

**JOINT MASTER OF SCIENCE IN ENVIRONMENT AND RESOURCES
CAPSTONE PROJECT GUIDELINES
ACADEMIC YEAR 2020-2021**

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1. OVERVIEW

1A. INTENT OF THE CAPSTONE PROJECT REQUIREMENT

The E-IPER Joint MS Capstone Project is an opportunity for students to make an impact: addressing a real-world environmental problem by integrating their E-IPER science and technology coursework with skills gained from their professional schools in an original, interdisciplinary project. The Capstone Project culminates in a final product of professional quality and a presentation to the E-IPER community.

1B. SCOPE AND FINAL PRODUCTS

The Capstone Project allows greater flexibility in topic, process, and presentation than a traditional master's thesis. Students may develop their own Projects individually or as a group, or work with a faculty member or PhD student to design a Project of mutual interest (see suggestions for generating project ideas below). The Capstone teaching team is available to help formulate and solidify Project ideas. Each Project will culminate in a final product such as a report or research paper of publishable quality, a business plan or proposal, a comprehensive analysis and recommendations for an off-campus client, a new economic model or computer program, etc. Students will present their work and final products to the E-IPER community at the Capstone Symposium.

Students create their own original Project. Examples include:

- Further develop a project initiated in a prior or concurrent project-based course (taken while enrolled in the Joint MS degree program)
- Collaborate with an off-campus client on a current environmentally-relevant problem (e.g., by expanding on a summer internship)
- Collaborate with a business or an entrepreneur to develop a business plan for a new venture
- Collaborate with a Stanford faculty member or E-IPER PhD student on a relevant research project

2. PROJECT PLANNING AND PROPOSAL

2A. REQUIREMENTS

Each student or group of students must submit a Capstone Project Proposal for approval. This ensures that each Project and proposed final product is of the appropriate scope to fulfill the Capstone Project requirements and that the Project plan and timeline are reasonable. **Students are strongly encouraged to discuss their project ideas with an instructor prior to enrolling in ENVRES 290.** The Capstone teaching team reviews draft proposals, and may refer proposals to other faculty members for review. Students may be required to submit revisions before a Proposal is approved. See Section 2E for a description of the approval process.

If a student or group plans to expand on a pre-existing project initiated in another course taken while enrolled in the Joint MS degree, they should submit the course syllabus and the work they already conducted in that course as an appendix to their Project Proposal. If a student or group plans to expand a project done through Independent Study, they should submit the Independent Study Agreement and final deliverables as an appendix to their Project Proposal.

Weekly course attendance and updates are required to ensure that students stay on track for timely completion of their Projects. Adjustments to the Project's scope and timeline may be

made as warranted (if, for example, students run into a logistical hurdle that requires a deviation from their proposed plan).

The final product should be of high quality, demonstrating scientific and technical knowledge and advanced analytical skills. The format of the final product will depend on the Project and must be pre-approved in the proposal process. Projects will be presented to the E-IPER community in a Capstone Symposium to be held at the end of the quarter in which students complete their Projects.

2B. GROUP PROJECTS

Students are encouraged to work in a group of up to three students, but may choose to work on their Projects individually. When forming a group, students should evaluate the unique strengths and skills that each participating student brings to the Project, what their specific responsibilities will be, and why working in that particular group is necessary for the success of the Project. These roles and responsibilities should be clearly described in the Project Proposal. The Project scope should be reflective of the group size (i.e., groups of three should produce a finished product approximately three times as ambitious in scope and comprehensiveness as those produced by individual students).

For example, if the Project involves working with a solar energy start-up company to develop a business plan, an appropriate group may consist of a student with interest or experience working with start-ups, a student with technical knowledge of the solar industry, and a student with experience in the regulatory environment as it relates to the approval process for new solar energy plants. Each student in the group must have a distinct and essential role in the Project so that their contributions can be clearly identified and articulated.

Team efforts are wholeheartedly encouraged, but sometimes team dynamics can be tricky, and team members may not do their share of the workload. Please proactively seek out the Capstone instruction team if this becomes an issue. Such concerns can understandably be uncomfortable to disclose. To help ensure an equitable distribution of work, a clear account of who did which portions of the Project must be submitted with the final product. A short, private online survey for members of Team Projects will also ask questions about group dynamics and participation at different milestones, that will help facilitate sharing of any extenuating circumstances.

2C. PROJECT ADVISING

Students are required to seek out faculty, E-IPER PhD students, and technical experts within the Stanford community to provide input and guidance for their Projects. Students may recruit a Project Advisor with technical expertise from a relevant project-based course they have taken, or elsewhere in the University. Students working with off-campus clients should seek advising/supervision from a Stanford faculty member, in addition to the clients' institutions. It is recommended that students arrange at least 3 meetings with their advisor per quarter. Because advisors often have a high rate of unforeseen scheduling conflicts, aim to get 4 meeting times scheduled early in the quarter, with the assumption that one will fall through or can be cancelled if unneeded.

Students should discuss their initial Project ideas with a Capstone instructor and with a selected Faculty advisor before the class starts. A project advisor must be secured by Week 1. The Capstone instruction team will: provide feedback on and approve students' proposals; review

and provide comments on interim drafts and reports, grade final written products and presentations, and provide general Project advice and oversight.

2D. PROPOSAL FORMAT

The Capstone Project Proposal should fully describe the Project, its goals, methods, and anticipated outcomes using the format outlined below. Proposals should not exceed six single-spaced pages, including the executive summary, figures, tables, references, and budget. The use of tables, figures, and/or outlines is encouraged as long as the proposal is understandable to a non-expert reader.

The proposal should contain the following sections:

Title

Team Member(s) and Degree(s) (i.e., MS-MBA, MS-JD, etc.)

Advisor(s)

Clients/Other Collaborators and Affiliations (if applicable)

Executive Summary (1-2 paragraphs) – Provide a summary of the Project. Include the significance of the Project, how scientific and technical knowledge will be integrated with your professional school training, and how that knowledge will be used in the Project to make an impact.

Project Description and Impact – Describe the problem to be addressed and the need for the Project. State the Project goals, expected outcomes, and potential impact. Discuss how science and technical knowledge will be incorporated and used in the Project, and how this will be integrated with professional school skills.

Include in your description responses to the following questions:

- What is the fundamental problem that provides the central motivation for the Project?
- What new and previously unavailable information will this Project generate?
- What barriers or challenges will have to be overcome to successfully complete this Project?
- Has some work already been done by the student(s) or other parties?
- Will this Project build on previous internship or course work? If yes, describe in detail how you will substantively expand that work for your Capstone Project.

Approach – Discuss in detail the approach you will take to complete the Project. Provide a clear description of methodology and a discussion of why a particular approach will be used. Please use accepted methods relevant to your work (e.g., conducting research, analyzing qualitative or quantitative data, conducting interviews, generating models or running simulations, etc.), and be specific about implementation (e.g., not just that you will perform statistical analyses, but which analyses will be carried out and why).

Deliverables – Describe the final product that will result from the Project and any interim products that will be generated. The product format will depend on the Project, but potential products could include an article for publication, a report, a business plan, a model, a prototype,

etc. Interim products could include datasets, reports, protocols, etc. Describe the recipient(s) (other than the E-IPER community) of the interim and final products.

If working with proprietary information, describe what arrangements are in place, and specify what will be presented to the E-IPER community and what will be presented only to the client. Note that the final products and presentations will be open to the E-IPER community, so be sure that your project can stand on its own independent of such proprietary information, and ensure that the critical science, engineering, and technology evaluation will be available for public presentation.

One of your interim products will be chosen by you, and approved by the Capstone teaching team through the proposal submission, after the proposal submission as a formal interim milestone. This part of the project will be due by Week 7. The nature of the milestone is flexible depending on project details and timeline; if you have ideas on which of your interim products should fulfill this requirement, note them in your Project Proposal.

Team – Briefly describe the relevant expertise of the Project Advisor, client/research leader, and other relevant stakeholders. If working in a group, describe what each participating student brings to the Project, his/her specific responsibilities, and why working as a group is necessary for the success of the Project.

Preparation – Discuss the skills required for completion of the Project. Do the student(s) already possess these skills, or will the Project require training and/or learning new skills? If training is required, describe where/how this will be obtained within the Project timeframe. Include a description of classes, previous coursework, and work experience that is supportive of the Project scope.

Timeline – Provide an outline of your Project completion plan with milestones along the way, including a meeting schedule with your Project Advisor and when you will submit interim Project updates, draft products and final products. For group Projects, indicate specific responsibilities and deadlines for individual group members. Explain any time constraints or deadlines (outside of those for ENVRES 290) that must be met. Be as detailed as possible, with the understanding that the timeline may change as the Project progresses. Where possible, try to foresee potential bottlenecks (e.g., relying on deliverables from external partners) and work these hurdles into your timeline projections.

Annotated Budget and Resource List – Include a table listing the resources required to successfully complete the Project, how and where those resources can be obtained, and what funding may be requested. Required resources could include transportation to a client, specialized software or equipment, or designated meetings with a particular person. If financial resources are needed for the Project, describe those and also identify potential funding sources (see 2F below for information on E-IPER Capstone Project funding).

References – List relevant references and the individuals consulted in the preparation of the Project Proposal. Please note that final products must include an annotated bibliography (an example will be provided) and should include primary research sources.

2E. PROPOSAL APPROVAL PROCESS

Proposals must be uploaded to the course Google site by the stated deadline in the Syllabus. Proposals will be reviewed by the Capstone instruction team and comments provided to

students as quickly as possible. The instructors may request a revised Project Proposal if substantial revisions are necessary before the Project can be approved.

2F. FUNDING

E-IPER maintains a fund to which Joint MS students may apply for small grants to support their Capstone Projects. Students may request up to \$500 per Project; approved Project expenditures are available on a reimbursement basis.

The fund can support expenses directly relevant to the Capstone Project, such as:

- Software, equipment, and supplies;
- Limited (local) travel expenses directly related to a Capstone Project; or
- Publication-related expenses for papers resulting from Capstone Projects.

Requests should be submitted using the Capstone Funding Request form via e-mail to the Instructors. The request should include a detailed budget with a description of each expense and its purpose. Requests will be evaluated by E-IPER staff and relevant faculty members as necessary.

3. COURSE CREDITS AND PROJECT TIMELINE

3A. COURSE CREDITS

Students must enroll in ENVRES 290 *Capstone Project Seminar in Environment and Resources* during the quarter in which they are working on their Projects. ENVRES 290 is a 3-unit one quarter course. The Project Scope should be reflective of 3 units of work as per Stanford policy: <https://studentaffairs.stanford.edu/registrar/faculty/unit-of-credit>

ENVRES 290 *Capstone Project Seminar in Environment and Resources* functions as a facilitated independent study course, providing students with structure and guidance to initiate, complete, and publicly present their required Capstone Projects. The course is required for all students pursuing the E-IPER Joint MS degree. There will be designated meeting times of approximately 2 hours each week. The time slot will be used for class meetings, presentation practice, for consultations with the teaching team, and to make progress toward Project goals.

3B. MULTIPLE QUARTER CAPSTONE PROJECTS

Student may elect to extend their Capstone Project over two quarters for greater depth of experience and/or more time to complete a project. Interested students may enroll in a 1 or 2 units of independent study (such as ENVRES 399) with their selected faculty advisor in the quarter *prior* to their Capstone (i.e., ENVRES 399 in Autumn Quarter, ENVRES 290 in Winter Quarter). Students must complete the following requirements during this independent study:

- Draft project proposal
- Draft annotated bibliography
- Project completion plan, specifying progress to be made during that quarter, including timeline and milestones
- Interim deliverables outlined in project proposal

Students must gain approval for the Independent Study scope and approach from the Joint MS Program Manager in adherence with the E-IPER Joint MS Independent Study requirements.

The project should be completed in the quarter the student presents in the Capstone Symposium.

4. DELIVERABLES

4A. ASSIGNMENTS

Students must complete the following assignments outside of their final deliverables:

- Draft & final project proposals
- Draft annotated bibliography - include key sources and references, with a brief explanation of the source and how it supports the student's work
- Interim project updates including literature reviews, raw data, preliminary results or analysis and a discussion of challenges and next steps
- Storyboarding resource assignment
- Interim milestone, defined in conversation with Capstone teaching team
- Draft presentation

4B. FINAL PRODUCT

Each Capstone Project will result in a final product and presentation of professional quality. Final products may take the form of a report, a paper for publication, a business plan, a policy brief, a series of recommendations to a client, multi-media project, etc. The format of the final product should match what was approved in the Project Proposal and should be comprehensible *on its own* to a non-expert reviewer. Not all final products will themselves be written reports; however, it is expected that all projects will be accompanied by a written statement describing how they fulfill the criteria listed below. All final products must also include an annotated bibliography that provides a critical analysis of the reference sources consulted for the Project. Annotated bibliographies will be discussed in ENVRES 290.

The final product and presentation should meet high professional standards based on five main criteria described below. Students will receive a grading rubric at the beginning of the quarter outlining what constitutes acceptable and exceptional levels of success in meeting these criteria.

Potential impact: Is the student solving a problem identified as important by an industry, specific population of people, or society as a whole? Does the project build on previous contributions in this area (no matter how big or small)? Does the student effectively describe the potential impact of the project to the intended/target audience?

Integration: Has the student demonstrated that they have effectively examined and/or applied scientific, technical, or engineering knowledge to an environmental or resource issue or problem? Does the project use skills from the student's professional school? Has the student effectively integrated content and ideas from both the E-IPER coursework as well as his/her professional school experience?

Quality: Do the presentation and written product demonstrate a high level of quality and rigor? Were methods for research, data collection, analysis, and interpretation appropriate and of sufficient depth to address the unique environmental and resource problems the project is meant to impact? Were the stated methods executed with high quality and integrity?

Implementation strategy: Does the student describe a well-constructed and realistic method of implementing the Project? Do the proposed steps to implement the Project findings and outcome (e.g., start-up, presentation to outside audience, grant funding, policy white paper, academic publication) make sense and provide an innovative way forward?

Clarity: Do the presentation and written product communicate the student's ideas effectively to a wide audience? Do the presentation and written product communicate clear, logical points that are connected by cohesive transitions that help the reader understand the progression of ideas? Can someone with little background related to the project pick up the final product and understand the premise, methods, and results of your work?

4C. FINAL PRESENTATION

All students must give a formal presentation of their Capstone Projects during the Capstone Symposium. The presentation should clearly reflect the body of their Capstone work, including demonstrating the potential impact of the Project and the successful integration of professional school and technical/scientific concepts to solve environmental problems. For group Projects, all students in the group must take part in the presentation. Presentations should be understandable by the non-expert, but should also contain enough detail to satisfy Project advisors and/or clients.

Students should prepare presentation slides in PowerPoint or other presentation software and may use props, handouts, or other visual aids as appropriate. Students are required to practice their presentations to ensure fluidity and adherence to the time limit (to be determined in each quarter, but generally between 10 and 12 minutes) in front of an audience who can provide constructive feedback.

The Capstone Symposium is open to the public, including the E-IPER community, Project clients, and advisors. It is organized at the end of each quarter in which ENVRES 290 is offered.

Capstone Project presentations will be made publicly available on the E-IPER website to showcase students' work and provide a reference for other students; *presentations should not include any privileged or sensitive information*. If a student plans to work on a Project that may contain privileged information, this should be discussed in the Project Proposal and with the teaching team during proposal development.

4D. GRADING

All Joint MS students must take the Capstone Seminar for a letter grade in all quarters during which they are registered for the course. Students working in a group will not necessarily receive the same grade.

There are four major components to students' grades as described below.

Participation	Contribute to classroom discussions and peer-review sessions/ feedback. <i>Students are expected to attend and participate fully in every class meeting, including practice presentations. Unexcused absences will negatively affect participation grade.</i>	10%
Interim Assignments	Annotated bibliography, project updates, interim milestone, storyboarding assignment, draft presentation	25%
Final Presentation	Final presentation at Capstone Symposium	25%
Final Product	Final professional product detailing all required aspects of Capstone Project	40%

5. CAPSTONE PROJECT RESOURCES

Many resources are available to students in the planning and execution of their Capstone Projects. Please let E-IPER staff know of additional resources that should be added.

Past E-IPER Capstone Project presentations and other useful information are posted on the E-IPER website at <https://earth.stanford.edu/eiper/capstone-project>.

Capstone Teaching Team: Nik Sawe, Lecturer (sawe@stanford.edu) will teach both quarters, with [John](#) Weyant, Professor of Management Science and Engineering, (weyant@stanford.edu) in Autumn. Nic Buckley will be the Teaching Assistant in Autumn. The additional instructor and TA for Winter Quarter are yet to be determined.

E-IPER Affiliated Faculty: a list of E-IPER's more than 110 Affiliated Faculty members is available on our website: <https://earth.stanford.edu/eiper/people/faculty>.

The Woods Institute for the Environment and the Precourt Institute for Energy provide lists of Stanford environmental and energy faculty, many of whom are also E-IPER affiliated faculty, who are also great resources:

- <http://woods.stanford.edu/about/woods-faculty-researchers>.
- <https://energy.stanford.edu/people/faculty>