**UMS Program Innovation Fund**

**Proposal Narrative**

**Executive Summary**

We propose to design and implement a four-course Sustainability Module (S-Mod) that integrates a sustainability perspective and practices into any major. The skeleton of the module consists of:

“Sustainability Essentials[[1]](#footnote-1)” (new course). The team-taught introductory course lays the foundation for the module, provides a wide (multidisciplinary) and deep (interdisciplinary) overview, and promotes creative thinking about solutions. Each student designs an individual plan for subsequent courses to achieve personal goals consistent with a sustainability outlook.

Tools for Sustainability. A pair of courses emphasizes the diverse, multidisciplinary approach needed to achieve sustainability. These “how to” classes provide students with disciplinary tools—best practices—relevant to tackling sustainability challenges. Optimally, one course develops a technical skill (e.g., statistical analysis of data, spreadsheets, box models), the other course a liberal arts skill (e.g., effective oral and written presentation, collaboration).

Projects in Sustainability. A project-based course employs interdisciplinary teams of students to tackle real world issues by combining their disciplinary expertise. This is the “doing” class, think tank approach where students collaborate to complete real world projects while developing their people skills such as group dynamics, conflict resolution, and leadership.

The unique blend of technical and liberal arts skills will prepare students for a variety of career pathways in a future world ripe with rapid change and uncertainty. Inter-campus collaboration, during the pilot stage between UMF and UM, provides a model for capitalizing on expertise in the UMS and to seed additional collaborations. By providing opportunities for students to pursue their interests, to develop skills highly pertinent to their future employment, and to satisfy an ethical desire to contribute to the overall health of the coupled human-earth system, we expect the module to bolster enrollment through both retention and its broad appeal.

“They paved paradise and put up a parking lot…”

—Joni Mitchell (1970)

“Climate change is the millennial generation’s top concern for the third year in a row.”

—Loudenback and Jackson (Business Insider, 2018/2/26)

**1. Preamble**

The systems paradigm, successfully applied in ecology and across the full spectrum of disciplines, recognizes that relationships among components of a system are paramount. Humanity is inseparable from its matrix, the Earth system, and the trajectory of the coupled human-Earth system has become the central issue of the 21st century. The sustainability ethic refers to the Golden Rule in time—“Rob not your grand kids.” Humanity has recently become a quantifiable planetary force to the extent that a new geologic time period has been proposed, the Anthropocene. Rapid rates of change, primarily powered by fossil fuel, have created a coupled human-planetary crisis that is, while variably perceived, decidedly unprecedented in magnitude. The aim of sustainability efforts is to adapt appropriately and creatively in order to maintain a healthy state of the coupled system.

Humanity has over time diversified to an extraordinary extent, not only adapting to the wide range of habitats on the planet but also birthing such a host of distinct cultural niches that communication barriers sometimes obscure the unity of the whole system. In academia, scholarship in the time of da Vinci or Goethe was free to wander from science to art, from mathematics to politics. The challenge of our time, to maintain health of the coupled human-earth system, is hyper complex, and begs for expertise from across the disciplines. Natural and social scientists can recognize problems, technical and social engineers can propose solutions, and political/educational/religious/business leaders at international through local level can implement changes to avert the dire consequences of “business as usual.”

**2. Program description, background, and rationale**

In the context provided above, we propose a strategy that is simple in design yet far-reaching in its impact. Currently, no mechanism exists to ensure that UMS graduates acquire the mindset, knowledge, and skills needed to understand dynamical systems and to effect sustainable behaviors. Our proposed strategy consists of a 4-course sequence that includes a “super foundation,” two mid-level courses to acquire a relevant liberal arts skill and technical skill, and project-based capstone experience with opportunity to demonstrate concrete application.

*Humans-Earth: A dynamical system*

“System” simply refers to any portion of the universe in which the parts interact. “Dynamical” emphasizes the temporal behavior ranging from steady states maintained by powerful stabilizing feedbacks to viral/exploding behavior driven by positive feedback (Kleidon, 2016). Dynamical systems theory originated in the fields of physics and mathematics. Generally speaking, dynamical systems theory attempts to describe the flow of relationships among the components of some whole phenomenon (e.g., the solar system, social unit, economic system). The Earth system comprises the solid Earth, hydrosphere, atmosphere, and biosphere, including humanity (anthroposphere). Recent political events suggest that it would be prudent to include as well the “noösphere” or sphere of the mind (e.g., Vernadsky, 1945). A good example of the practical application of systems theory is the U.S. Constitution including its numerous and deliberate “checks and balances” to ensure the welfare of the American people. Mathematically, a dynamical system consists of a set of variables that describe its state and a law that describes the evolution of the state variables with time. The state of the system in the next moment of time depends on the input and its state in the previous moment of time.

*Fundamental interdisciplinary nature of the initiative*

The nature and magnitude of the coupled human-planetary crisis begs an interdisciplinary approach like no other. Potential strategies cross the spectrum of human endeavors, e.g., from nuclear-powered carbon sequestration proposals to empowering women in third world countries. Of note, the initiative builds on current and prior efforts that include a semester-long, campus-wide forum at UMF during spring 2013 “State of the Planet, Intergenerational Justice, and Our Collective Future” and proposal for Interdisciplinary General Education reform entitled “Healthy Systems: Mind-Body-Community-Planet.”

### *Rationale and overarching goal.*

### Whereas the political community is divided, there is strong consensus in the scientific community that a planetary crisis is, if not here already, in the making. Of necessity, a very different and novel workforce will replace the traditional one that is rooted in fossil fuel extraction. Technical solutions are relatively easy to imagine, while socio-political-economic-psychological obstacles continue to be monumental. The planetary crisis cannot be addressed without simultaneously addressing the human crisis (i.e., poverty, violence, social injustice; Langmuir and Broecker, 2012), hence the socio-economic and physical systems are intricately linked/coupled.

 *In this context of the 21st century state of the coupled human-earth system, the overarching GOAL of the S-Mod initiative is for our students to graduate with the ability to solve a wide range of dynamic real world problems in real time, contributing to the overall health of the coupled system.*

**3. Enrollment demand and projections**

We anticipate that, if cleverly framed and advertised, the S-Mod initiative will appeal strongly to both high school students and enrolled undergraduates, who would like to merge their interests, their need for future job security, and their ethical desire to contribute to building a healthier human-Earth system

The Princeton Review reports “that 69% of college applicants say having information about a college’s commitment to environmental issues would contribute to their decision to apply to or attend the school.” In a USA Today article, “College students are flocking to sustainability degrees, careers,” David Soto of the Princton Review states: “Students are really savvy shoppers these days, so they’re realizing, with a changing economy and green jobs looking to take a leap within the next couple of years, that they want to be armed with those types of skills.”

According to the [Association of American Colleges and Universities](https://www.aacu.org/press/press-releases/employers-more-interested-critical-thinking-and-problem-solving-college-major%22%20%5Ct%20%22_blank), 93 percent of employers value critical thinking, clear communication, and complex problem solving skills more than an undergraduate’s major. The S-Mod initiative is data driven and forward thinking, aimed at tackling an anticipated future plethora of challenges that Maine and the world will face. The skill set focus is on hard and soft skills that match documented employer needs. It is premature to envision the precise characteristics of the workforce that will be needed in the future, but the menu of skills, knowledge, and attitudes hinted at in this proposal will assuredly be key in preparing our students to address these new challenges. In addition, the initiative will constantly seek to incorporate “in demand” skills as they arise in real time.

**4. Curriculum overview**

The program as currently envisioned was inspired by several other efforts, including UM’s Institute for Quaternary Studies, PSU’s Earth System initiative, and Colby College’s COMP-X option. In particular, the Colby computer science faculty has reached out to serve students in a variety of disciplines. The intended learning outcomes of our initiative include a minimum of one technical skill and one liberal arts skill that are combined in a project experience during which students demonstrate an understanding of how to effect sustainability in the real world.

The current initiative capitalizes on existing institutional assets. Specifically, it builds synergistically on a variety of existing programs and courses, taking care to support current efforts with a similar and/or overlapping agenda while avoiding counter-productive competition.

*Intended student outcomes*

What are the skills/knowledge/attitudes that we think will be of value to our graduates upon entering the workplace? Broadly, they can be divided into those traditionally associated with the liberal arts (e.g., critical thinking, interdisciplinary teamwork, traditional communication skills) and technical education (e.g., writing code, communicating on social media platforms, “hacking mindset”). More specifically, we see students needing a combination of soft and hard skills. Soft skills, such as working collaboratively in an interdisciplinary environment, running focus groups and other leadership skills will prepare students for the fast paced and ever changing work environment. The hard skills, including coding, data analysis and geographical information systems (GIS) provide students with transportable in-demand skills to power the modern "gig" economy. In summary, the initiative will merge liberal arts (i.e., educate broadly, think critically, develop passion for lifelong learning) and technical education (i.e., educate deeply with a core of “in-demand” skills).

*Specific plans*

The majority of requested funds will be devoted to the design and implementation of pilot foundation courses, Sustainability Essentials at UMF (Table 1) and Life on Earth at UM. An exciting possibility that we intend to explore is an inter-campus forum in which students at one campus participate either synchronously (e.g., Winter term 2018-2019) or asynchronously (student products resulting from “Life on Earth” during Winter term are shared with UMF students in “Sustainability Essentials” during a following semester and vice versa).

For the present, students may select from a diverse menu of courses to satisfy the “Sustainability Tools” and “Projects in Sustainability” requirements (Table 2). A principle student outcome of the entry-level course is a self-designed, customized plan for subsequent courses initiated by the individual student with faculty advice.

*Entry-level super foundation course.* Delivery of “Sustainability Essentials” will be approximately in the spirit of TED talks. The idea is to pull just the relevant material from the diverse disciplines represented on campus (Table 1). Following a 40-student pilot stage, and demonstration of widespread appeal, we will need to plan in subsequent years for large enrollment (Lincoln Auditorium). The principal student outcome at this level is to propose a rationale for subsequent courses in a discipline that is meaningful to the individual.

*Skill development.* The intermediate-level course(s) would in most cases be chosen from a student’s major (double counting would be fine), and the objective is to acquire a disciplinary skill that contributes to the overarching goal of maintaining a healthy human-earth system. Optimally, the student will effectively combine a “technical” skill, e.g., data acquisition and analysis, with a “liberal arts” skill, e.g., effective verbal communication.

*Capstone.* The third requirement is a project-based capstone in which the student applies their “skill” within the context of the “human-earth system” foundation/umbrella. Environmental ethics is introduced during stage 1, and stage 3 affords the opportunity to practice/walk/implement the “talk.” Students choose from existing project-based capstone courses and/or design an independent study approved by the coordinator.

Table 1. Tentative design of entry-level super foundation course (INT 100 Sustainability Essentials).

|  |  |  |
| --- | --- | --- |
| Week | Contributor | Contribution |
| 1 | Humanities-history | Reality of the human-earth system and historical roots of present crisis |
| 2-3 | Physics | Energy’s fundamental role: climate system through human activity |
| 4-5 | Geology-chemistry | Cycling of carbon and other vital materials |
| 6-7 | Biology-ecology | Population ecology, adaptation, natural selection |
| 8-9 | Geography-economics-business | Ecology of human economic systems |
| 10-11 | Political science-geography | The flow of political power; making democracy work |
| 12-13 | Sociology-psychology | Understanding versus action/implementation |
| 14 | Humanities-philosophy | An ethical umbrella and mandate |

**UMF’s Sustainability Pathway**

UMF faculty members have recently submitted a Sustainability Pathway proposal, coordinated by Dr. Harper, to the UMF General Education Committee for approval. The proposal borrows from a successful pathway developed by Santa Clara University faculty. “Sustainability is most often defined as meeting our present needs without compromising the ability of future generations to meet their needs. The recognition that sustainability is an imperative that must be met stems from the fact that humans are using the earth’s resources and degrading its ecosystems in ways that compromise the health and well-being of future generations and the planet. The sustainability pathway will allow students to learn about sustainability from multiple disciplinary perspectives and in interdisciplinary ways. This will help our students integrate the interconnected ideals of viable ecological integrity, viable economies, and equity and justice. Several critical sustainability themes that will be embedded in the curriculum of Sustainability Pathway classes include Human Connections to the Physical and Natural World; How Natural Systems Function; Ethics and Values; Technological and Economic Relationships to Encourage Sustainability; Motivating Environmentally Sustainable Behavior; and Critical Engagement with Sustainability Issues.”

There is no point in re-inventing the wheel. As well, the many existing courses at UMF that include a significant sustainability component will constitute the “above ankle” portion of the skeleton of the 4-course module (Table 2).

Table 2. Existing UMF courses with significant sustainability content.

ANT 235S Culture of Capitalism

ANT 240S Cultural Ecology

ANT/GEO 265S Climate Change and Society

ANT 300 Food and Culture

BIO 110N Ecology and Environment (Barton)

BIO 110N Global Change Ecology (Hovel)

BIO 294 Forest Ecology and Conservation

ECO 228 Environmental and Natural Resource Economics

ENG 362 American Environmental Writing

ENV 110N Introductory Environmental Science

ENV 111 Practicing Sustainability

ENV 257 Soil Science

ENV 353 Conservation Biology

ENV 361 Ecology

ENV 383 Aquatic Ecology

EPP/GEO 131S Conservation and the Environment

EPP/GEO 231S Environmental Issues

EPP/GEO 235 Physical Geography

EPP/GEO 304 Environmental GIS

EPP/GEO 310 Sustainable Development

EPP/GEO 320 Environment, Economy, Society

EPP/GEO 331 Nature and Society

EPP/GEO 340 Sustainable Land Use

GEO 337 Environmental Regulations

GEY 101N Environmental Geoscience

GEY 104N How to Build a Habitable Planet

GEY 203 Surficial Processes

GEY 303 Climate Change

GEY 304 Geochemistry

HEA 210 Environmental Health

HEA 245 Nutrition and Ecological Concerns

INS 100S Introduction to international and global studies

PHI 111H Environmental Philosophy

PHI 240 Consciousness and Reality

PHY 116 Energy, Physics  and the Environment (Stancioff)

POS 220 Environmental Politics

POS 227S African Politics

POS 322 European Union (Erb)

POS 336 Globalization

**5. Faculty roles and collaborations**

Faculty who have committed to a specific role in the planning, design, and implementation of the program are listed on the application form. Initially, we envisioned piloting the foundation course during spring semester 2019 but are considering the feasibility of Winter Term 2018-19 and either May term or June term 2019.

As a concrete example of inter-campus collaboration, Dr. Kreutz (UM) will deliver a summary of his climate change research on ice cores. We will likely experiment with a distance (versus on-site) presentation format.

Drs. Maasch (UM) and Reusch (UMF) will customize a tutorial on dynamical systems that is appropriate for an entry-level course and that demonstrates the wide applicability of this approach across multiple disciplines (e.g., Strogatz, 1988). They will build on “Earth Systems Thinking: An InTeGrate Module That Can Be Used in Any Course” by Kreutz et al. (2015). From their abstract, “Students prepare to address complex systems issues for a sustainable future by 1) identifying the parts of a system and explaining how the parts interact, 2) developing skills to model complex systems using data and examples relevant to the course, and 3) applying a systems approach to evaluate a societal challenge.”

As mentioned previously, we will experiment with inter-campus exchanges, either synchronous or asynchronous, among students in “Life on Earth” (UM) and “Sustainability Essentials” (UMF).

Other contributions include the important role of the humanities, both historically and in the present (Dr. Case, UMF Humanities), quantitative problem sets (Dr. Hardy, UMF Mathematics), and graphics for advertising/promoting the program (Dr. Nye, Visual and Performing Arts).

**6. Program assessment**

Central in the systems paradigm is feedback. Environmental monitoring, for example, is clearly of paramount importance. Perhaps the most stunning, iconic, and motivating metric that assesses net human activity is the concentration of atmospheric carbon dioxide. It begs for a response and provides the rationale for moving from carbon-based to clean energy sources.

As for program assessment, Dr. Gerbi (UM) has significant experience with curricular assessment, and during the pilot stage UMF faculty will use similar tools to assess both the “Life on Earth” and “Sustainability Essentials” entry-level courses. At UMF, we plan to seek advice from Dr. Montgomery, the newly appointed Director of UMF’s Teaching and Learning Collaborative. A more substantive plan for program assessment, taking into account recent developments (e.g., Worthen, 2018), will be an outcome of summer meetings.

**References Cited**

Incropera, F.P., Climate Change: A Wicked Problem (Complexity and Uncertainty at the Intersection of Science, Economics, Politics, and Human Behavior). Cambridge University Press, 337 p.

Kleidon, A., 2016. Thermodynamic Foundations of the Earth System. Cambridge University Press, 396 p.

Langmuir, C. and Broecker, W., 2012. How to Build a Habitable Planet: The Story of Earth from the Big Bang to Humankind. Princeton University Press, 718 p.

MacKay, D.J.C., 20xx. Sustainable Energy Without the Hot Air.

Strogatz, S., 1988. Love affairs and differential equations. Mathematics Magazine, vol. 61, p. 35.

Vernadsky, V.L., 1945. The biosphere and the noösphere. American Scientist, vol. 33, p. 1-12.

Worthen, M., 2018. “The Misguided Drive to Measure Learning Outcomes.” New York Times, 2/23 (https://nyti.ms/2sRSoam).

**7a. Budget for pilot activities**

|  |  |  |
| --- | --- | --- |
| Dates | Description | Amount ($) |
| June 2018 | Faculty compensation for design and planning | 15,000 |
| Fall 2018 | Advertising/marketing | 2,000 |
| Spring 2019 | Pilot courses  | 15,000 |
|  | Release time for coordinator | 5,000 |
|  | Materials and supplies | 3,000 |
|  | TOTAL | $40,000 |

**7b. Anticipated budget for full implementation**

Full implementation will largely be funded by tuition, as no new personnel are needed. A ~1-2-week commitment by each faculty member constitutes a small overload, but this would be compensated for by tuition generated by the foundation course.

In addition, an unspecified amount is suggested for an annual end-of-year conference (analogous to the Spring Meeting of the Climate Change Institute and/or UMF Symposium Day).

Table 3. Venues for end-of-year conferences

2019 UMF, 2020 UM, 2021 UMA, 2022 UMS

1. “Sustainability Essentials” to be piloted at UMF collaboratively (~co-taught) with “Living on Earth” to be piloted at UM. [↑](#footnote-ref-1)