 students by 2031. See **Tables 1-2** below, which use school-specific freshman retention and 3rd year transfer rates (e.g. from other UC, Cal State or community colleges combined) to estimate standalone projections for each enrollment channel.

[14] UC Santa Cruz's B.S. in Technology and Information Management offered by the Baskin School of Engineering (BSoE) is classified as CIP 11.1099: *Computer/Information Technology Services Administration and Management, Other*. This UCSC major is more akin to the Data Science & Analytics B.A. recently approved by UCM, and so it is not directly comparable to the proposed MIST major in terms of its disciplinary classification. However, it is useful for estimation as it is a relatively small major within the BSoE. As such, projection of MIST enrollment based upon the share of TIM enrollment in BSoE yields an estimate of roughly 166 UCM students in 2030, which is again consistent in magnitude with the estimates specifically based upon the two MIST program CIP codes.

Table 1: Scenario 1 - Standalone SSHA enrollment channel projects 110 MIST majors by 2031

		Fall 2025	Fall 2026	Fall 2027	Fall 2028	Fall 2029	Fall 2030	Fall 2031
Frosh Growth Rates			5%	5%	5%	5%	5%	5%
New Frosh		28	29	31	32	34	36	38
Transfer Growth Rates					5%	5%	5%	5%
Transfer				4	4	4	5	5
Frosh Retention								
to Year 2	70%	0	20	21	22	23	24	25
to Year 3	54%		0	15	16	17	18	18
to Year 4	49%			0	14	14	15	16
to Year 5	7%				0	2	2	2
Transfer Retention								
to Year 2	85%			0	3	4	4	4
to Year 3	33%				0	1	1	1
to Year 4	5%					0	0	1
to Year 5	1%						0	0
MIST Projected Enrollments								
		Fall 2025	Fall 2026	Fall 2027	Fall 2028	Fall 2029	Fall 2030	Fall 2031
Total Enrollment		28	49	71	91	99	104	110

Table 2: Scenario 2 - Standalone SoE enrollment channel projects 25 MIST majors by 2031

		Fall 2025	Fall 2026	Fall 2027	Fall 2028	Fall 2029	Fall 2030	Fall 2031
Frosh Growth Rates			5%	5%	5%	5%	5%	5%
New Frosh		6	6	7	7	7	8	8
Transfer Growth Rates					5%	5%	5%	5%
Transfer				1	1	1	1	1
Frosh Retention								
to Year 2	74%	0	4	5	5	5	5	6
to Year 3	47%		0	3	3	3	3	3
to Year 4	52%			0	3	3	3	4
to Year 5	19%				0	1	1	1
Transfer Retention								
to Year 2	88%			0	1	1	1	1
to Year 3	56%				0	0	1	1
to Year 4	6%					0	0	0
to Year 5	2%						0	0
MIST Projected Enrollments								
		Fall 2025	Fall 2026	Fall 2027	Fall 2028	Fall 2029	Fall 2030	Fall 2031
Total Enrollment		6	11	15	20	22	24	25

And finally, one additional statistic supporting MIST enrollment from the IRDS report regards referral pool applications to the UCSC major in *Technology and Information Management*: "In fall 2023, there were 41,539 students in the referral pool. Of those students, 97 had applied to UC Santa Cruz's Technology and Information Management program (up from 48 in 2022), composing 0.2% of the referral pool." Combined with the potential for the MIST major to increase the retention rate for students in the SoE who leave UC Merced (totaling 181 students for the 2020 freshman cohort; 175 for the 2017 cohort) or switch to another UCM school (67 for 2020; 87 for 2017), we believe there are multiple distinct channels for enrollment growth for this major.

1.6 Program elements

The proposed MIST program is an interdisciplinary program that applies principles and theory of technology and innovation to issues at the intersection of the social and management sciences (e.g., leadership, organizations, entrepreneurship, behavioral, economic, crisis and risk management, complex systems, and team science) cast against global challenges relating to climate and sustainability (e.g., climatology, climate and social justice, protected area management, wildfire science).

Provided a balanced education across these two backdrops, students will receive holistic training in the identification of opportunities suitable for the application of technological capabilities that strategically address the constraints imposed by sustainable and ethical values. As such, the proposed MIST curriculum aligns with the philosophy of the engineering approach, which is to define a problem according to certain constraints, which thereby guides the design of feasible solutions that satisfactorily address the boundary conditions. Hence, while not a traditional engineering discipline, because technology management operationalizes this common "design-thinking" approach to problems calling for socio-technical innovation, the most similar undergraduate majors are commonly found in either a School of Engineering (e.g. UC Santa Barbara and UC Santa Cruz) or Business/Management (e.g. UT Austin, UC Davis, CSU Fullerton, CSU East Bay).

The first two years of the curriculum are comprised of three components: (a) general education; (b) major preparation: STEM fundamentals (e.g. non-vector calculus, introductory statistics) and MIST 001 "Intro to MIST"; (c) and MIST fundamentals involving relevant theory (e.g. creativity & innovation, sustainability, systems thinking) and methods (entrepreneurship, data analytics).

The final two years offer students the opportunity to either specialize or generalize by way of MIST Core electives that develop more specific MIST problem domains (e.g. climate change, parks and protected areas, energy policy, retail management, data ethics) and methods bases (e.g. cognitive engineering, data governance, service innovation, social network analysis, computer-aided decision-making for financial analysis, econometrics, financial accounting). The fourth year synthesizes MIST principles in a culminating experience consisting of a year-long team-based capstone project. Given the complementarity with the DSA major (which focuses on the application of data science methods for analytics, communication and inference relating to the digital economy), the DSA and MIST capstones will be conjoined to promote cross-pollination of perspectives and technical expertise between students in these two programs, as well as supporting efficient programmatic delivery.

The MIST program does not involve travel, field work, exposition, or any other element common to other non-traditional programs.

1.7 Overlaps and complements to existing undergraduate programs

The four most similar majors at UCM are: Economics (ECON) and Management and Business Economics (MBE) offered in SSHA; the Environmental Systems Science (ESS) offered in SNS; and the newly approved Environmental Humanities program offered in SSHA starting in 2024. Below we elaborate on how the proposed MIST program overlaps and complements these existing programs.

1.7.1 Relation to Economics (BS/BA) and Management and Business Economics (BS)

The Economics (ECON) major offers fundamental coursework in "How to think like an economist". By way of example, the six program learning outcomes (PLOs) for this program terminating in. B.S. (68 required units) or B.A. (48 required units) are:

1. Demonstrate an understanding of the role of organizations and institutions in a society, the impact of organizations and institutions on the economic environment and outcomes, and how incentives influence individual and organizational behavior and performance.
2. Recognize and describe how government actions affect economic performance and how economic interests influence government decisions.
3. Design and conduct research that will inform managerial and policy decision making, including the collection, analysis and interpretation of data using familiar software packages.
4. Define problems and identify multifaceted explanations for complex economic phenomena by using information and data from multiple sources to answer the questions at hand.
5. Demonstrate critical thinking about the information encountered, whether it is in coursework or reported in the media.
6. Communicate clearly and cogently in written and oral form using modern technology

As such, this program is focused more specifically on traditional financial and economic bottom line principles as they relate to private and public (in particular government) enterprises.

The Management and Business Economics (MBE) major terminates in. B.S. and consists of 60 required units. This major is a high-demand major, offering "rigorous analytical and quantitative training from a blend of fields including economics, management theory and other social sciences." By way of example, the five program learning outcomes (PLOs) for this program are:

1. Analyze key data and solve problems related to business management.
2. Apply theories and concepts from disciplines in Management and Business Economics (e.g. accounting, economics, statistics, finance, and marketing) to business management situations.
3. Use effective written and oral communication consistent with the discipline and professional environments.
4. Apply information technology to develop business proposals, models, and reports, with recommendations for economics and management strategies and actions.

5. Evaluate ethical, social and external issues as they relate to the organization, operations, human resources and business ventures.

As such, the MBE has less focus on economic theory, and is instead more similar to the proposed MIST major in that it "prepares students for a broad range of management-related careers [by way of developing] analytical tools that are needed to succeed in a modern, volatile business environment." Consequently, the proposed MIST major complements the MBE by extending the application domain of traditional management sciences to a myriad of intersectional domains emphasizing systems-level interactions, i.e. environmental, informatics, service systems, protected area management, wildfire management and political ecology.

Both ECON and MBE majors provide ample preparation for students to pursue graduate education in Economics or in an MBA program. And given the distinct differences in the treatment of theory, we do not expect the MCS PhD program to compete for demand with the ECON PhD program.

1.7.2 Relation to Environmental Systems Science (BS)

The Environmental Systems Science major consists of 81-92 required credits and offers a degree in environmental science by way of coursework in "fundamental physical, chemical and biological processes that shape our environment with practical applications to real-world problems." Some of the professions identified are atmospheric scientist, botanist, ecologist, geophysicist, oceanographer, park ranger, and seismologist. With the exception of a few climate science courses cross-listed with this program (namely MIST 116/ENVE 116/ESS132, and MIST 110/ESS110 offered by Prof. Abatzoglou) the proposed MIST program does not plan on introducing new natural science-oriented courses that might introduce redundancies between the two programs. Moreover, the MIST program courses will be open to students from this and other related sustainability majors.

The distinction between the ESS major and the proposed MIST Major are thus illustrated by comparing the respective program PLOs. The 5 PLOs for the ESS program are:

1. Foundational knowledge of physics, chemistry, biology, and mathematics related to environmental systems that supports a working knowledge of basic research methodologies, data analysis, and interpretation for a variety of environment-related data.
2. Knowledge of major concepts, theoretical principles, experimental findings, and areas of study related to environmental systems science, and comprehension of the interactions between natural environmental systems and human economic, political, and social systems.
3. An ability to employ critical thinking, quantitative and numerical analyses, and hypothesis-driven methods of scientific inquiry in the formulation of research questions, experimental design, application and use of laboratory and field instrumentations, and analysis and interpretation of data related to environmental systems.
4. Effective written and oral communication skills, especially the ability to transmit complex technical information.
5. An ability to work effectively individually and in teams in classroom, laboratory, and field settings.

1.7.3 Relation to Environmental Humanities (BA)

The Environmental Humanities major also represents a program that casts a traditional discipline (namely writing and communication studies, broadly defined) against the backdrop of environmental and sustainability issues. The CIP code for this program is also 03.0103: *Environmental Studies*. Since the EH major is positioned as a writing and communications program with a sustainability focus, whereas the proposed MIST major is a technology management program including a sustainability component, we do not anticipate many students changing majors between the programs.

For completeness, the 6 EH program PLOs are:

1. Use written and oral communication to clearly explain both the scientific and social aspects of environmental issues to various stakeholders, with acute sensitivity to audience and an understanding of the principles of effective communication.
2. Synthesize and articulate extant research on the realities of climate change and biodiversity loss, the principles of ecology, and scientific methods.
3. Synthesize and articulate extant research on the legal and economic factors that contribute to environmental injustice, including the ways racism, income inequality, and geography contribute to the environmental circumstances in which people find themselves.
4. Conduct research on global and local environmental issues.
5. Work efficiently and effectively both independently and in a group, with the ability to adapt quickly to changing circumstances.
6. Create and lead a caring and constructive team while attending to potentially traumatic issues.

Aside from the intersection with sustainability contexts, there is little intersection along methodological or theoretical dimensions of the EH program and the proposed MIST program. This does, nevertheless, provide opportunities for cross-listing of elective courses between the programs to increase student access to different methods and practices relating to sustainability.

2. Program Requirements

2.1 Overview

Students will develop critical-thinking skills for systems-oriented real-world problem-solving, and obtain experience designing an innovative and marketable solution in a culminating senior-year team project. The major coursework consists of (i) lower-division fundamentals courses introducing principles of innovation, sustainability, technology management coupled with methods courses equipping students with basic computational and data analytics tools for scoping and identify opportunities and effectively communicating them to existing and potential stakeholders; and entrepreneurial skills for developing a marketable solution that accounts for constraints associated with social, financial, sustainability, and equity considerations; and (ii) upper-division core courses that expose students to real-world problem domains in which technologically-mediated solutions involve systems thinking and multi-disciplinary collaboration in order to bring big ideas to fruition – including but not limited to: developing a technology-enabled service; deploying an web-interactive decision-support tool to enable risk-assessment

and disaster response; organizing and leading a community to action; and launching an entrepreneurial venture.

Students will integrate fundamental concepts and core skills in a year-long senior-year experience that launches students into the domain of real-world problem solving under time, team and other resource constraints. The senior capstone in its simplest form is a team-based research project supervised by the instructor, in which the target problem is inspired or derived from a real-world problem. Students will fashion a business plan and pitch their solution in a final cohort-wide showcase.

As the program matures, local (campus administrators, faculty) and regional (public, private businesses) will have the opportunity to provide target problems that are appropriate for either a single team, or are sufficiently oriented such that the project could be passed along cohorts, which was a successful model used by the Engineering Service Learning program at UC Merced.

Collecting and selecting capstone target problems, monitoring capstone team progress, and organizing the final showcase will be managed by the capstone instructor of record. Because the main deliverable is a business plan that outlines and argues the proof-of-concept, we expect the financial resources required to launch and sustain this capstone will be significantly less than the resourced required of the Engineering School's Innovate2Grow, which involves hardware purchasing, lab space for mock-ups, travel, etc.

2.2 Lower and upper division course requirements

The program is comprised of 15 courses for 52 units. Many of the MIST Fundamentals and Core Electives courses fulfill requirements for the Minor in Management Analytics and Decision-Making (MAD) so that students who change major could still obtain the MAD minor with relatively little effort.

Only 5 new courses are needed for students to graduate from this proposed major. Only one course (MIST 001 Intro to MIST: Leadership, Organizations and Communications) would be needed to start the program in AY 2024-25; only one new MIST Fundamentals course (either MIST 070 Innovation Management or MIST 080 Systems Thinking) would be needed by year 2 of the program; and only three required upper-division courses (Capstone 1 and 2 and MIST Seminar) would be needed by year 4 of the program so that the first cohort could graduate in AY 2028-29.

2.2.1 Three Emphasis Tracks: (Innovation, Sustainability, Technology) × Management

Students who complete particular combinations of 6 courses below (24 units in total) will satisfy the requirements for the following Emphasis Track degree designations. The following *Emphases* are not compulsory, nor are they automatically designated upon completion of the appropriate set of courses; rather, they must be declared using a *Major Change form* by the student opting to pursue a single *Emphasis* designation described below. For more elaboration, see Appendix Folder document: *MIST BA Concentrations.pdf*

In brief, students must complete at least 2 MIST Fundamentals courses and 4 MIST Core Electives from the specific emphasis track options listed below; see the Appendix Section I *Course Descriptions* for the specification of courses belonging to each Core Elective group:

- **Innovation Management –** *MIST Fundamentals:* MIST 050: Intro to Entrepreneurship; MIST 070: Innovation Management; *MIST Core Electives*: 4 courses from Core Elective groups 2 and 3.

- **Sustainability Management–** *MIST Fundamentals:* MIST 011: Climate Justice; MIST 080: Systems Thinking; EH 001: Introduction to Environmental Communications; ENVE 020: Introduction to Environmental Science and Technology; *MIST Core Electives*: 4 courses total from Core Elective groups 3 and 4.

- **Technology Management –** *MIST Fundamentals:* MIST 075: Information Systems for Management; CSE 030: Data Structures; ENVE 020: Introduction to Environmental Science and Technology. *MIST Core Electives*: 4 courses total from Core Elective groups 1 and 2.

2.2.2 Course Requirements:

Table 3: Distribution of required courses: MIST Major – 15 Courses, 52 Units

		Courses	Units
Lower Division			
	Major Preparation	5	18
	MIST Fundamentals	3	12
Upper Division			
	MIST Core Electives	4	16
	Culminating Experience (Capstone + Prof. Dev.)	3	6
	Total	**15**	**52**

In the lists provided below, new (to-be-proposed) courses are indicated with an asterisk (*). See *Appendix I* for course descriptions.

Lower Division Major Requirements [8 courses, 30 Units]

Required Major Preparation [18 Units]
Complete the following 5 courses:

- **MATH 011** or MATH 021: Calculus I (4 Units)
- **MATH 012** or MATH 022: Calculus II (4 Units)
- **MIST 060/DSA 001:** Introductory Data Analytics (4 Units)
    - Accepted substitutes: PSY 010 or ECON 010 or MATH 018 or MATH 032
- **ENGR 096:** Human-Centered Research and Design (2 Units)
- * **MIST 001:** Intro to MIST: Leadership, Organizations and Communications (4 Units)

MIST Fundamentals [12 units]
Complete 3 of the following 6 courses:

- **ENG/EH 001**: Introduction to Environmental Communications (4 Units)
- **MIST/ESS 011:** Climate Justice (4 Units)
- ***MIST 040:** Project Management (4 Units)
- **MIST 050:** Intro to Entrepreneurship (4 Units)
- * **MIST 070:** Innovation Management (4 Units)
- * **MIST 075:** Information Systems for Management (reformatting/replacement of existing course **MIST 175**: Information Systems for Management)
- * **MIST 080:** Systems Thinking (4 Units)
- * **MIST 085:** Life Design (4 Units)
- ***MIST 090**: Lower division MIST topics course – accommodating courses that have already been offered via SPARK are future candidates as MIST Fundamentals options: Cybersecurity & Data Privacy; Ethnography & Innovation; Living with Wildfire; Science of Science.

Engineering students changing major - one of the following can be counted:

- **CSE 030:** Data Structures (4 Units)
- **CE 020:** Introduction to Civil and Environmental Engineering (4 Units)
- **ENVE 020:** Introduction to Environmental Science and Technology (4 Units)

Upper Division Major Requirements [7 courses, 22 Units]

Upper Division MIST Core - Electives [16 units]
Complete 4 of the following courses, grouped by catalog course codes (All courses are 4 units unless otherwise indicated; only 2 lower-division courses are allowed):

MIST Courses

- ***DSA 002**: Thinking like a programmer
- **MIST 110**: Hydrology & Climate
- **MIST 116**: Applied Climatology
- **MIST 118**: Climate Change: Science & Solutions
- **MIST 120**: Parks & Protected Areas
- **MIST 128**: Cognitive Engineering
- **MIST 130:** Statistical Data Analysis and Optimization in R for Decision Support
- **MIST 131**: Data Governance for Analytics Projects
- **MIST 132**: Geographic Information Systems Analysis in Management
- **MIST 133**: Service Innovation
- **MIST 134**: Methods of Data and Network Science
- **MIST 135**: Technical Communication and Visualization
- **MIST 136**: Retailing Management
- **MIST 137**: Managing Teamwork
- **MIST 138**: Systematic Financial Trading & Analysis
- ***MIST 139**: Operations Management
- **MIST 150**: Service Science
- **MIST 164**: Energy Policy
- ***MIST 1XX**: User Experience
- **MIST 190**: Special Topics Course (can be counted only once)

SoE Courses

- **CSE 015**: Discrete Mathematics (** If CSE major switching to MIST)
- **CSE 100**: Algorithm Design & Analysis (** If CSE major switching to MIST)
- **ENVE 155**: Decision Analysis in Management
- **ENGR 155**: Engineering Economic Analysis

Options for engineering student changing majors to MIST - count one of the following:

- **CSE 022:** Introduction to Programming (4 Units) or **MSE 021:** Engineering Computing (4 Units) or **EE 021:** Introduction to Electrical Engineering Programming (4 Units) or **BIOE 021**: Introduction to Computing with Python (4 Units); **ENGR 057**: Statics & Dynamics (4 units)

SSHA Courses

- **ECON 007**: Managerial Accounting
- **ECON 110**: Econometrics
- **ECON 005**: Introduction to Business and Finance
- **COGS 104**: Complex Adaptive Systems
- **PHIL 123**: Technology Ethics

MIST Culminating Experience (Capstone & Prof. Dev.) - Required [6 units]
Complete the following two courses:

- * **MIST 180**: Capstone 1 (2 Units)
- * **MIST 181**: Capstone 2 (2 Units)
- * **MIST 182:** MIST Seminar (2 Units)

2.3 Learning goals and outcomes

Upon completion of the program, students will have the skillset for navigating an increasingly intersectional world and professional technology-oriented workforce.

Five Program Learning Outcomes (PLOs) for the proposed MIST Major

The overall educational objective is for students to develop basic competence in management of innovation, sustainability and technology as it relates to a range of real-world problems confronted by inflexible constraints imposed by sustainable objective criteria, and for students to be ready to engage in lifelong learning and continuing education. There are five **MIST** PLOs (color-coded here to identify synergies between the thematic pillars):

1. **Critical Thinking (IT).** Students will identify and use appropriate analytical, quantitative, and qualitative methods from multiple disciplines in order to develop innovative solutions that leverage technology to support the management of complex systems.

2. **Technology Management (TM)** Students will learn the foundations of organizations and principles of effective teamwork in the context of developing technology-oriented solutions.

3. **Sustainable and Ethical Innovation (SI).** Students will develop candidate solutions that account for the constraints imposed by sustainability and ethics principles. Students will identify real-world ethical, legal, and social issues that characterize responsible approaches to the management of coupled human and natural systems.

4. **Communication & Leadership (M).** Students will integrate various communication frameworks (verbal, oral, graphical) and gain leadership experience in effectively engaging and inspiring diverse audiences comprised of experts and non-experts. Students will develop and apply these frameworks in classroom and project settings.

5. **Applications (MIST).** Students will synthesize theory and practice of innovation, sustainability and technology management to design innovative solutions that tackle strategic, organizational, and technical challenges and also satisfy boundary conditions associated with feasibility, ethics and sustainability.

2.4 Course relationship with learning outcomes

Table 4 shows how the lower and upper division course requirements support the 5 PLOs; The bottom row indicates the year that assessment of the given PLO will occur.

Table 4: Curriculum map relating required courses to PLOs and their relevant skills.

* indicates planned new course

MIST Course-PLO Matrix	Elective Group	PLO 1: Critical Thinking	PLO 2: Technology Management	PLO 3: Sustainable & Ethical Innovation	PLO 4: Communication & Leadership	PLO 5: Applications
Lower Division						
Major Preparation						
MIST 001 Intro to MIST *			▮		▮	
MIST 060/DSA 001: Introductory Data Analytics		▮	▮			
MIST Fundamentals						
MIST/ESS 011: Climate Justice				▮	▮	
MIST 040: Project Management*			▮		▮	
MIST 050: Intro Entrepreneurship					▮	▮
MIST 085: Life Design*			▮		▮	
ENG/EH 001: Intro. Environ. Comm.				▮	▮	
MIST 070: Innovation Management *			▮			▮
MIST 075: Information Systems for Management*		▮	▮			
MIST 080 Systems Thinking *			▮			▮
CSE 030/ENVE 020/CE 020		▮	▮			
Upper Division						
Core Electives						
MIST 110: Hydrology & Climate	4	▮		▮		
MIST 116: Applied Climatology	4	▮		▮		
MIST 118: Climate Change: Science & Solutions	4			▮	▮	
MIST 120: Parks & Protected Areas	4	▮		▮		
MIST 128: Cognitive Engineering	3	▮			▮	
MIST 130: Statistical Data Analysis and Optimization in R for Decision Support		▮	▮			
MIST 131: Data Governance for Analytics Projects	2	▮	▮			
MIST 132: Geographic Information Systems Analysis in Management	1	▮			▮	
MIST 133: Service Innovation	2	▮	▮			
MIST 134: Methods of Data and Network Science	1	▮			▮	
MIST 135: Technical Communication and Visualization Skills	3		▮		▮	
MIST 136: Retailing Management	2	▮	▮			
MIST 137: Managing Teamwork	2	▮	▮			
MIST 138: Systematic Financial Trading & Analysis	1	▮			▮	
MIST 150: Service Science	2	▮	▮			
MIST 164: Energy Policy	4	▮		▮		
MIST 190: Special Topics						
Professional Development						
MIST Professional Seminar * (1 Credit)						▮
Capstone 1 / Senior Project * (2 Credit)						▮
Capstone 2 / Senior Project * (2 Credit)						▮
Assessment Year (Course)		**1 (060), 4 (130)**	**2 (070), 1 (001)**	**2 (011) 3 (164)**	**4 (001), 3 (135)**	**4 (Capst.) 2 (050)**

2.5 Outcome assessments

We plan to follow standard UCM protocol for administering routine program assessment using the PLO assessment rubric shown in **Table 5**. Internal and external reviews will be obtained and administered by MCS faculty in conjunction with the Office of Institutional Assessment. The last row of **Table 4** indicates the year in which each PLO will be evaluated, along with the specific course. Instructors will develop PLO-specific rubrics for their courses, and specific assignment or project outcomes will be used to identify high, average and below-average outcomes, thereby identifying areas for improvement and ways in which different courses addressing the same PLO can also facilitate improvement.

Programmatic continuity will be assessed by way of tracking the number of students declaring the major upon arrival to UC Merced, and tracking the retention rate by cohort and program year. Once the program is in year 3, similar tracking of students changing into the MIST program from other majors and transferring from community colleges will provide analog retention measures.

Lower-division program assessment will focus on how students understand and appreciate the holistic approach to MIST and the identification and communication of its value to individuals, organizations and planet. Upper-division program assessment will focus on: (a) incoming and outgoing major-change rates, in particular with respect to the CSE undergraduate major; (b) program/faculty quality and support; (c) student educational outcomes and achievements; (d) capstone outcomes as a measure of students understanding of the holistic approach to MIST and its application in real-world problem solving; (e) employment and post-graduate outcomes, either communicated by students or by tracking alumni LinkedIn profile updates.

Periodic program review assessment based upon the aforementioned annual PLO assessments and exit reviews will evaluate: (a) program/faculty quality and support; (b) student learning outcomes and achievements; (c) capstone outcomes; (d) employment and post-graduate outcomes, either communicated by students or by tracking alumni LinkedIn profile updates.

Table 5. PLO Assessment Rubric

PLO/Level	Expert	Advanced	Intermediate	Introductory
1. Critical Thinking	Clearly states the problem and decomposes it across fundamental issues and constraints, and evaluates alternative methods and objectives. There is a logical flow between analysis, inference, and proposed recommendations. The action plans incorporate a constraints-based perspective and ranks options accordingly. First steps in the action plan are feasible, and a timeline is indicated.	Clearly states the problem and decomposes it across fundamental issues and constraints, and evaluates alternative methods and objectives. There is a logical flow between analysis, inference, and proposed recommendations. The action plans incorporate a constraints-based perspective. First steps in the action plan are feasible.	States the problem, but may miss some of the key issues. Identifies alternative methods and objectives, but may not evaluate them. Connection between analysis, inference, proposed recommendations and action plans are satisfactory; first steps in the action plan may not be feasible.	Unclear what the key issues are that need to be addressed. Alternative methods and objectives are briefly mentioned but not detailed. Connection between analysis, inference, feasibility of solutions, proposed recommendations and action plans is unclear. First steps in the action plan are unfeasible, or may be lacking.
2. Technology Management	Can effectively communicate the role of structure and function in technology-oriented organizations, can identify real-world examples where technology plays a role in facilitating greater capabilities and efficiencies, and can also describe hypothetical applications of innovative technology that transform capabilities and efficiencies. Tasks are equitably delegated and leverage the strengths of the team members. All team members attend meetings and thoroughly complete assigned work on schedule. Delegated tasks are tracked and supported through group accountability. All team members maintain responsibility for their parts and awareness of all parts of project. Team members build on the work of others to advance the project. Team members identify and acknowledge conflict and address it appropriately. All team members make strong contributions to data analysis and coding.	Can effectively communicate the role of structure and function in technology-oriented organizations and can identify real-world examples where technology plays a role in facilitating greater capabilities and efficiencies. Tasks are equitably delegated and leverage the strengths of the team members. All team members attend meetings and thoroughly complete assigned work on schedule. Team members identify relevant, alternative solutions or ideas that build on the work of others to advance the project. Team members identify and acknowledge conflict and address it appropriately. All team members contribute even incrementally to data analysis and coding.	Understands the importance of structure and function in organizations but unable to identify examples where technology plays a role in facilitating greater capabilities and efficiencies. Tasks are delegated disproportionately across team members. Team members attend meetings and completed assignments are mostly submitted on time and mostly thorough. One or two team members offer new ideas and seem to drive the group while the others contribute by expressing support for those ideas. Conflict is acknowledged but not addressed appropriately. A limited number of students are responsible for data analysis and coding.	Unclear about the structure and function of organizations and the mediating role that technology plays in facilitating greater capabilities and efficiencies. Tasks are unevenly distributed across team members. Assigned work is turned in on time, but is not always complete. A small number of team members dominate the group and are responsible for data analysis and coding, while the others passively follow along. Conflict is not acknowledged.

3. Sustainable and Ethical Innovation	Develops multiple candidate solutions to a given problem and ranks them according to a justifiable rubric that identifies at least two innovative pathways forward. Candidate solutions satisfy the constraints imposed by sustainability and ethics principles in different ways. Discussion of the ramifications of each candidate solution identifies potential unintended negative consequences.	Develops multiple candidate solutions to a given problem and provides a reasonable justification for an innovative pathway forward. Multiple candidate solutions satisfy the constraints imposed by sustainability and ethics principles. Discussion of the ramifications of multiple candidate solutions considers the potential for unintended negative consequences.	Develops multiple candidate solutions to a given problem without fully justifying the recommended pathway forward. The proposed solution vaguely satisfies the constraints imposed by sustainability and ethics principles. Discussion of the ramifications of the proposed solution only vaguely considers the potential for unintended negative consequences.	Develops a solution to a given problem without fully justifying the approach or considering alternatives. Unable to identify constraints imposed by sustainability and ethics principles. Discussion of the ramifications of a solution and the potential for unintended negative consequences is vague, or missing.
4. Communication & Leadership	Writing is clear, concise, comprehensive and engaging. Case/thesis is clearly stated and well-argued, making the reader think about the topic in a new light. Evidence strongly supports the case/thesis. Uses conventional grammar and syntax. Tables, figures, and appendices are effectively used to summarize and convey information. Verbal presentations are creative, comprehensive, and compelling, making efficient use of the allotted time. Transitions between presenters and/or topics are smooth. Eye contact is sustained throughout presentation. Visual tools (power point, handouts, etc.) are easy to read and complement the presentation. Responses to questions are convincing and relevant. Appearance is professional. Tasks are delegated to balance the strengths of the team. Delegated tasks are tracked and appropriate performance is rewarded. All team members maintain responsibility for their parts and awareness of all parts of project. Team members build on the work of others to advance the project. Team members identify and acknowledge conflict and work to resolve conflicts.	Writing is clear, concise and persuasive. Case/thesis is clearly stated and well-argued, flowing logically among relevant points. Evidence is relevant and supports the case/thesis. Topics are organized logically. Uses conventional grammar and syntax. Makes good use of tables, figures and appendices to summarize and convey information. Verbal presentations are clear, thorough, using allotted time well. Transitions between presenters and/or topics are relatively smooth. Eye contact is sustained throughout presentation. Visual tools (power point, handouts, etc.) are easy to read and support the presentation. Responses to questions are convincing and relevant. Appearance is professional. Tasks are delegated to balance the strengths of the team. All team members attend meetings and thoroughly complete assigned work on schedule. Team members offer relevant, alternative solutions or ideas that build on the work of others to advance the project. Team members identify and acknowledge conflict and stay engaged with it.	Writing is clear and mostly organized. Case/thesis is fairly persuasive, logical, and supported by evidence. Uses conventional grammar and syntax with minimal typos. Uses tables and figures to summarize and convey information, some may be unclear and additional appendices may be needed. Verbal presentations are clear and mostly thorough. Stays within allotted time. Transitions between presenters and/or topics may be a little abrupt. Eye contact fluctuates throughout the presentation. Visuals tools (power point, handouts, etc.) are easy to read, but reiterate rather than support the presentation. Responses to questions are on-topic and mostly thorough. Appearance is mostly professional. Tasks are delegated somewhat unevenly across team members. Team members attend meetings and complete assigned work mostly on-time and is mostly thorough. One or two team members offer new ideas and seem to drive the group while the others contribute by expressing support for those ideas.	Writing is unclear and does not flow. Topics are not clearly organized. Case/thesis is broad and not well-supported with evidence. Lapses in grammar and syntax, with multiple typos. Tables and figures are used, but may not effectively summarize or complement information in the text. Verbal presentations may ramble, be difficult to understand. Presentation is either too short, or goes well-over allotted time. Eye contact is spotty throughout. Visual tools (power point, handouts, etc.) are hard to read, irrelevant, or completely lacking. Responses to questions go off on tangents and may not answer the original question. Appearance may not be professionally appropriate. Tasks are unevenly distributed across team members. Assigned work is turned in on time, but is not always complete. One or two team members seem to drive the group, while the others passively accept the ideas/viewpoints/opinions. Conflict is not acknowledged.

			Conflict is acknowledged but not engaged with.	

5. Applications	The problem-solving approach identifies feasible strategy for developing a marketable application. Several feasible alternative approaches are also identified and ranked. The proposed solution optimally balances across ethical, legal and social factors that constrain the problem-solving space. The proposed solution has boundary-spanning applications and can be scaled to reach across multiple application domains.	The problem-solving approach identifies a feasible strategy for achieving a well-defined objective. Several alternative approaches are also identified and considered. The proposed solution sufficiently balances across ethical, legal and social factors that constrain the problem-solving space. The proposed solution has wide application scope.	The problem-solving approach identifies both an objective and strategy for achieving the objective, but lacks consideration of feasibility. The proposed solution casually considers ethical, legal and social factors that constrain the problem-solving space. The proposed solution has limited application scope.	The problem-solving approach is piecemeal, lacking a clear objective, lacking a clear strategy, and lacking alignment between the strategy and the objective. The proposed solution lacks consideration for ethical, legal and social factors that constrain the problem-solving space. The proposed solution has no real-world utility.

2.6 Minimum and maximum credits

Range: 44-52 (Minimum assumes a student testing out of Math 011, 012 based on sufficient AP test score; Maximum corresponds to 15 required courses).

2.7 Sample Program

Lower Division: Many lower-division required major preparation courses are common to other SoE programs, with the exception of MIST 001: Inro to MIST. Students who do not pass the remaining 4 major preparation courses will have difficulty in completing the major in 4 years, but this would also be the case in many other STEM majors.

Upper Division: MIST Core Electives tend not to have pre-requisites, meaning that a student can flexibly complete these requirements, and certainly within a 2-year window. The Culminating Experience is thus the only stringent requirement.

MIST courses satisfying UD GE: Crossroads (MIST 130), Writing in the Discipline (MIST 130), Culminating Experience (MIST 193), Approaches to Knowledge – NES (MIST 130); SSHA (MIST 050); Intellectual Experience (MIST 130), Literary and Text Analysis (MIST 120), Media and Visual Analysis (MIST 135), Diversity and Identity (MIST 011), Global Awareness (MIST 011), Sustainability (MIST 011), Ethics (MIST 011)

In summary, between 6-9 (MATH 011, MATH 012, MATH 032, ENGR 096, CSE 015, CSE 022, CSE 030/CE020,ENVE020, ENGR 155, CSE022/MSE021/EE021/BIOE021) of the 15 required major courses could be fulfilled by a SoE student who switch into the MIST program in

Y3, this program would support timely student graduation outcomes and the capitalization on SoE investment in Y1/Y2 curriculum delivery to those students.

Table 6 shows the feasibility of accomplishing this major in 4 years if the student declares the major in Y1. **Table 7** (respectively, **Table 8**) shows the 4-year completion pathway for a CSE major who changes major after completing the standard first-year (resp., second-year) curriculum. **Table 9** shows the 4-year completion pathway for a generic SoE major who changes major after completing the standard second-year curriculum. And **Table 10** shows the transfer pathway for a hypothetical Merced Community College transfer incoming in Y3.

Table 6: Example 4-year plan for **UCM student declaring MIST** major in Y1

Semester 1	**Units**	**Notes:**		**Semester 2**	**Units**	**Notes:**
SPARK	4	**GE**		WRI 10	4	**GE Writing**
MATH 011	4	**MAJOR PREP** ; **GE Quant R.** A2K-NS		MATH 012	4	**MAJOR PREP**
MIST 001	4	**MAJOR PREP**		Language	4	**GE Language**
Elective	4			MIST 070	4	**MIST FUND**
	16				16	
Semester 3				**Semester 4**		
EH 001	4	**MIST FUND;** A2K – Lit. Text An.		MIST 050	4	**MIST FUND**
Elective	4			Elective	4	
MIST 060	4	**MAJOR PREP**		MIST Elective GX	4	
ENGR 096	2	**MAJOR PREP**		Elective	4	
	14				16	
Semester 5				**Semester 6**		
MIST 120	4	**MIST CORE**		MIST 130	4	**MIST CORE**
MIST 132	4	**MIST CORE**		Elective	4	
Elective	4			Elective	4	
Elective	4			Elective	4	
	16				16	
Semester 7				**Semester 8**		
MIST 134	4	**MIST CORE**		Elective	4	
Elective	4			Elective	4	
Elective	4			MIST 181 Capstone	2	**MIST CE**
MIST 180 Capstone	2	**MIST CE**		MIST 182 Seminar	2	**MIST CE**
	14				12	

Table 7: Example 4-year plan for **UCM CSE student** changing major after Y1; Emphasis in *Tech. Mgmt.*

Semester 1	**Units**	**Notes:**		**Semester 2**	**Units**	**Notes:**
SPARK	4	**GE**		Social Science GE	4	
MATH 021	4	**MAJOR PREP** ; **GE Quant R.** A2K-NS		MATH 022	4	**MAJOR PREP**
CSE 022	4	**GE Language ; MIST CORE**		CSE 024	4	
WRI 10	4	**GE Writing**		CSE 015	4	**MIST CORE**
	16				16	
Semester 3				**Semester 4**		
MIST 001	4	**MAJOR PREP**		MIST 050	4	**MIST FUND**
MIST 060	4	**MAJOR PREP**		MIST 075	4	**MIST FUND**
ENGR 191	1			Elective	4	
EH/ENG 001	4	**MIST FUND**				
	13				12	
Semester 5				**Semester 6**		
MIST 132	4	**MIST CORE**		Elective	4	
ENGR 096	2	**MAJOR PREP**		Elective	4	
Elective	4			Elective	4	
Elective	4					
	14				12	
Semester 7				**Semester 8**		
MIST 134	4	**MIST CORE**		Elective	4	
Elective	4			Elective	4	
Elective	4			MIST 181	2	**MIST CE**
MIST 180	2	**MIST CE**		MIST 182	2	**MIST CE**
	14				12	

Table 8: Example 4-year plan for **UCM CSE student** changing major after Y2; Emphasis in *Tech. Mgmt.*

Semester 1	**Units**	**Notes:**		**Semester 2**	**Units**	**Notes:**
SPARK	4	**GE**		Social Science GE	4	
MATH 021	4	**MAJOR PREP** ; **GE Quant R.** A2K-NS		MATH 022	4	**MAJOR PREP**
CSE 022	4	**GE Language ; MIST CORE**		CSE 024	4	
WRI 10	4	**GE Writing**		CSE 015	4	**MIST CORE**
	16				16	
Semester 3				**Semester 4**		
MATH 023	4			Arts & Human. GE	4	
MATH 032	4	**MAJOR PREP**; A2K-SS		MATH 024	4	
CSE 030	4	**MIST FUND.**		CSE 100	4	**MIST CORE**
ENGR 191	1			CSE 031	4	
	13				16	
Semester 5				**Semester 6**		
MIST 132	4	**MIST CORE**		MIST 050	4	**MIST FUND**
ENGR 096	2	**MAJOR PREP**		EH/ENG 001	4	**MIST FUND**
MIST 001	4	**MAJOR PREP**		Elective	4	
Elective	4					
	14				12	
Semester 7				**Semester 8**		
MIST 134	4	**MIST CORE**		Elective	4	
Elective	4			Elective	4	
Elective	4			MIST 181	2	**MIST CE**
MIST 180	2	**MIST CE**		MIST 182	2	**MIST CE**
	14				12	

Table 9: Example 4-year plan for generic **UCM SOE major** starting with MATH 005 changing major after Y2; Emphasis in *Tech. Mgmt.*

Semester 1	**Units**	**Notes:**		**Semester 2**	**Units**	**Notes:**
SPARK	4	GE		WRI 010	4	GE Writing
CHEM 001	4			MATH 021	4	MAJOR PREP; GE Quant R. A2K-NS
MATH 005	4			PHYS 008	4	
WRI 001	4			CHEM 002	4	
				ENGR 096	2	MAJOR PREP
	16				18	
Semester 3				**Semester 4**		
MATH 022	4	MAJOR PREP		Arts & Human. GE	4	
PHYS 009	4			MATH 024	4	
ME 021/BIOE 021/MSE 021/CE 022/ ENGR 057	4	MIST CORE		ENGR	4	
ENGR 191	1			ENGR	4	
	13				16	
Semester 5				**Semester 6**		
Econ 010	4	MAJOR PREP; A2K-SS		MIST 050	4	MIST FUND
MIST 001	4	MAJOR PREP		EH/ENG 001	4	MIST FUND
Elective	4			Elective	4	
Elective	4			MIST 130	4	MIST CORE
	14				16	
Semester 7				**Semester 8**		
MIST 134	4	MIST CORE		Language	4	GE Language
MIST 132	4	MIST CORE		Elective	4	
MIST 080	4	MIST FUND		MIST 181	2	MIST CE
MIST 180	2	MIST CE		MIST 182	2	MIST CE
	14				12	

Table 10: Example 4-year schedule for **Merced Community College** transfer; Emphasis in *Tech. Mgmt.*

Semester 1	**Units**	**Notes:**		**Semester 2**	**Units**	**Notes:**
ENGL 01A	4			ENGL 01B	3	GE Writing
MATH 04A	4	MAJOR PREP; GE Quant R.		MATH 04B	4	MAJOR PREP
Elect/Ex: ECON 01	3			Elect/Ex: ECON 02	3	Satisfies ECON 001
Elect/Ex: CPSC 06	3	GE Language		Elect/Ex: ACTG 04A	4	Satisfies ECON 006A
				Elect/Ex: HIST 17A	3	
	14				17	
Semester 3				**Semester 4**		
MATH 10	3	MAJOR PREP		Elect/Ex: ARTD 40A	3	
ACTG 04B	4	Satisfies ECON 007; MIST CORE		Elect/Ex: PSYC 01A	3	
Elect/Ex: HIST 17B	3			Elect/Ex: GEOL 01	4	
Elect/Ex: BIOL 01	4			Elect/Ex: SOC 01	3	
				Elect/Ex: POSC 01	3	
	14				16	
Semester 5				**Semester 6**		
ECON 006B	4	MIST CORE		MIST 050	4	MIST FUND
ENGR 096	2	MAJOR PREP		EH/ENG 001	4	MIST FUND
MIST 001	4	MAJOR PREP		Elective	4	
Elective	4			Elective	4	
	14				16	
Semester 7				**Semester 8**		
ECON 007	4	MIST CORE		Elective	4	
MIST 132	4	MIST CORE		Elective	4	
MIST 080	4	MIST FUND		MIST 181	2	MIST CE
MIST 180	2	MIST CE		MIST 182	2	MIST CE
	14				12	

2.8 Accessibility for transfer students

A total of 5 out of 15 required courses can be completed in two years via community college transfer credits – namely, WRI 010, GE Language, MATH 011, MATH 012, ECON 007; Also note that SPARK is waived for community college transfer students. See **Table 10** for a summary of a junior-level MCC transfer pathway designed for a student seeking to specialize in the *Technology Management* emphasis track incoming with at least 60 units. Note the ample room for student electives and with no semester unit totals exceeding 16 units during the final two years at UC Merced.

Transfer students are expected to satisfy the minimal UC Merced requirements for the School of Engineering (see https://admissions.ucmerced.edu/transfer/major-preparation-schools - soe, e.g. min. GPA 2.4 for residents, and 2.8 for nonresidents, with a grade of "C" or better, and a minimum total of 60 UC transferable semester units the term prior to enrollment). Regarding transfer requirements, we recommend the following additional Course Requirements:

- **Required:**
  - MATH 011/021 Calculus 1
  - MATH 012/022 Calculus 2

- **Strongly Recommended**

One of the following
  - ECON 010 Statistical Inference
  - PSY 010 Analysis of Psychological Data
  - MATH 018 Statistics for Scientific Data Analysis
  - MATH 032 Probability and Statistics
  - MIST 060 Introductory Data Analytics

Transfer Admission Guarantee (TAG) requirements

For a TAG to be approved, eligible California Community College (CCC) students must be Junior transfer applicants and meet the following additional requirements:

- Minimum transferable unit GPA of 3.0 or higher[15]
- Course Requirements:[16]
  - MATH 011/021 Calculus 1
  - MATH 012/022 Calculus 2

[15] 3.0 is the minimum GPA for TAG applicants to all SoE majors.
[16] We list the required courses only, following the format used in the TAG section of the admissions website.

Table 11: Example Courses at Merced College

	Merced College Articulated Course	UC Merced
Required MIST Major Prep Courses	MATH 04A (4 units)	MATH 021/011
	MATH 04B (4 units)	MATH 022/012
Recommended MIST Major Prep Courses	MATH 10 (3 units)	MATH 018

Example courses provided are specific to Merced College. CA Community College articulated courses can be found on www.assist.org.

2.9 Draft Catalogue Description

Management of Innovation, Sustainability and Technology Major terminating in B.A.

What is MIST? The undergraduate major in *Management of Innovation, Sustainability and Technology* (MIST) combines fundamental coursework in leadership, organizations, entrepreneurship, finance, policy, data analytics, technology management, and sustainable innovation. The resulting multi-dimensional "T-shaped" skillset integrates core management skills with a broad understanding of how to design sustainable and equitable solutions by way of teamwork and technology.

Why combine these different perspectives? Have you ever had a great idea and wondered what it would take to bring that idea to market? If it were easy, then people would be starting their own companies left and right. In fact, to some degree they do - according to a recent survey, around 16% of the US workforce are self-employed entrepreneurs[17].

To this end, this program will provide a multi-dimensional skillset that enables students to understand *where* and *why* entrepreneurial opportunities exist, *what* are the constraints that define them, *how* to identify candidate solutions that are in principle marketable, and also *how* to develop an action plan that is grounded in the *Triple Bottom Line* of ethical treatment of workers and environmental sustainability, in addition to the traditional bottom line of value generation – i.e., identifying solutions that are well-balanced across people, planet, profit (PPP) considerations.

How is the major designed? The program curriculum will comprehensively develop fundamentals skills of management with emphasis on the integrated roles of innovation, sustainability, and technology. Students will learn how modern day problems - from climate change across global environmental systems, to other challenges associated with designing and managing social, food, and energy systems – require various different ways of understanding these problems and their candidate solutions.

In particular, students will develop a *systems thinking* mindset for understanding where and why global crises emerge; a *technology management mindset* for understanding how to design

[17] https://www.gemconsortium.org/report/gem-2018-2019-global-report

scalable and equitable solutions; and a *digital mindset* for harnessing the modern data analytics paradigm that is critical to decision-support, effective communication and inspiring action.

This set of management and entrepreneurship fundamentals combine with applied skills in data analysis, operations, planning, communication and leadership to equip MIST graduates with a valuable array of skills for pursuing a wide range of careers in profit and not-for-profit organizations and public and private enterprises.

3. Accreditation

As an interdisciplinary program, and to the best of our knowledge, there is no accreditation for this type of educational program, and so there are no plans to seek accreditation.

4. Resources Needed and Plan for Providing Them

This program strategically aligns with the Data Science & Analytics (DSA) major, in that there are many regularly offered lower-division and upper-division electives (e.g., MIST 050, 060, 070, 075 and MIST 130-135) as well as a conjoined capstone (MIST 180/181), that together support co-delivery. In the short term, existing MCS faculty will be sufficient to cover instructional needs. To do so, the MCS department will be streamlining graduate course offerings to ensure a smooth ramp of the DSA and the proposed MIST majors. However, as both the proposed MIST major and the DSA major (launching in AY 2024) ramp to larger enrollment numbers, there will be need for two faculty lines – one teaching and one research – to support the department and bother majors over the medium to long term.

1) Teaching faculty line request: Within 2 years of the launch of the MIST major, the MCS department will need one LPSOE to provide instructional resiliency in the core domains shared by both majors, namely: technology management (data visualization, introductory computational methods, machine learning for natural language processing) and project management (productivity & team management, capstone). This teaching professor will also provide instructional resiliency for DSA major courses that the MCS faculty provide, and that satisfy major requirements for the proposed MIST major.

2) Research faculty line request: Upon reaching enrollment targets of 150 students combined students across the DSA and MIST majors, the MCS department will need one additional research faculty line in the area of *information systems, project management and data security* in order to fill need in this core technology management area, and to also provide instructional support for the planned MIST and approved DSA upper-division courses. An additional contingency on this research faculty line is that the MCS faculty who went on unpaid leave in AY 2022-2023 do not return in a reasonable time; if either returns, then we will consider this line filled. (We note that these faculty left after the DSA major proposal was submitted; as such, we also note that no faculty lines were initially requested for the new DSA major at the time of its proposal submission).

In addition to these two faculty resource needs, the new program will also need commensurate administrative support: 0.25 FTE Undergraduate Advisor and 0.25 Curriculum Planner, both to be hired no later than July 1, 2025; and also a commitment for suitable marketing resources to advertise the new major.

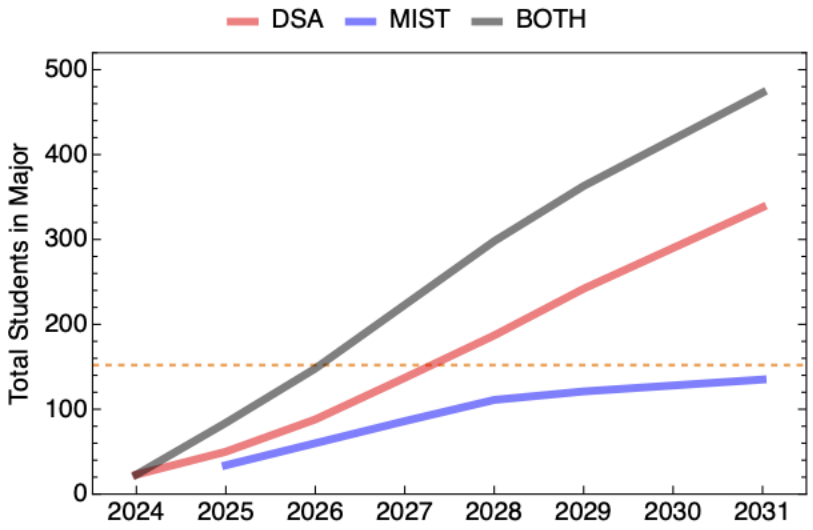


Figure 5: Projected total number of students declaring MIST and DSA majors - based upon IRDS Enrollment projections for both programs. For context, the horizontal dashed line represents the 152 students enrolled in the Cognitive Science major according to the 2022 campus census of student enrollments.

4.1 Faculty members

The following is a list of MCS department faculty members and their disciplinary background that is relevant the multi-disciplinary curriculum. **Table 12** shows the 5-year teaching plan based upon program requirements and electives, the vast majority of which are existing courses.

1. **John Abatzoglou**: PhD, Earth Systems Science; courses in applications of technology to climate change science and adaptive management.
2. **Roger Bales**: PhD, Environmental Engineering; courses in environmental systems engineering, solar technology systems.
3. **Spencer Castro**: PhD, Psychology, Cognition and Neural Science; courses in cognitive engineering and data science.
4. **Jeffrey Jenkins**: PhD, Environmental Studies; courses in national parks and protected area management, spatial analytics.
5. **Crystal Kolden**: PhD, Geography; courses in GIS and fire management.
6. **Tea Lempiälä**: PhD, Organizations and Management: courses in creativity, innovation, leadership, organizations and communications.
7. **Paul Maglio**: PhD, Cognitive Science; courses in service science, technology-enabled service.
8. **Russel McBride**: PhD, Philosophy; courses in Entrepreneurship, social reality.
9. **Tracey Osborne**: PhD, Energy and Resources; courses in climate justice, climate change mitigation.

10. **Alexander Petersen**: PhD, Physics; courses in data science and analytics, visualization, network science, quantitative tools for management.

11. **LeRoy Westerling**: PhD, Economics and International Affairs; courses in fire science, adaptive management.

12. **Lisa Yeo**: MBA; PhD, Operations and Information Systems; courses in information security, information systems management.

4.1.1 Five-year teaching plan

Table 12: Five-year teaching plan

* indicates an UG service course that is already taught, independent of the proposed major

** GS indicates a qualified graduate student who has passed to candidacy.

COURSE	YEAR 1	Y2	Y3	Y4	Y5
MAJOR PREPARATION					
MATH 011/012: CALCULUS I/II	*	*	*	*	*
MIST 060: INTRO. DATA ANALYTICS	Petersen / Westerling / Abatzoglou	Petersen / Westerling / Abatzoglou	Petersen / Westerling / Abatzoglou	Petersen / Westerling / Abatzoglou	* Petersen / Westerling / Abatzoglou
ENG 096: HUMAN-CENTERED RESEARCH & DESIGN	*	*	*	*	*
MIST 001: INTRODUCTION TO MIST	Lempiala / Jenkins / Maglio	Jenkins / Lempiala / Maglio	Lempiala / Jenkins / Maglio	Jenkins / Lempiala / Maglio	Lempiala / Jenkins / Maglio
LOWER DIV – MIST FUNDAMENTALS					
MIST/ESS 011: CLIMATE JUSTICE	Osborne / Kolden	Osborne / Kolden	Osborne / Kolden	Osborne / Kolden	Osborne / Kolden
MIST 040: PROJECT MANAGEMENT		Yeo / McBride		Yeo / McBride	
MIST 050: INTRO TO ENTREPRENEURSHIP	McBride / Maglio	McBride / Maglio	McBride / Maglio	McBride / Maglio	McBride / Maglio
EH 001: INTRO TO ENVIRONMENTAL COMMUNICATIONS	Bristin Jones (LLC Dept.)	Bristin Jones (LLC Dept.)	Bristin Jones (LLC Dept.)	Bristin Jones (LLC Dept.)	Bristin Jones (LLC Dept.)
MIST 070: INNOVATION MANAGEMENT	Lempiala / Petersen		Lempiala / Petersen		Lempiala / Petersen
MIST 075: INFORMATION SYSTEMS FOR MANAGEMENT	Yeo / Maglio		Yeo / Maglio		Yeo/Maglio
MIST 080: SYSTEMS THINKING		Osborne / Jenkins / Abatzoglou		Osborne / Jenkins / Abatzoglou	
CSE 030: DATA STRUCTURES	*	*	*	*	*
UPPER DIV – CORE ELECTIVES					
MIST 110: HYDROLOGY & CLIMATE		Abatzoglou			Abatzoglou
MIST 116: APPLIED CLIMATOLOGY			Abatzoglou		
MIST 118: CLIMATE CHANGE: SCIENCE & SOLUTIONS	Abatzoglou			Abatzoglou	
MIST 120: PARKS & PROTECTED AREAS	Jenkins		Jenkins		Jenkins
MIST 128: COGNITIVE ENGINEERING	Castro	Castro	Castro	Castro	Castro
MIST 130: STATISTICAL DATA ANALYSIS AND OPTIMIZATION IN R FOR DECISION SUPPORT	Castro / Westerling	Westerling / Castro	Castro / Westerling	Westerling / Castro	Castro / Westerling
MIST 131: DATA GOVERNANCE FOR ANALYTICS PROJECTS		Yeo		Yeo	
MIST 132: GEOGRAPHIC INFORMATION SYSTEMS ANALYSIS IN MANAGEMENT	Kolden	Jenkins	Kolden	Jenkins	Kolden
MIST 133: SERVICE INNOVATION			Maglio		
MIST 134: METHODS OF DATA AND NETWORK SCIENCE	Petersen		Petersen		Petesren
MIST 135: TECHNICAL COMMUNICATION AND VISUALIZATION SKILLS		Petersen	Westerling	Petersen	Westerling
MIST 164: ENERGY POLICY	Keske	Keske	Keske	Keske	Keske
MIST 175: INFORMATION SYSTEMS FOR MANAGEMENT	Yeo		Yeo		Yeo
PROFESSIONAL DEVELOPMENT					
MIST 180/181 – FALL/SPRING				Staff/Faculty	Staff/Faculty
MIST 182 - SPRING				Staff/Faculty	Staff/Faculty

4.1.2 Timeline for rolling out new courses

The main short-term course needed to be approved in order to launch the program is MIST 001 "Intro to MIST: Leadership, Organizations and Communications".

Two other new courses (MIST 070 Innovation Management and MIST 080 Systems Thinking) would need to be developed and approved in time for the second year so that students have at least two options for their MIST Core Elective.

The two capstone courses (MIST 180 and 181) will not need to be taught until three years after commencing. As such, given the relatively small resource requirements of the program, we believe the program could feasibly launch as early as Fall 2024.

Regarding long-term resource requirements, the program requires developing a sufficient number of feasible and relevant capstone projects to foster a culminating educational experience. To address this gap in the short term, faculty and other entities on campus (e.g. the Library or Facilities Management) will be able to develop suitable projects for capstone teams, which would be charged with tasks such as developing a climate mitigation and sustainability plan for particular entities on campus or in the region. As with other capstone programs on campus and elsewhere, assembling students from different programs into multi-disciplinary teams would benefit the objectives and design of the program. For example, we envision students in the proposed MIST major could naturally blend into capstone projects in the proposed Data Science & Analytics (DSA) major. To optimize resources, we plan to strategically engage this interface once both programs have been launched, given that the MCS department is one of four departments (along with CIS, Economics and Political Science) delivering the proposed DSA major.

4.1.3 Administration of Senior Capstone

This course will not be anywhere near as complicated to run as the Engineering Capstone because all projects will be based upon hypothetical scenarios. Students will collaborate in teams through an entire year to identify and understand a problem, identify innovative solutions, develop a business plan for a particular technology-oriented solution, develop a funding pitch, and write a detailed report summarizing the project and their strategy for deploying a beta test version.

The course will be managed by a single instructor who will match students to problems, provide guidance, facilitate meetings with professionals as needed, and organize the final showcase in the Spring semester.

4.2 Specialized staff/needed FTE

None.

4.3 Instructional space needs

None.

4.4 Instructional computing resources

No special instructional computing resources needed. The anticipated campus-level laptop policy will ensure students have access to the computing needs required of all courses in the program.

4.5 Library resources needed

This program will not require special library resources beyond what is already provided to undergraduate students.

Regarding new Library/Collections needs, this program does not anticipate any new journals or data collections, as it will leverage open data sources and existing open textbook collections.

Included in the Appendix is a letter of support on behalf of the UCM Library (**MIST-program-library-support-oct2023.pdf**).

4.6 Resource needs for field studies or off-campus activities

None.

4.7 Specialized facilities

None.

5. Program Governance

The proposed MIST program will be offered and governed by core members of the MCS department. The program chair will be nominated by the MCS department chair and appointed by the Dean of the school to which the MCS department belongs. This program chair will be responsible for all aspects of governance of the program.

The School of Engineering will assume student advising staff responsibilities. In the case that the Gallo School of Management is approved and launched, this new school will assume the student advising staff responsibilities, and the responsible dean will shift to the Dean of the Gallo School.

6. Potential for non-majors to participate

All courses except for MIST 180/181 (Capstone) will be open to non-majors satisfying prerequisites.

7. Timetable for implementation

7.1 Timeline

First cohort in Fall 2025 – Freshman only.

UCM Sophomore (Junior) major change admissions considered for Fall 2026 (Fall 2027).

Community College incoming Junior transfer admissions considered for Fall 2027.

Appendix I – Course Descriptions

If no prerequisites are listed then there are none.

Major Preparation Course – 5 Courses, 18 Units

MATH 011*: Calculus I* (4 Units) - Introduction to differential and integral calculus of functions of one variable, including exponential, logarithmic and trigonometric functions, emphasizing conceptual understanding and applying mathematical concepts to real-world problems (approximation, optimization).

- Alternative substitutes: MATH 021

MATH 012*: Calculus II* (4 Units) - Continuation of MATH 011. Introduction to integral calculus of functions of one variable and differential equations, emphasizing conceptual understanding and applying mathematical concepts to real-world problem.

- Alternative substitutes: MATH 022

MIST 060: *Introductory Data Analytics* (4 Units) – Introduces the data-for-decision-making paradigm through the lens of the Wolfram computing suite – comprised of WolframAlpha, the Mathematica language, and computable notebooks. Lectures introduce methods and best practices of data collection, integration and visualization, together reinforced via team exercises drawing on real-world domains. To facilitate explorative autodidactic learning, students will learn how to self-instruct new coding skills by using Mathematica Document Center 'help pages' in conjunction with myriad open coding demonstrations.

ENG 096*: Human-centered Research & Design* (2 Units) - Students learn the techniques associated with research and design practices focusing on the user experience of end users and other stakeholders. Topics include, need assessment, market analysis, specification development, user requirements, functional decomposition, DFMEA, prototyping, field testing, product assessment and ethics. Students gain understanding of these concepts through real-world examples of engineering projects in the areas of energy and sustainable design.

*** *MIST 001:*** Intro to MIST: Leadership, Organizations and Communications (4 Units) Draft: Using management and organizational behavior theories, students will identify and evaluate examples of functional and dysfunctional leadership in workplace settings. Students will also learn and apply strategies for effectively managing employees and other human resources through the use of organizational case materials, leadership assessments, and team exercises involving both oral and written communications. Class and group discussions will focus on improving individual and team performance in work organizations with sensitivity to cross-cultural differences.

Lower Division MIST Fundamentals – 3 **Courses,** 12 **Units**

ENG/EH 001: *Intro. To Environmental Communications* (4 Units) – Introduces the basics of ecology and climate change; scientific methods; environmental justice; and the principles of effective environmental communications. Introduces emotional resources for caring for themselves and others when dealing with heavy issues like environmental injustice and climate change. Features guest speakers from environmental law, business, activism, the National Park Service, and government.

***MIST/ESS 011:** *Climate Justice* (4 Units) – Provides an overview of climate justice, a field that addresses climate change from a social justice perspective. Students will be prepared with the knowledge and tools necessary to address climate change from an equity perspective. Provides space for student reflection on their role as global citizens and their contribution to the public good.

* **MIST 040**: *Project Management* (4 Units) – To be developed

***MIST 050:** *Introduction to Entrepreneurship* (4 Units) - Provides hands-on training in the practice of entrepreneurship where students learn to make actual money in challenging exercises in "the real world" (or measurably improve a social good if students choose a social entrepreneurship project).

***MIST 070:** *Innovation Management* (4 Units) - Provides exposure to key concepts, practices and theories of innovation management. On this course the students will learn how to lead innovative collaboration, support innovative organizational cultures, and effectively apply tools and processes of innovation management. The course also offers understanding of key leadership and decision-making concepts and practices. Emphasis is placed on leading diversity and sustainability in complex environments.

***MIST 075**: *Information Systems for Management* (4 Units) - Introduces principals of design, implementation and management of information systems and information technology, and discusses how these create value for technology-based organizations and industries, with relevant case studies in AgTech.

*Presently an upper-division course which will be re-designed and submitted to UGC as a lower-division course.

***MIST 080:** *Systems Thinking* (4 Units) – Develops concepts, theory and modeling of complex systems using real-world examples of coupled socio-economic, political, environmental and technological systems. Students learn how the systems thinking framework transforms the understanding of both vulnerability and resiliency in systems characterized by emergent and collective phenomena.

* **MIST 085**: *Life Design* (4 Units) – To be developed

***MIST 012-019**: courses that have already been offered via SPARK are future candidate alternatives to MIST 011: Cybersecurity & Data Privacy; Ethnography & Innovation; Living with Wildfire; Science of Science.

CSE 030: Data Structures (4 Units) – Focuses on the design, analysis, and implementation of fundamental data structures, design patterns, and algorithms used throughout computer science, including linked lists, stacks, queues, trees, hash tables, graphs, recursion, and methods for searching and sorting. Prerequisite Courses: CSE 024. (Only an option for CSE students changing major).

CE 020: Introduction to Civil and Environmental Engineering (4 Units) – Introduces civil and environmental engineering principles for civil engineers. Engineers have to conduct environmental impact analyses before projects are approved. This requires sustainable engineering and infrastructure practices to build and operate objects with an healthy environment in mind. At a minimum, topics include environmental chemistry, risk assessment, sustainable engineering, clean air and water supply, methods for pollution prevention, control, and treatment. Principles of mass and energy balances will be applied throughout the course. Prerequisite Courses: (MATH 021 or equivalent exam) and (CHEM 010 or CHEM 010H or equivalent exam). (Only an option for CSE students changing major).

ENVE 020: Introduction to historical and current issues in the diverse field of environmental engineering. Principles of mass and energy balance. In-depth analysis of several key innovations from the field that have been instrumental in advancing the field. Design project. Prerequisite Courses: (CHEM 010 or CHEM 010H or equivalent exam) and (MATH 021 or equivalent exam). (Only an option for ENVE students changing major).

Upper Division MIST Core – *7* Courses, 22 **Units**

UD MIST Core Electives – *4* Courses, 16 **Units –** Choose 4 from any Elective Group; (strategic selection of these courses satisfies the requirements for one of 3 Emphasis Tracks in Innovation Management; Sustainability Management; or Technology Management):

MIST Elective Group 1 – Critical Thinking Methods for Management

ECON 007: *Managerial Accounting* (4 Units) - Learn what financial information is needed within an organization; where to obtain this information; and how managers can use this information. Topics include cost behavior and forecasting, capital budgeting, activity-based costing and management, costs of quality and productivity improvement programs, cost-volume analysis, tactical decision making and transfer pricing. Pre-req.: ECON 006A

CSE 015: *Discrete Mathematics* (4 Units) - Explores basic concepts of discrete mathematics used in computer science and other disciplines that involve formal

reasoning. Topics include logic, proof, counting, discrete probability, relations, graphs, trees, and Boolean algebra. (** Only available for CSE students changing major.)

CSE 100: *Algorithm Design & Analysis* (4 Units) – Introduction to the design and analysis of computer algorithms. Topics will include concepts of algorithm complexity, and various algorithmic design patterns like divide and conquer, dynamic programming and greedy algorithms. Also covers major algorithms and data structures for searching and sorting, graphs and some optimization techniques. (** Only available for CSE students changing major.)

***MIST 130**: Statistical Data Analysis and Optimization in R for Decision Support* (4 Units) – Introduces statistical analysis and optimization for decision support using the R programming environment. Analyze and visualize data and model relationships using graphing techniques, correlation and regression analysis, scenario development and analysis, sensitivity analysis, simulations, and optimization. Emphasizes applied work using real data from resource management and service management examples to support decision making. Case driven and team-focused, emphasizes best practices and professional ethics for analyzing, modeling and communicating empirical data and model results. Pre-Reqs: (MATH 032 or MATH 018 or BIO 018 or equivalent exam) and (MATH 050 or ME 021 or BIOE 021 or CSE 020 or equivalent exam). The Pre-requisites for this course will be reduced.

MIST 132: *Geographic Information Systems Analysis in Management* (4 Units) - Introduces geographic information systems (GIS) for sustainability management as the technology of processing spatial data, including input, storage and retrieval; manipulation and analysis; reporting and interpretation. Emphasizes GIS as a decision support tool for analysis, visualization, and problem solving in natural resource management, organizations/logistics, and non-profit sector.

MIST 134: *Methods of Data and Network Science* (4 Units) - Explores methods to efficiently manage and analyze large complex datasets. The computer lab will introduce the Mathematica programming language with a focus on extracting data from websites, exploring, and inquiry-oriented analyses and visualizations. Introduction to network science theory useful in understanding and managing complex socio-technological systems. Prerequisite Courses: (MATH 012 or equivalent exam) and (MATH 050 or CSE 020 or CSE 019 or ME 021 or BIO 021 or equivalent exam)

MIST 138: *Systematic Financial Trading & Analysis* (4 Units) - Financial investing and trading can be divided into: fundamental (using macro and micro economic information); technical (price charts indicators); discretionary (gut feeling); and systematic (statistically supported rule generation). After learning some financial basics, we will touch upon all of these but the focus of the course will teach how to analyze, build, and evaluate trading systems, especially the process of determining 'robustness'—whether the system will work in the real world.

ENVE 155: *Decision Analysis in Management* (4 Units) - Presents the tools of decision science using a quantitative approach with a focus on investment, finance, management, technology and policy decisions. These tools include decision tree analysis, risk and uncertainty analysis, stochastic dominance, the value of information, probability bias, and subjective probability. Pre-Reqs.: ECON 100 and (ECON 010 or POLI 010 or equivalent exam)

ECON 110: *Econometrics* (4 Units) - Introduction of problems of observation, estimation and hypotheses testing in economics through the study of the theory and application of linear regression models, critical evaluation of selected examples of empirical research and exercises in applied economics. Pre-reqs.: (ECON 010 or equivalent exam) and (MATH 011 or MATH 021 or equivalent exam)

ENGR 155: *Engineering Economic Analysis* (3 Units) - Microeconomic principles and methods. Time value of money, interest and equivalences, analysis of economic alternatives, depreciation, inflation and taxes, estimates of demand, cost and risk, decision theory.

COGS 104: *Complex Adaptive Systems* (4 Units) - Introduction to the study of complex phenomena using dynamical computer simulations, which exhibit emergent properties, sensitivity to initial conditions, fractal structure, phase transitions in random graphs, and shifts from stability to meta-stability to chaos. Matlab projects include: probability games, neural networks, the Lorenz attractor, the logistic map, the Mandelbrot set. Pre-reqs.: COGS 001

One of the following 5 courses can be counted if the student is changing major from a UCM engineering program:

CSE 022: *Introduction to Programming* (4 Units) –Introduces students to programming, computational thinking, and problem solving concepts, teaching students how to use computers as tools rather than appliances. In addition to programming skills, students also learn industry-standard practices, such as version control, unit testing and debugging. Follows a Project-Based Learning Philosophy, with Python as the main programming language, but students also get exposure to HTML, CSS, JavaScript, and SQL. Prerequisite Courses: CSE 005 or equivalent exam.

MSE 021: *Engineering Computing* (4 Units) – Introduction to Matlab and a line programming language including FORTRAN, PYTHON, and C++. Concepts of formatted input/output, data types, variables, arrays, strings, variable scopes, logic statements, loops, functions and subroutines, and data graphing. Computing examples are drawn from mechanical engineering topics including linear algebraic equations and root search.

EE 021: *Introduction to Electrical Engineering Programming* (4 Units) – Introduces students to programming and the logical thinking required to use electrical inputs to

control a process. Concepts related to data types (e.g. variables, strings, arrays), logic statements, functions, and graph creation. Emphasizes Python but will also introduce other programming tools. A key focus is for students to be able to write programs to control circuits.

BIOE 021*: Introduction to Computing with Python* (4 Units) – Provides an introduction to scientific and engineering computer programming using Python as the language. Covers programming fundamentals using specific engineering applications with examples drawn from various engineering and related disciplines including Bioengineering, Chemical Engineering, Economics, Biology, Bioinformatics. Being laboratory-based, focuses equally on programming concepts and on actual coding and implementation.

ENGR 057*: Statics and Dynamics* (4 Units) – Fundamentals of statics. Kinematics and equations of motion of a particle for rectilinear and curvilinear motion. Planar kinematics of rigid bodies. Kinetics for planar motion of rigid bodies, including equations of motion and principles of energy and momentum.

MIST Elective Group 2 – Management of Innovation, Technology, and Organizations

ECON 005: *Introduction to Business and Finance* (4 Units) - Provides an introduction to the modern business enterprise. It covers the role of the business enterprise in the global economy; financial tools, including the time value of money and capital budgeting; product pricing and marketing; and personal financial management.

MIST 131: *Data Governance for Analytics Projects* (4 Units) - Introduces skills and technologies to appropriately collect, manage, and safely dispose of data; known as "Data Governance" in industry. Explores the analytics research process from translating business problems into research questions that can be addressed through analytics. Develops the ability to frame a business problem, map alternative solutions, and identify sources for relevant data. Investigates threats to collection, storage, and protection of relevant data, and creating a plan to protect the important data assets.

MIST 133: *Service Innovation* (4 Units) - Focuses on service innovation, generation of new successful service ventures. Helps students gain the skills necessary to be successful in three main aspects of service production and delivery systems: the back office, the front office, and service design.

MIST 136: *Retailing Management* (4 Units) - Provides students with a panoramic view of the changing nature of retailing and the many complex management issues facing retailers today using a social scientific approach. Emphasis is placed on the analysis of retail business models and operational strategies to market goods and services in two or more channels. Students learn about evolving consumer behavior and omnichannel supply chain management, as well as the social, environmental and economic impacts of retailing.

MIST 137: *Managing Teamwork* (4 Units) - Provides students with a comprehensive understanding of how individuals respond to doing complex work in small groups using a social scientific approach. Students learn about important interpersonal processes and how to make them more effective, both individually and collectively. Emphasis is placed on managing and leading high-performing diverse teams to maximize positive individual and collective outcomes in a variety of organizational contexts.

*** MIST 139**: *Operations Management* (4 Units) – To be developed

MIST 175: *Information Systems for Management* (4 Units) - Introduces organizational use of information systems and information technology, and discusses how these create value for organizations. Cross-listed with: ENGR 175 and MGMT 170.

MIST 150: *Service Science* (4 Units) - Services e.g., restaurants, hotels, lawyers, information technology operations, business consulting – account for more than 80% of jobs in the US. Through case studies of businesses and scientific studies of people in real service settings, this course focuses on how to align people and technology effectively to generate value. Cross-listed with: MGMT 150 and COGS 182.

MIST 120: *Parks & Protected Areas* (4 Units) - Covers themes of parks and other domestic and international protected areas. Topics range from historical foundations of the park conservation model, indigenous peoples, wilderness philosophy, visitor use management and carrying capacity, cultural heritage, climate change and natural hazards, human-wildlife conflict, and the intersection of political-legal mandates with the above. Students will learn how to pose research questions and pursue facts through critical inquiry and scholarly resources. These findings will be communicated through writing and presentation.

MIST Elective Group 3 – Communication & Leadership

ECON 005: *Introduction to Business and Finance* (4 Units) - Provides an introduction to the modern business enterprise. It covers the role of the business enterprise in the global economy; financial tools, including the time value of money and capital budgeting; product pricing and marketing; and personal financial management.

ECON 108: *Marketing and Consumer Behavior* (4 Units) - Outlines the foundations of marketing and its relationship with consumer behavior. Emphasis on the fundamental concepts underlying modern marketing practices including consumer preferences, product value, pricing strategies, retail markets, brand loyalty, advertising, product development and marketing ethics. Pre-req.: ECON 001 or equivalent exam

MIST 135: *Technical Communication and Visualization Skills* (4 Units) - Theory of effective communication in quantitative contexts drawing on various presentation modes – written, oral, graphical, powerpoint, poster. Seminars on theory and best-practices

combined with individual and team project presentations. Opportunity to improve inquiry-oriented communication skills, to give and receive constructive feedback, and to learn graphical methods for developing striking visualizations.

MIST 128: *Cognitive Engineering* (4 Units) - Provides an introduction to cognitive engineering, with an emphasis on cognitive science. Topics include human computer interaction, human robot interaction, speech recognition systems, animated characters, virtual reality systems, ubiquitous computing, computer supported cooperative work, and the implications of cognitive science research on the design and use of electronic devices and user interfaces in the 21st Century.

PHIL 123: *Technology Ethics* (4 Units) - Provides an introduction to moral problems with computer and information technology. Topics may include: responsibility, surveillance, privacy, automation, artificial intelligence, and changes in the human condition owing to revolutionary technologies. Cases to be discussed include both historical and contemporary technologies. Pre-reqs: Any lower-division PHIL course.

MIST Elective Group 4 – Sustainable and Ethical Innovation

MIST 118: *Climate Change: Science & Solutions* (4 Units) - Introduces the science, impacts, and solutions of global climate change with a focus on real-world applications. Explores how scientific and engineering disciplines contribute to the complexity of the climate system and solutions to mitigating change. Introduction to multi-dimensional aspects of the problem including social science, technology, ecosystem management, governance, economics and market incentives. A team project culminating in a final presentation will provide the opportunity for students to apply course material to science and policy. Pre-reqs.: MATH 011 or MATH 021 or MATH 018 or BIO 018 or MATH 032 or equivalent exam; Cross-listed with: ENVE 118.

MIST 116: *Applied Climatology* (3 Units) - Spatial and temporal patterns in climate and their association with land surface characteristics and processes. Methods for exploiting these for hypothesis testing, modeling, and forecasting. Applications include seasonal forecasting, ecological modeling, and analysis of processes such as flooding and wildfire. Pre-reqs: ENVE 110 or ESS 110; Cross-listed with: ENVE 116, ESS 132; Conjoined with: ES 232.

MIST 110: *Hydrology & Climate* (4 Units) - Develops an understanding of the conceptual basis of the sciences of climate and hydrology and to introduce quantitative methods that (a) allow interpretation of hydrologic and climate data, (b) describe of linkages between the various components of the hydrologic and climate system, and (c) support decision making in resource management and conservation. Pre-reqs: (ENVE 020 or MATH 015) and (MATH 012 or MATH 022 or equivalent exam); Cross-listed with: ESS 110.

MIST 120: *Parks & Protected Areas* (4 Units) - Covers themes of parks and other domestic and international protected areas. Topics range from historical foundations of the park conservation model, indigenous peoples, wilderness philosophy, visitor use management and carrying capacity, cultural heritage, climate change and natural hazards, human-wildlife conflict, and the intersection of political-legal mandates with the above. Students will learn how to pose research questions and pursue facts through critical inquiry and scholarly resources. These findings will be communicated through writing and presentation.

ENG/EH 130: *Writing to Save the Planet* (4 Units) - Students both read texts that urge environmental action, and create their own. They read essays, non-fiction books, poems, plays, and stories about the natural world, ecological disaster and renewal, and climate justice, analyzing what makes this writing effective for its audience. Working individually and in teams, they then turn scientific research on the environment and climate catastrophe into op-eds, tweets, essays, screenplays, graphic novels, websites, and works of literature that could reach larger audiences.

MIST 164: *Energy Policy* (4 Units) - Introduces students to contemporary energy policy and presents fundamental tools for modeling firm and market behavior in the energy sector. Pre-reqs: MATH 024 and (ENGR 155 or ECON 100). Cross-listed with: ENVE 164; Conjoined with: MIST 264 and ES 264.

Upper Division Culminating Experience – *3* Courses, 6 **Units**

Capstone – 2 Courses, 4 Units

*** *MIST 180:*** *Capstone I* (2 Units) – Integrative team-based 2-semester Capstone project to address a real-world problem defined by an academic or industry advisor. Satisfies GE Culminating Experience badge.

**** MIST 181:*** *Capstone II* (2 Units) – Continuation of MIST 180. Pre-Reqs: MIST 180

Professional Development – 1 course, 2 Units

**** MIST 182:*** *MIST Seminar* (2 Units) – Students will attend the MCS Seminar Series (in either Fall or Spring) and gain real-world examples of MIST problem solving. Students will synthesize an integrative communication (report, poster, website, etc.) that showcases their understanding of MIST principles and applications.

Appendix II – IRDS Assessment

Job Market Assessment

For more elaboration, see Appendix Folder document: *08.15.For MIST job section.pdf*

List A1: Job Types and Median Annual Salaries by CIP Code

***52.0216 – Science/Technology Management*:**

- Business Operations Specialists, All Other;
- Managers, All Other;
- Project Management Specialists

Median annual salary of $104,200 in CA (2022).

***30.3301 - Sustainability Studies*: Median annual salary (2022) of 104,200 in CA.**

- Business Operations Specialists, All Other;
- Managers, All Other;
- Sales Representatives of Services, Except Advertising, insurance, Financial Services, and Travel

Median annual salary of $85,400 in CA (2022).

List A2: Key Skill Competencies

Specialized: Marketing; Project Management; Finance; Product Management; Agile Methodology; Computer Science; New Product Development; Data Analysis; Auditing; Business Development

Common: Communications; Management; Leadership; Operations; Sales; Planning; Customer Service; Problem Solving; Writing; Detail Oriented.

Software Skills: Microsoft Professional Suite (Word/Excel/Office/Powerpoint/Outlook); SQL; Python; JIRA software (Bug tracking system, project management); Amazon Web Services; Tableau

Appendix III : Supplemental Appendix Documents

- Letter of support on behalf of the UCM Library: MIST-program-library-support-oct2023.pdf
- Letter of support on behalf or the LLC department and Environmental Humanities (BA) program**:** EnvironmentalHumanities_LetterOfSupport_EmailThread.pdf
- Letter of support on behalf or the ECON department and Mgmt. Business Economics MBE (BS) program: EconomicsDept-MBEprogram_LetterOfSupport_EmailThread.pdf

- IRDS Lightcast employment prospectus: *08.15.For MIST job section.pdf*
- IRDS enrollment estimations: *2023.08.17.MIST Data Sheet.pdf*
- Catalogue supplement – MIST emphasis track course list: *MIST BA Concentrations.pdf*

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October 23, 2023

Dear Alex Peterson & Proposal Development Team,

Re: Bachelor of Arts in Management of Innovation, Sustainability, and Technology (MIST) Proposal

Thanks for providing your program proposal for review and meeting with Library staff to share more specifics about its curriculum and structure. This program's multi-disciplinary approach, sustainability emphasis, People, Planet, and Profit (PPP) mindset, and a focus on problem-solving seems highly relevant to our current environment. Importantly, your program will accommodate transfer students and contribute to student retention by providing a pathway for Engineering majors to pivot to a degree that aligns with their interests yet is less technical.

As per our discussion, the Library does not anticipate the need to acquire new information resources. The Library has some lab space that students in the program may wish to take advantage of, though these spaces are not directly necessary for the program's success. Once students embark on the capstone for the course, there may be additional opportunities for the Library to coordinate with the program to offer projects that support student learning and contribute to Library assessments and initiatives. The Library currently has staff with expertise in geospatial data, computational methods, and business research who may serve as resources.

Congratulations on your program proposal. We wholeheartedly support its acceptance and implementation as it will offer another degree option for UC Merced students and prepare them for a range of employment and educational opportunities. As the program launches, we look forward to collaborating in support of the program's success.

Sincerely,

Haipeng Li
University Librarian

Re: Draft proposal for MIST Major -- soliciting comments and letter of support

Virginia Adan-Lifante <vadan-lifante@ucmerced.edu>
Wed 10/18/2023 1:31 PM

To:Alexander Petersen <apetersen3@ucmerced.edu>;LeRoy Westerling <lwesterling@ucmerced.edu>
Cc:Alvin Cha <acha2@ucmerced.edu>;Tea Lempiala <tlempiala@ucmerced.edu>;Spencer Castro <scastro39@ucmerced.edu>;Bristin Jones <bjones34@ucmerced.edu>

1 attachments (694 bytes)
vadan-lifante.vcf;

Dear Prof. Petersen,

I am glad you find helpful the recommendations we made.

Yes, please include this email threat in the appendix of materials.

Regards,

Virginia

Dr. Virginia Adán-Lifante
Chair, Dept. Literatures, Languages, and Cultures
World Languages Coordinator
University of California, Merced

On 10/18/2023 10:54 AM, Alexander Petersen wrote:

> Dear Profs. Adán-Lifante and Jones,
>
> Thank you for your timely reply and for these excellent recommendations.
>
> I'm just writing to confirm that in the revised proposal we have included EH 001 as an option to satisfy the lower-division MIST Fundamentals component, as well as one of the required courses for the Sustainability Management concentration. And we also added EH 130 to the MIST Elective Group 4; as your program evolves, please send us any updated course offerings that you feel would be appropriate for the list.
>
> And unless you prefer writing a more formal letter of support, I will just include this email thread in the appendix materials submitted with the proposal.
>
> Best, -alex

From: Virginia Adan-Lifante <vadan-lifante@ucmerced.edu>
Sent: Wednesday, October 11, 2023 10:13 AM
To: Alexander Petersen <apetersen3@ucmerced.edu>; LeRoy Westerling <lwesterling@ucmerced.edu>
Cc: Alvin Cha <acha2@ucmerced.edu>; Tea Lempiala <tlempiala@ucmerced.edu>;

Spencer Castro <scastro39@ucmerced.edu>; Bristin Jones <bjones34@ucmerced.edu>
Subject: Re: Draft proposal for MIST Major -- soliciting comments and letter of support

Dear Prof. Petersen,

Thank you for the opportunity to comment on the MIST major proposal.

I have consulted the issues you mentioned with Prof. Bristin Jones, coordinator of the EH program.
Regarding the relation of the proposed MIST and EH majors outlined in section 1.7.3, we consider that there is not any negative overlap between the two programs.

As for existing or planned EH courses appropriate to include as candidate electives, Porf. Jones considers that EH 001: Introduction to Environmental Communications and ENG/EH 130: Writing to Save the Planet would be appropriate for MIST Elective Group 4.

The only other comment we have is that we support this proposal as it represents one more step toward the goal to have sustainability programs in every school.

Regards,

Virginia M. Adán-Lifante
Chair, Dept. Literatures, Languages, and Cultures
World Languages Coordinator
University of California, Merced

On 10/5/2023 2:08 PM, Alexander Petersen wrote:

> Dear Prof. Virginia Adan-Lifante,
>
> As Chair of the Department of Literatures, Languages, and Cultures department, please find attached a draft proposal for a new undergraduate major in *Management of Innovation, Sustainability and Technology* terminating in a Bachelors of Arts (BA) to be delivered by the Management of Complex Systems department, School of Engineering.
>
> Based upon our identification of the new *Environmental Humanities (EH)* major as having similar sustainability themes, we are soliciting any comments your department may have regarding the following:
>
> - The relation of the proposed MIST and EH majors outlined in section 1.7.3
> - Any existing or planned EH courses that you see as appropriate to include as candidate electives
> - Other
>
> Conditional on your availability, we would be happy to discuss the proposal in more detail.
>
> Once we have had a chance to address any comments your department raises, we hope to obtain a letter of support from you as chair which we will include in the transmittal of the final proposal.

Best, -alex

Alex Petersen, PhD
Associate Professor
Management of Complex Systems Department
Ernest and Julio Gallo Management Program
School of Engineering
University of California, Merced
Research Website

Re: Draft proposal for MIST Major -- soliciting comments and letter of support

Christian Fons Rosen <cfons-rosen@ucmerced.edu>
Tue 11/28/2023 9:54 AM

To:Alexander Petersen <apetersen3@ucmerced.edu>;Anthony Westerling <leroy.westerling@icloud.com>
Cc:LeRoy Westerling <lwesterling@ucmerced.edu>;Tea Lempiala <tlempiala@ucmerced.edu>;Spencer Castro <scastro39@ucmerced.edu>;Jason Lee <jlee287@ucmerced.edu>;Jesus Sandoval Hernandez <jsandoval-hernandez@ucmerced.edu>;Justin Hicks <jhicks2@ucmerced.edu>

Dear Alex,

Thank you for your email.

I confirm that we have had interactions on this proposal and that our suggestions have been incorporated. For this reason, we support the initially and are happy to stay in touch on this matter if needed.

Best regards,

Christian

From: Alexander Petersen <apetersen3@ucmerced.edu>
Sent: Monday, November 27, 2023 9:48 AM
To: Anthony Westerling <leroy.westerling@icloud.com>; Christian Fons Rosen <cfons-rosen@ucmerced.edu>
Cc: LeRoy Westerling <lwesterling@ucmerced.edu>; Tea Lempiala <tlempiala@ucmerced.edu>; Spencer Castro <scastro39@ucmerced.edu>; Jason Lee <jlee287@ucmerced.edu>; Jesus Sandoval Hernandez <jsandoval-hernandez@ucmerced.edu>; Justin Hicks <jhicks2@ucmerced.edu>
Subject: Re: Draft proposal for MIST Major -- soliciting comments and letter of support

Dear Chair Fons-Rosen,

We are nearing the point of submitting the MIST major proposal and would benefit from having a letter from the ECON department confirming that we consulted for feedback and also to identify any issues that the proposal may introduce.

As noted below, we replaced ECON 010 in the lower-division Major Preparation course list with DSA 001 to alleviate the enrollment burden (see attached the most recent version).

We plan to submit the proposal in the coming weeks, so a simple confirmation of this exchange by replying to this email will be totally sufficient to serve as a letter of support.

best, -alex

From: Leroy Westerling <leroy.westerling@icloud.com>
Sent: Tuesday, October 17, 2023 2:30 PM
To: Christian Fons Rosen <cfons-rosen@ucmerced.edu>
Cc: Alexander Petersen <apetersen3@ucmerced.edu>; LeRoy Westerling <lwesterling@ucmerced.edu>; Tea Lempiala <tlempiala@ucmerced.edu>; Spencer Castro <scastro39@ucmerced.edu>; Jason Lee <jlee287@ucmerced.edu>; Jesus Sandoval Hernandez <jsandoval-hernandez@ucmerced.edu>; Justin Hicks <jhicks2@ucmerced.edu>
Subject: Re: Draft proposal for MIST Major -- soliciting comments and letter of support

Thanks Christian for helping us understand the resource constraints.

Regards

LeRoy

A. LeRoy Westerling

Chair, UC Disaster Resilience Network
Chair and Professor, Management of Complex Systems
Director, Management of Innovation, Sustainability, and Technology
University of California, Merced

leroy.westerling@icloud.com
http://ulmo.ucmerced.edu
+1-209-756-8793

On Oct 17, 2023, at 2:24 PM, Christian Fons Rosen <cfons-rosen@ucmerced.edu> wrote:

Hi Alex,

Let us stay in touch in case there are updates on our side, but I agree that things are not too rosy for our department. Anyway, I guess it is the usual on campus.

Christian

From: Alexander Petersen <apetersen3@ucmerced.edu>
Sent: Tuesday, October 17, 2023 12:52 PM
To: Christian Fons Rosen <cfons-rosen@ucmerced.edu>; LeRoy Westerling <lwesterling@ucmerced.edu>
Cc: Tea Lempiala <tlempiala@ucmerced.edu>; Spencer Castro <scastro39@ucmerced.edu>; Jason Lee <jlee287@ucmerced.edu>; Jesus Sandoval Hernandez <jsandoval-hernandez@ucmerced.edu>; Justin Hicks <jhicks2@ucmerced.edu>
Subject: Re: Draft proposal for MIST Major -- soliciting comments and letter of support

Hi Christian, Jason, Jusus and Justin,

Thank you for your consideration and timely response. Indeed, this paints a dire picture.

Hence, we will remove ECON 010 from the required course list to alleviate the demand - no problem. ECON 006 A/B are only listed as suitable electives, but regardless, we can eliminate them also to reduce implied demand. I will share an updated draft proposal in a week or so when this and other changes have been incorporated.

best, -alex

From: Christian Fons Rosen <cfons-rosen@ucmerced.edu>
Sent: Tuesday, October 17, 2023 11:17 AM
To: Alexander Petersen <apetersen3@ucmerced.edu>; LeRoy Westerling <lwesterling@ucmerced.edu>
Cc: Tea Lempiala <tlempiala@ucmerced.edu>; Spencer Castro <scastro39@ucmerced.edu>; Jason Lee <jlee287@ucmerced.edu>; Jesus Sandoval Hernandez <jsandoval-hernandez@ucmerced.edu>; Justin Hicks <jhicks2@ucmerced.edu>
Subject: Re: Draft proposal for MIST Major -- soliciting comments and letter of support

Hi Alex,

I just had a meeting with our Course Scheduling Team (Jason, Jesus, Justin). There is no problem with the electives except for ECON 006 A/B, because they already have waiting lists.

Similarly, ECON 010 is also at maximum capacity (180 students plus waiting list). For the foreseeable future, due to the high demand for our majors, the limited availability of classrooms and TAs, we cannot increase even further the class size. Several of our own students cannot even join the class during Fall or Spring, and this is why we also started to offer this course in the Summer. Otherwise, our students will have a very hard time to finish in 4 years.

The upside of the Summer Session is that it is online, so that the capacity constraints are gone. If this is an option for students in your major, then that would be a great relief to us.

There are currently many things that are in flux (e.g. Gallo School, new majors within our department, potentially new hires with ACE money) that could potentially improve the situation. But at this juncture, the realistic picture is that even our students are in waiting lists for ECON 010 (as well as ECON 006 A/B).

Happy to talk in person about it with you and the Course Scheduling Team can join if needed. I am sorry to not have better news, but since we lost our (unreplaced) faculty members, things are very tight in our department.

Best,

Christian

From: Alexander Petersen <apetersen3@ucmerced.edu>
Sent: Thursday, October 5, 2023 1:48 PM
To: Christian Fons Rosen <cfons-rosen@ucmerced.edu>; LeRoy Westerling <lwesterling@ucmerced.edu>
Cc: Tea Lempiala <tlempiala@ucmerced.edu>; Spencer Castro <scastro39@ucmerced.edu>
Subject: Draft proposal for MIST Major -- soliciting comments and letter of support

Dear Prof. Fons-Rosen,

As Chair of the Economics Department, please find attached a draft proposal for a new undergraduate major in *Management of Innovation, Sustainability and Technology* terminating in a Bachelors of Arts (BA) to be delivered by the MCS department.

Based upon our identification of the ECON and MBE majors as having similar themes and curriculum, we are soliciting any comments and concerns your department may have regarding the following:

- The relation to those two majors outlined in section 1.7
- ECON/MBE courses that we have identified as candidate required or electives courses:
    - **ECON 010** Statistical Inference **(required course)**
    - **ECON 006 A/B**: Financial Accounting I/II **(Elective)**
    - **ECON 007**: Managerial Accounting **(Elective)**
    - **ECON 110**: Econometrics **(Elective)**
    - **ECON 005**: Introduction to Business and Finance **(Elective)**
- Any new courses that are under development that you may see as appropriate to include as electives
- Other

Depending on your availability, we would be happy to discuss the proposal in more detail, and to even join an ECON faculty meeting if that is the most convenient method to communicate with your department at large.

Once we have had a chance to address any comments/concerns your department raises, we hope to obtain a letter of support from you as chair which we will include in the transmittal of the full proposal.

Best, -alex

Alex Petersen, PhD
Associate Professor
Management of Complex Systems Department
Ernest and Julio Gallo Management Program
School of Engineering
University of California, Merced
Research Website

MIST BA Job Market Information

52.0216- Science/Technology Management

Graduates of Science/Technology Management programs in California are in a market with a high and growing demand, and they are highly paid. Lightcast[1] data shows that there were 148,343 job postings for graduates of Science/Technology Management programs in the 12 months period from July 2022 to June 2023. There were 230,988 jobs for graduates of Science/Technology Management programs in California in 2022, which was 16% above national average. The number of jobs for the graduates have grown rapidly in the last decade (2013-23), registering a growth rate of 86.6% in California. The top three occupations for the graduates[2]—Business Operations Specialists, All Other; Managers, All Other; and Project Management Specialists—all registered over 90% growth, and are indicative of the innovative nature of the graduates' occupations that do not fit in the traditional occupational codes. The number of jobs for graduates of Science/Technology Management programs is projected to grow 12.7% in the next decade in California.

Median annual salary for the graduates of Science/Technology Management programs in 2022 was $104,200 in California. Even at the entry level (as defined as Bureau of Labor Statistics' 10th-percentile national wages), graduates of Science/Technology Management programs earned $98,017.[3] Unemployment rate is not available in national databases at this time.

30.3301—Sustainability Studies

Graduates of Sustainability Studies programs in California are also faring well in the state's job market. Lightcast data shows that there were 106,505 job postings for graduates of Sustainability Studies programs in the 12 months period from July 2022 to June 2023. There were 319,986 jobs for graduates of Sustainability Studies programs in California in 2022, which was 11% above national average. The number of jobs grew in California by 53.1% in the last decade (2013-23), perhaps reflecting the rapid growth of "green jobs." The top three occupations for the graduates were Business Operations Specialists, All Other; Managers, All Other; and Sales Representatives of Services, Except Advertising, insurance, Financial Services, and Travel. The number of jobs is projected to grow 9.1% in the next decade in California.

Median annual salary for the graduates of Sustainability Studies programs in 2022 was $85,400 in California. At the entry level (as defined as Bureau of Labor Statistics' 10th-percentile national wages), graduates of Sustainability Studies programs earned $56,799, which was 72nd-percentile among all academic programs.[4] The high demand for these graduates is also reflected on their low unemployment rate, which was 3% for both graduates under 30 years old and graduates between 30 and 60 years old.[5] In comparison, the national average unemployment rate for all civilian occupations ranged from 3.5% to 5.7%.[6]

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[1] Unless otherwise noted, information in this and next paragraphs was retrieved from *Lightcast™,* last accessed August 3, 2023. Lightcast™ (result of a merger of Burning Glass and EMSI) is a higher education and labor market analytics platform used by UC Merced. Data provided are for California.

[2] Defined as occupations with the largest number of jobs for all graduates of Bachelor's programs.

[3] Data retrieved from GRAY Associates PES+Market, last accessed August 3, 2023.

[4] Data retrieved from GRAY Associates PES+Market, *op.cit*..

[5] GRAY, op.cit.. Data from the National American Community Survey. Data is for 2015-19 in California.

[6] U.S. Bureau of Labor Statistics (BLS) Civilian Unemployment Rate, for the same period (2015-19). Last accessed May 16, 2023.

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MIST BA Data Sheet

Enrollment Projections

According to the program description in the MIST BA proposal, the closest CIP code matches are 52.0216, Science/Technology Management, and 30.3301, Sustainability Studies (definition provided at the end of this data sheet). 52.0216 is a new CIP code that was introduced in 2020. There are only 6 programs in CIP code 52.0216 nationwide that have reported completions. In contrast, there were 35 research universities that reported completions in programs in CIP code 30.3301. However, only two universities had comparable/target undergraduate population to UC Merced's (10/15K), with completions of 9 at one and 26 at the other.

To estimate the size of a program, IRDS uses a proxy measure called the rule of 5. This methodology estimates enrollment by multiplying the number of degrees awarded (i.e., completions) by 5. Applying this rule to the national median completions at universities that offered programs in the 30.3301 CIP code (Sustainability Studies) generates the estimated enrollments of 25 at R2 universities, and 110 at Research (R1 and R2) universities. As for the two 10/15K universities, the estimated enrollment would be 45 and 130. There was one 10/15K university that had completions in a program in the 52.0126 (Science/Technology Management) CIP code in 2021, whose estimated enrollment, using the rule of 5, is 95.

The faculty proposing the MIST program has identified UC Santa Cruz's B.S. in Technology and Information Management, a Baskin School of Engineering (BSoE) program, as a comparable major. In AY 2022-23, this program had 217 students enrolled relative to the BSoE's 4684, i.e., roughly 4.6% of the BSoE population. At UC Merced, the School of Engineering's target enrollment is 3600 students in 2030. 4.6% would equal roughly 166 students. This program's CIP Code is 11.1099, which would encompass a wide variety of programs.[1] For this reason, we did not attempt projections based on this program's CIP code.

IRDS typically provides three enrollment projection scenarios (low, medium, and high). For the MIST BA program, the low scenario is based on the lowest estimated enrollment (25), from R2 universities' Sustainability Studies programs, and the high scenario is based on the highest estimated enrollment (166), based on the enrollment (proportionately adjusted) in the UC Santa Cruz program. For the medium scenario, the middle number between the three estimated enrollments (95, 110, and 130) was chosen, which is the estimated enrollment based on Sustainability Studies program completions at Research Universities. The projection methodologies and projected enrollment in 2031 according to each scenario are shown below in Table 1. For each scenario, projection details are described in pages 5-XX of this document.

Table 1: Enrollment Projection Scenarios

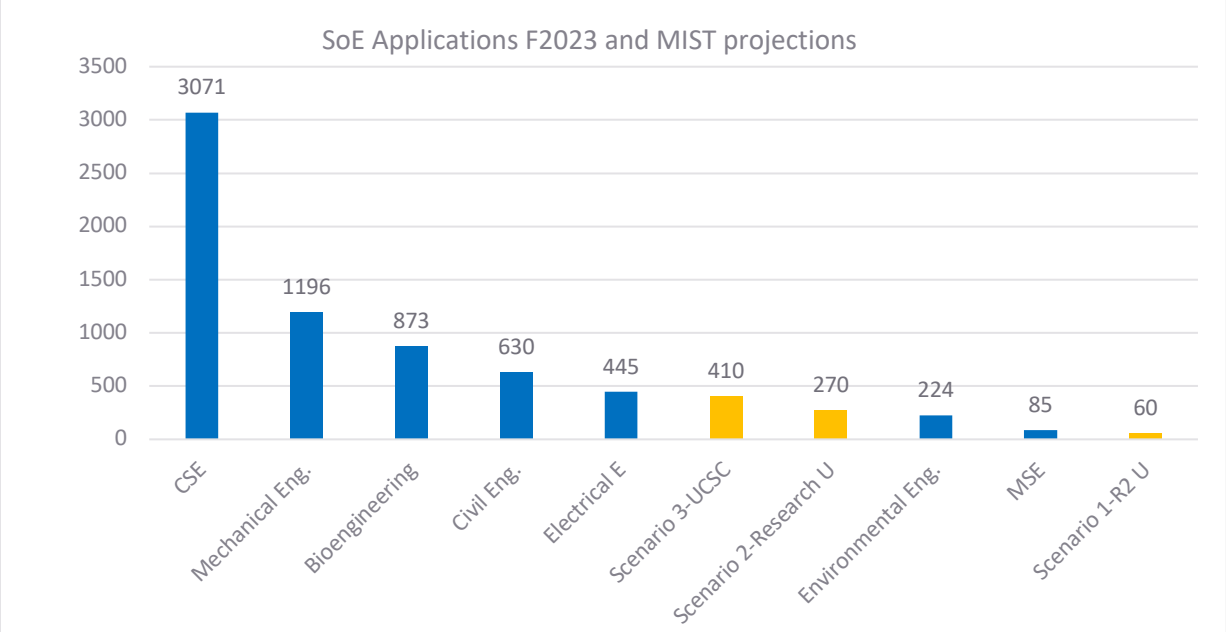
[1] CIP codes ending in 99 are used by programs that do not find a good match among the CIP descriptions for the specific subfields associated with other 6-digit program codes for the subject area.

Projection Methodology	2031 Projection	Detail Table
R2 Universities in CIP 30.3301	25	Scenario 1
Research Universities in CIP 30.3301	110	Scenario 2
UC Santa Cruz (program % of SoE population)	166	Scenario 3

We developed scenarios 1 through 3, using the average admission, SIR, and enrollment rates for fall 2022 and the most recent retention rates of the School of Engineering where the program faculty is currently housed, as well as those of Social Sciences, Humanities and Arts, given that the program's main CIP, 52.0216, is in the Business family of CIP codes traditionally associated with economics. The scenarios employed the projected average annual enrollment growth rate for the UC Merced campus as a whole, which IRDS set at 5% in April 2023 (which might be updated later in 2023).

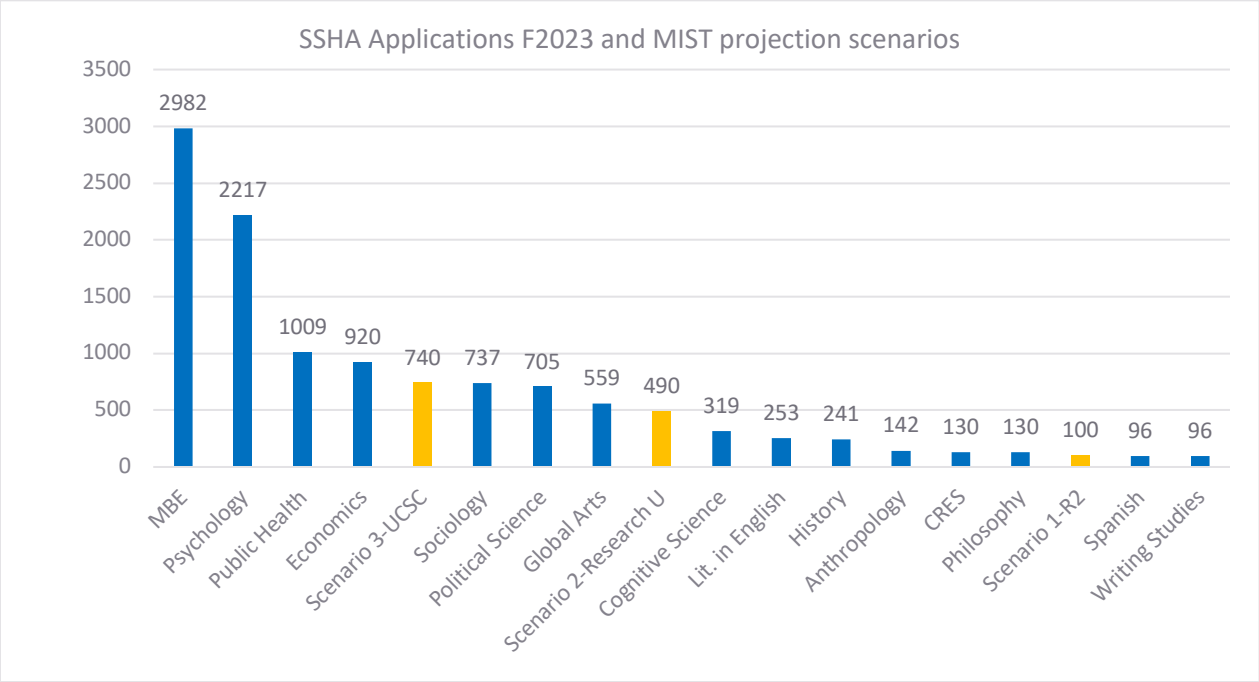
Figures 1 and 2 show Fall 2023 frosh applications for SoE and SSHA majors, respectively, and the number of applications the MIST major would need to generate the first year of the program to reach the projected 2031 enrollment for each of the three scenarios outlined above.

Figure 1: SoE applications in Fall 23 and the 3 enrollment scenarios



- For scenario 1 (25 students in 2031), MIST would need to generate 25 fewer applications than Materials Science and Engineering receives, in the first year of the program's offering.
- For scenario 2 (110 students in 2031), MIST would need to generate 46 more applications than Environmental Engineering.
- For scenario 3 (166 students in 2031), MIST would need to generate 186 more applications than Environmental Engineering, and 35 fewer than Electrical Engineering.

Figure 2: SSHA applications in Fall 23 and the 3 enrollment scenarios



- For scenario 1 (25 students in 2031), MIST would need to generate 4 more applications than Spanish or Writing Studies, and 30 less than Philosophy and Critical Race and Ethnic Studies each received in Fall 2023, in the first year of the program's offering.
- For scenario 2 (110 students in 2031), MIST would need to generate 171 more applications than Cognitive Science did in 2023.
- For scenario 3 (166 students in 2031), MIST would need to generate 3 more applications than Sociology, and 180 fewer than Economics.

Estimates of Demand and Competition

UCM Applicants Who Enrolled Elsewhere in Programs Similar to MIST

One method of estimating student demand is how many of UC Merced's undergraduate applicants enrolled in a similar major at another university. Given that there was no university in California that reported program completions in 2021 under the proposed CIP of 52.0216, and only two California institutions reported completions in 30.3301 programs in 2021, this method is not likely to produce a reliable or valid estimate of demand. The Fall 2022 dashboard shows that two applicants who were admitted but did not enroll at UC Merced went on to major in programs in the Sustainability Studies CIP code.[2] No admitted applicants went on to major in Science/Technology Management; as a reference, 17 went on to major at another institution in Entrepreneurship/Entrepreneurial Studies.

Data Source: Non-Enrolling Applicants Tableau workbook link -

[2] Because not all institutions report the majors of incoming students, the actual number is likely higher than the reported.

https://visualizedata.ucop.edu/#/site/UCMerced/views/NonEnrollingApplicants/Non-EnrollingApplicants

The Referral Pool

A second method for estimating student demand is to look at majors of students in the UC referral pool.

The referral pool is composed of students who apply to other UC campuses (but not UC Merced) during the traditional November application period. Students who are evaluated as UC eligible, but for whom there is inadequate capacity to offer enrollment at other campuses, are given the opportunity to apply to UCM. In effect, the referral pool is comprised of degrees where student demand exceeds the UC system's supply of available seats. The total number of students in the referral pool varies from year to year. In fall 2023, there were 41,539 students in the referral pool. Of those students, 97 had applied to UC Santa Cruz's Technology and Information Management program (up from 48 in 2022), composing 0.2% of the referral pool.

Data Source: Referral Majors Dashboard -
https://visualizedata.ucop.edu/t/UCMerced/views/2023ReferralMajors/Summary
https://visualizedata.ucop.edu/t/UCMerced/views/2023ReferralMajors/SantaCruz

Implications for Overall Undergraduate Enrollment at UC Merced

The proposed program has some overlap in course requirements and may attract students from the recently approved Data Science and Analytics major, as well as Economics, Management and Business Economics (MBE), and Environmental Systems Science. However, given the distinct foci of these majors, the impact is likely to remain small. The proposers also suggest that the program would serve as a degree completion major for students in the other School of Engineering programs. If so, the proposed program may help raise the retention rate for the School of Engineering, contributing to overall increase in the School's enrollment. For reference, 181 of the SoE 2020 cohort left UC Merced, and 67 switched to another UCM school, before entering into their third year of program. Of the 2017 cohort, there were 174 students who left UC Merced, and 87 switched to another UCM school before entering their third year of study.

R2 Universities (Scenario 1)

In order to have 25 students in MIST by 2031, IRDS projections show the program would need to enroll 6 frosh in fall 2025 and 1 transfer students in fall 2027, regardless of whether SoE or SSHA retention rates are used. Tables 3 and 4 show the number of applications UCM would need to generate in order to meet the enrollment target. Table 3 is based on SoE's application-to-enrollment yield rates. Table 4 is based on SSHA's application-to-enrollment yield rates.

Table 3: Projected Application and Yield Rates-SoE

R2- Frosh	Headcount	Yields		R2 - Transfers	Headcount	Yields

Applicants	60			Applicants	10	
Admits	55	91%		Admits	5	52%
SIRS	8	14%		SIRS	1	20%
Enrollment	6	78%		Enrollment	1	60%

Table 4: Projected Application and Yield Rates-SSHA

R2 - Frosh	Headcount	Yields		R2- Transfers	Headcount	Yields
Applicants	100			Applicants	15	
Admits	86	86%		Admits	12	77%
SIRS	8	10%		SIRS	1	11%
Enrollment	6	67%		Enrollment	1	60%

Table 5 shows new student enrollments (frosh and transfer) plus retention rates which were used to project year by year headcount enrollments using SoE retention rates. Because the SSHA projection is very similar, the corresponding table has been omitted (available upon request).

Table 5: Projected 25 MIST Majors by 2031-SoE

		Fall 2025	Fall 2026	Fall 2027	Fall 2028	Fall 2029	Fall 2030	Fall 2031
Frosh Growth Rates			5%	5%	5%	5%	5%	5%
New Frosh		6	6	7	7	7	8	8
Transfer Growth Rates					5%	5%	5%	5%
Transfer				1	1	1	1	1
Frosh Retention								
to Year 2	74%	0	4	5	5	5	5	6
to Year 3	47%		0	3	3	3	3	3
to Year 4	52%			0	3	3	3	4
to Year 5	19%				0	1	1	1
Transfer Retention								
to Year 2	88%			0	1	1	1	1
to Year 3	56%				0	0	1	1
to Year 4	6%					0	0	0
to Year 5	2%						0	0
MIST Projected Enrollments								
		Fall 2025	Fall 2026	Fall 2027	Fall 2028	Fall 2029	Fall 2030	Fall 2031
Total Enrollment		6	11	15	20	22	24	25

Research Universities (Scenario 2)

In order to have 110 students in MIST by 2031, IRDS projections show we would need to enroll 27 frosh in fall 2025 and 4 transfer students in fall 2027 if using SoE retention rates, and 28 frosh in fall 2025 and 4 transfer students in fall 2027 if using SSHA retention rates. Tables 6 and 7 show the number of applications UCM would need to generate in order to meet the enrollment target.

Table 6: Projected Application and Yield Rates-SoE

Research U - Frosh	Headcount	Yields		Research U - Transfers	Headcount	Yields
Applicants	270			Applicants	60	
Admits	246	91%		Admits	31	52%
SIRS	34	14%		SIRS	6	20%
Enrollment	27	78%		Enrollment	4	60%

Table 7: Projected Application and Yield Rates-SSHA

Research U - Frosh	Headcount	Yields		Research U - Transfers	Headcount	Yields
Applicants	490			Applicants	70	
Admits	421	86%		Admits	54	77%
SIRS	41	10%		SIRS	6	11%
Enrollment	28	67%		Enrollment	4	60%

Table 8 shows new student enrollments (frosh and transfer) plus retention rates which were used to project year by year headcount enrollments using SSHA retention rates. Because the SoE projection is very similar (27 frosh vs. 28 frosh in the first year), the table has been omitted (available upon request).

Table 8: Projected 110 MIST Majors by 2031-SSHA

		Fall 2025	Fall 2026	Fall 2027	Fall 2028	Fall 2029	Fall 2030	Fall 2031
Frosh Growth Rates			5%	5%	5%	5%	5%	5%
New Frosh		28	29	31	32	34	36	38
Transfer Growth Rates					5%	5%	5%	5%
Transfer				4	4	4	5	5
Frosh Retention								
to Year 2	70%	0	20	21	22	23	24	25
to Year 3	54%		0	15	16	17	18	18
to Year 4	49%			0	14	14	15	16
to Year 5	7%				0	2	2	2
Transfer Retention								
to Year 2	85%			0	3	4	4	4
to Year 3	33%				0	1	1	1

to Year 4	5%					0	0	1
to Year 5	1%						0	0
MIST Projected Enrollments								
		Fall 2025	Fall 2026	Fall 2027	Fall 2028	Fall 2029	Fall 2030	Fall 2031
Total Enrollment		28	49	71	91	99	104	110

UC Santa Cruz (Scenario 3)

In order to have 166 students in MIST by 2031, IRDS projections show we would need to enroll 41 frosh in fall 2025 and 5 transfer students in fall 2027 if using SoE retention rates, and 42 frosh in fall 2025 and 6 transfer students in fall 2027 if using SSHA retention rates. Tables 6 and 7 show the number of applications UCM would need to generate in order to meet the enrollment target.

Table 9: Projected Application and Yield Rates-SoE

UCSC - Frosh	Headcount	Yields
Applicants	410	
Admits	373	91%
SIRS	52	14%
Enrollment	41	78%

UCSC - Transfer	Headcount	Yields
Applicants	75	
Admits	39	52%
SIRS	8	20%
Enrollment	5	60%

Table 10: Projected Application and Yield Rates-SSHA

UCSC - Frosh	Headcount	Yields
Applicants	740	
Admits	636	86%
SIRS	62	10%
Enrollment	42	67%

UCSC - Transfer	Headcount	Yields
Applicants	110	
Admits	85	77%
SIRS	9	11%
Enrollment	6	60%

Table 11 shows new student enrollments (frosh and transfer) plus retention rates which were used to project year by year headcount enrollments using SoE retention rates. Because the SSHA projection is very similar, the corresponding table has been omitted (available upon request).

Table 11: Projected 166 MIST Majors by 2031-SoE

		Fall 2025	Fall 2026	Fall 2027	Fall 2028	Fall 2029	Fall 2030	Fall 2031
Frosh Growth Rates			5%	5%	5%	5%	5%	5%
New Frosh		41	43	45	47	50	52	55
Transfer Growth Rates					5%	5%	5%	5%
Transfer				5	5	6	6	6
Frosh Retention								

to Year 2	74%	0	30	32	33	35	37	39
to Year 3	47%		0	19	20	21	22	23
to Year 4	52%			0	21	22	24	25
to Year 5	19%				0	8	8	9
Transfer Retention								
to Year 2	88%			0	4	5	5	5
to Year 3	56%				0	3	3	3
to Year 4	6%					0	0	1
to Year 5	2%						0	0
MIST Projected Enrollments								
		Fall 2025	Fall 2026	Fall 2027	Fall 2028	Fall 2029	Fall 2030	Fall 2031
Total Enrollment		41	73	101	132	149	157	166

CIP Codes

52.0216-Science/Technology Management

Definition: A program that prepares individuals to develop science, technical, and business skills required for management of people and systems in technology-based industries, government agencies, and non-profit organizations. Includes instruction in computer applications, general management principles, production and operations management, project management, quality control, safety and health issues, and statistics.

30.3301-Sustainability Studies

Definition: A program that focuses on the concept of sustainability from an interdisciplinary perspective. Includes instruction in sustainable development, environmental policies, ethics, ecology, landscape architecture, city and regional planning, economics, natural resources, sociology, and anthropology.

MIST B.A. Concentrations

* Students can submit a petition to the MIST program committee for the inclusion of 1 course not appearing on each core elective list, subject to committee approval.

** At most one course of the six total electives can be for 3 units

Innovation Management Emphasis [23-24 Units**]

Complete these two MIST Fundamentals courses:

- MIST 050: Intro to Entrepreneurship
- MIST 070: Innovation Management

Complete four of the following courses, either as part of or in addition to core elective requirements*:

- MIST 131: Data Governance for Analytics Projects
- MIST 133: Service Innovation
- MIST 136: Retailing Management
- MIST 137: Managing Teamwork
- MIST 139: Operations Management
- MIST 175: Information Systems for Management
- MIST 150: Service Science
- MIST 120: Parks & Protected Areas
- ECON 005: Introduction to Business and Finance
- ECON 108: Marketing and Consumer Behavior
- MIST 128: Cognitive Engineering
- MIST 135: Technical Communication and Visualization Skills
- PHIL 123: Technology Ethics

Sustainability Management Emphasis [23-24 Units**]

Complete two of the following MIST Fundamentals courses:

- MIST 011: Climate Justice
- MIST 080: Systems Thinking
- ENG/EH 001: Intro. To Environmental Communications
- ENVE 020: Intro. Environmental Science & Technology

Complete four of the following courses, either as part of or in addition to core elective requirements*:

- ECON 005: Introduction to Business and Finance
- ECON 108: Marketing and Consumer Behavior
- MIST 128: Cognitive Engineering
- MIST 135: Technical Communication and Visualization Skills
- PHIL 123: Technology Ethics
- MIST 118: Climate Change: Science & Solutions
- MIST 116: Applied Climatology

- MIST 110: Hydrology & Climate
- MIST 120: Parks & Protected Areas
- ENG/EH 130: Writing to Save the Planet
- MIST 164: Energy Policy

Technology Management Emphasis [23-24 Units**]

Complete two of the following MIST Fundamentals courses:

- MIST 075: Information Systems for Management
- CSE 030: Data Structures
- ENVE 020: Introduction to Environmental Science and Technology

Complete four of the following courses, either as part of or in addition to core elective requirements*:

- ECON 006B: Financial Accounting II
- ECON 007: Managerial Accounting
- CSE 015: Discrete Mathematics
- CSE 100: Algorithm Design & Analysis
- MIST 130: Statistical Data Analysis and Optimization in R for Decision Support
- MIST 132: Geographic Information Systems Analysis in Management
- MIST 134: Methods of Data and Network Science
- MIST 138: Systematic Financial Trading & Analysis
- ENVE 155: Decision Analysis in Management
- ECON 110: Econometrics
- ENGR 155: Engineering Economic Analysis
- COGS 104: Complex Adaptive Systems
- One of the following 5 courses can be counted if the student is transferring from a UCM engineering program
    - CSE 022: Introduction to Programming
    - MSE 021: Engineering Computing
    - EE 021: Introduction to Electrical Engineering Programming
    - BIOE 021: Introduction to Computing with Python
    - ENGR 057: Statics and Dynamics
- ECON 005: Introduction to Business and Finance
- MIST 131: Data Governance for Analytics Projects
- MIST 133: Service Innovation
- MIST 136: Retailing Management
- MIST 137: Managing Teamwork
- MIST 139: Operations Management
- MIST 175: Information Systems for Management
- MIST 150: Service Science
- MIST 120: Parks & Protected Areas