Engineering Educators Bringing the World Together
2025 ASEE Annual Conference & Exposition
Palais des congrès de Montréal, Montréal, QC • June 22–25, 2025
Paper ID #46938

Reinventing the Report: Teaching Sustainability and Justice in Materials Labs via Technical Communication

Dr. Timothy Chambers, University of Michigan

Dr. Chambers is a Lecturer at the University of Michigan in the Materials Science & Engineering Department. He teaches a variety of courses including junior-level MSE labs, Physics of Materials, Introduction to Engineering, and mathematical methods.

Dr. Katie Snyder, University of Michigan

Dr. Snyder is a lecturer in the Program in Technical Communication at the University of Michigan. She teaches writing and presentation strategies to students in the College of Engineering.

Reinventing the Report:
Teaching Sustainability and Justice in Materials Labs via Technical Communication

Abstract:

This paper presents a novel approach to teaching topics of sustainability, life cycle analysis, equity, and social/environmental justice in materials lab courses. We have redesigned the written deliverables in a junior-level functional materials lab course to create a scaffolded sequence of assignments that guide students to engage with multiple aspects of sustainability and justice in materials engineering. Instead of traditional lab reports, we assign students to produce written deliverables in a variety of genres that prepare them for different professional scenarios they may encounter after graduation. Writing these deliverables requires students to complete holistic analyses of materials problems including environmental, ethical, and economic considerations while communicating with a variety of audiences.

This approach also has the added benefit of building students' technical communication skills across a range of modes and mediums. While most of these deliverables are collaboratively written, we provide some opportunity for individual work to support each student's communication competency and confidence. We approach communication as an ethical practice, and use detailed, strategic feedback to help students consider the ways their writing about material science research may contribute (or not) to larger social justice aims. Here, we present three such written assignments along with student outcomes, our lessons learned through this curricular reform, and suggestions for anyone interested in implementing similar changes in their courses.

Introduction:

A long-running challenge in engineering education is the need to successfully bridge the gap between what students learn in the classroom and what they may need to know when they begin work as professional engineers [1]. Educators have approached this challenge from a variety of angles and with differing purposes. In some cases, we aim to better equip students to analyze and understand how social contexts (like politics, culture, and media) might shape project constraints and user needs [2]. In other cases, the aim is to help students approach design in the context of ethics or sustainability, with an eye toward the long-term impacts of their work across a range of users and circumstances [3]. Immersive classroom experiences like design-build-test assignments and community engagement projects can help facilitate this kind of knowledge [3-5]. Lab classes are good candidates for doing this kind of work, given the already hands-on nature of a typical materials science lab course. One area where the lab class has yet to excel, however, is in preparing students to communicate meaningfully about their work across diverse audiences and situations. In this paper, we argue that strategic focus on *contextualized technical communication* in a material science lab course can help address many of the gaps noted above, including improving understanding of sociotechnical contexts, considering ethical dilemmas, and designing for sustainable futures.

The communication deliverable most often required in lab courses is, of course, the lab report. Certainly, there is value in asking students to practice, even master, this particular genre. Much can be learned in writing lab reports, including important ideas about genre, convention, and rationales that inform these constraints. But the audience for these documents is not typically diverse or multifaceted. At the same time, as a genre, the lab report does not often invite students to be reflective or reflexive about sociotechnical concerns, ethics, or environmental sustainability, nor the applicability of their project work and data analysis to everyday engineering practice. Engineering curriculums are heavy with technical courses that leave little room for practicing technical communication, and the genres that do show up in these courses tend to be reports. Professional engineers certainly write reports, but they also create deliverables and other kinds of communications for clients, professionals outside of engineering and, in some cases, the lay public. Given the diversity of communication tasks professional engineers must take on, it stands to reason that engineering students should be given more time to practice and prepare for these tasks.

Course Implementation:

At our institution, the MSE curriculum contains two advanced lab courses as part of the core majors curriculum, typically taken by students in the first and second semesters of their junior year. The first semester focuses on structural materials and traditional scientific communication skills such as writing journal articles and giving research talks. The present work concerns the second semester, which in recent years has been reworked to be a functional materials lab course focused on materials technologies for energy storage and generation - specifically, batteries, photovoltaics, and magnets. Given the explicit connections between these technical topics and sustainability and environmental justice, they are currently of strong interest to the general public as well as business leaders. As such, we redesigned the communication activities and deliverables for the course to better prepare students to interact with non-academic audiences in their careers.

The course consists of four major projects, each lasting 3-4 weeks. In the fourth project, students choose their own topics and conclude with a poster fair; that project will not be discussed here. For the first three projects, as instructors we considered a variety of communication scenarios, genres, and deliverable types that might make sense in connection with each of the technical topics. Our goal was to help students develop skills in communicating with a wide variety of audiences, including different levels of technical expertise on the topic, motivation with respect to a societal or environmental problem, and agency in enacting or guiding potential solutions to the problem. Accordingly, the three communication assignments we developed are not a scaffolded series of tasks developing a single skill, nor are they tasks that must each accomplish a large number of learning objectives. Rather, they are elements of a set that combine to span a space of non-academic communication skills that students may need after graduation. As a set, they also require students to engage with a range of ethical questions around the societal and environmental impacts of these materials technologies. With this framework established, we then chose which communication skills to link to each topic and assignment, as detailed in the next section.

Each of the three projects is conducted in teams of 3-4 students each and follows a similar timeline. In the first week, we focus on technical content - apparatus and safety trainings, fundamental MSE principles relevant to the experiments, preliminary data collection and computational modeling, etc. We also introduce the final deliverable for the project and the associated scenario, both to help students plan effectively and also to contextualize their work more broadly societally. Over the next couple weeks, as students conduct their project work, we introduce more complex considerations and questions to address, both from the MSE side (how does this really work at a fundamental level?) and from the sociological perspective (who is helped and harmed by this technology? What are its geopolitical implications?). After students complete their project work, they work with their teams to create a draft of their deliverable, which receives formative feedback from the instructors, leading to revision and final submission.

Assignment Details and Pedagogy:

Technical communication is, by definition, information that is meant to be used. Audience is everything, and the work of technical communicators is fundamentally about granting audiences or users access to information that they need and would not otherwise be able to access or understand. Understood in this way, technical communication is a fundamentally ethical practice. Technical experts as technical communicators must think for and with their audiences, crafting information to meet their needs, uses, and frameworks of knowledge. In this course, we invited students to communicate in multiple modes; written, oral, and visual. We placed greatest emphasis on written communication for at several reasons, including:

1. As noted above, robust writing instruction and practice are not common in engineering curriculums but we know professional engineers spend quite a bit of their time developing and writing documents.
2. Writing drives reflective thinking [6]. This kind of thinking is, for many people, not accessible unless they put pen to paper (so to speak), and often leads to new insights, greater clarity, and overall improved cohesiveness of disciplinary understanding and thought.

3. Writing is difficult. It challenges us to think for ourselves, with our classmates, and for other people we may not know or even like. Requiring students to engage in productively challenging assignments will optimize their learning and growth.
4. Writing is vulnerable. Some have characterized writing as a technology of the self [6]. It is a way of sharing *you* with the world, and that if valuable but can also can feel intimidating or scary.
5. Writing is ambiguous. There is no one correct way to write a document. This fact mirrors real-life problems, and is particularly relevant in professional engineering where the path forward is often murky and does not lead to unique correct solutions.

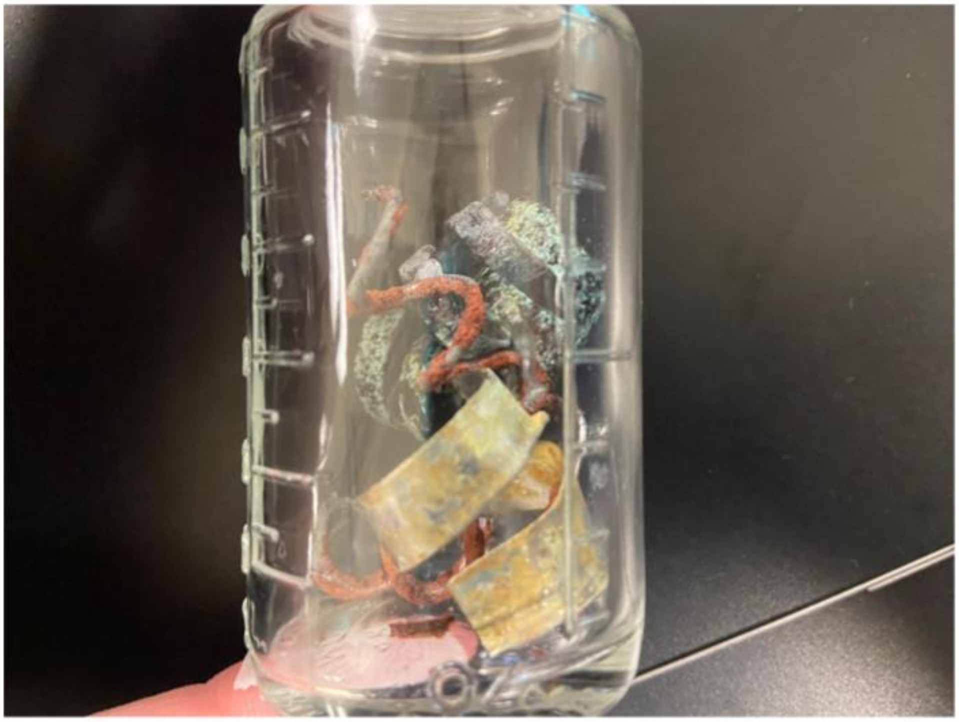
In sum, the value of writing practice for professional engineers is hard to overstate, both professionally and personally. It improves disciplinary and self-knowledge, invites understanding and empathy between author and audience. In this course specifically, we invited students into four technical communication tasks, divided across four materials science projects described in further detail below. These tasks include the following:

1. Writing a magazine article
2. Rewriting an SOP
3. Writing a grant

Magazine writing

The first major deliverable was a collaboratively written magazine article intended for readers of an issue of *Scientific American*. This assignment was tied to a 3-week lab sequence where students built simple batteries (of their own design) in the lab. Instead of writing a lab report about their work, students were invited to imagine they were contributing to a special magazine issue dedicated to dispelling myths about batteries and speculating about battery designs of the future. To prepare for this assignment, we provided sample magazine articles and offered a short lecture on magazine writing and typical story structure. Students were asked to pay attention to language, think about their audience's framework of knowledge, and design their narrative accordingly. At the same time, they were asked to include at least one meaningful visual and incorporate some of their lab data into their story in meaningful and relevant ways. A notable challenge encountered in this assignment was, we realized in hindsight, students do not read magazines very often. While, twenty years ago, students might be quite familiar with the genre, Today's Gen Z students are not. Still, the assignment was incredibly useful in getting students to think about what different audiences know about battery design, what their questions might be, and how to tailor their research findings to fit those needs. Excerpts of student work are included in Figure 1.

the lab to learn more about the specific reaction we were dealing with. Second, and most important, was that our failure had pointed us in a specific direction. Our batteries had too much electrolyte, so the solution was simple. Just lower the concentration. This, we knew, would be our springboard to a successful experiment.



These are a collection of the different reacted electrodes that we used in our "failed" tests. You can identify which are which based on the color of the residue on them- teal for magnesium, orange for aluminum, and yellow for steel. Notice how each one is heavily covered in these residues, pointing towards an extremely fast reaction.

Figure 1. Excerpt from a student magazine article. In contrast with a traditional lab report, students are both discussing the messy process of science via analysis of failed trials, and also choosing figures that are visually evocative for a popular audience rather than only using figures to convey data.

2. **Working quickly**, place the glass slide conductive-face down into the pool of TiO_2 using the Scotch tape to grip, see Figure 7. Lift the slide up as soon as the TiO_2 has contacted each part of the glass slide. After lifting out, you may need to tilt the glass slide around to get the paste to evenly coat the slide. You want a thin, translucent, and even layer of TiO_2.
    a. If the coating has cracks or pooling, you should use ethanol (following step 3 from Layer 1 & 6 procedure) to clean the slide and start over.

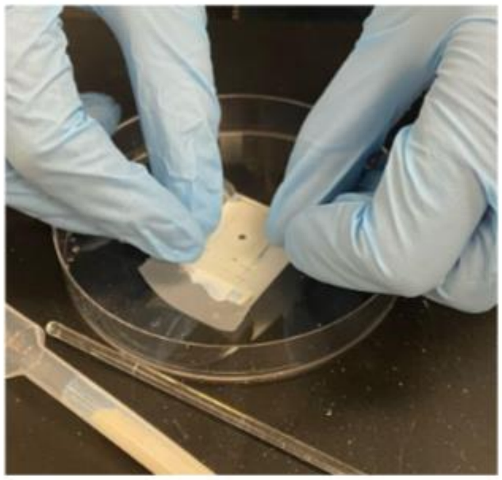


Figure 7. Place glass conductive-face down into the pool.

3. Place the TiO_2 coated slide face up on a paper towel and allow it to air dry completely. If the layer is thin enough, this should only take a couple of minutes.
    a. **Caution!** If cracks or uneven pooling develop in the TiO_2 while drying, use ethanol to clean the slide and start over. Figure 8 shows examples of what the slide looked like after sintering when cracks and pooling were present in the unsintered samples.

Figure 2. A sample page from a student-written SOP. The students have inserted conditional information to help future users make decisions in case of deviations from the ideal process.

SOP revising/revisioning

The second deliverable was a collaborative rewrite of Standard Operating Procedures for building a dye-sensitized solar cell. Students used a vendor-provided SOP to construct and test their cells in lab, then wrote their new SOPs based on their lab experience and including two additional sections. The first section was standard SOP instructions; the second section features physical explanations of how the cell operates and the reasoning behind steps in the instructions; and the third section traced some of the sociotechnical impacts of materials and/or processes used in the construction of the solar cell. Some teams, for example, traced the socioeconomic impacts of using critical minerals, costs related to shipping, or environmental impacts of mining-extracted materials. For this task, teams met with instructors for feedback, but given that students were already somewhat familiar with the genre, we did not provide lecture content in terms of how to write an SOP. However, we encouraged students to 1. Carefully document their steps as they worked through the original SOP and note any deviations or inaccuracies. And 2. To write the new SOP with next year's students in mind. This framing created a genuine and actionable need for students to reflectively consider, "what do I wish I had known at the start of this project" and communicate that forward to their peers. Our tentative plan is to ask next year's (now this year's) students to test and comment on the revised versions and iterate further.

Grant writing

The third deliverable was again collaboratively written on teams; this time, the task was to draft a grant proposal to a fictional government agency offering funds for projects using magnets in novel ways. In this case, we provided a lecture content and recommendations ahead of the project to familiarize students with typical features of grant proposals, with particular emphasis on establishing the need, using key evidence from their lab work to support their proposal, and building a cohesive credible argument for their proposed idea across all sections of the document. We also emphasized difference in audience and a tone here compared to prior documents, noting that strategic use of language, definitions, and concision. Important here was also to not make assumptions about what the audience may or may not know, given that grantors may have a range of expertise more or less consistent with the content provided in the proposal.

Across all three assignments, we asked students to think deeply about their audience, including their specific needs, uses, and frameworks of knowledge. These assignments also prompted quite a bit of reflective, discussion, and research about social, ethical, and environmental impacts of materials science research, development, and product design. Notably, student teams provided drafts in each case and received technical and non-technical feedback from instructors to guide revisions and completion of their work.

MSE pedagogy:

Laboratory courses (alongside design/capstone courses) are traditionally one of the main places in engineering curricula where students are required to deal with open-ended problems and design their own solutions. Even though the experiments per se are somewhat closed-ended due to logistical and equipment constraints, we took inspiration from senior design courses in developing writing assignments with realistic business scenarios wherein students would be accountable for delivering salient information to (imagined) clients and employers, rather than teachers. Because students had to make recommendations based on judgement and subjective analysis, choose what information to present and what to leave out based on audience needs, and conduct independent research to acquire necessary information that could not be gotten experimentally, these assignments served as a bridge from closed-ended lecture courses to the senior design experience. Furthermore, the necessary research pulled students outside of the academic bubble and led them to engage with primary sources such as government reports, legal documents and patents, industry publications, etc. Learning to find and read such sources of information was a benefit of these writing assignments that is typically not achieved by the traditional lab report.

While dealing with open-ended problems is a learning objective of many lab courses, developing robust conceptual understanding of MSE content is often an ancillary benefit of traditional lab reports, rather than a primary learning outcome. This set of writing assignments was intended to explicitly drive improvements in conceptual understanding via communication with non-technical and non-academic audiences. These assignments require students to unpack their understanding of the MSE principles underlying their project work without being able to rely on heavily mathematical and/or jargon-heavy explanations. They therefore push students to work through their own gaps in understanding as they attempt to write coherent explanations, and also help us as instructors probe for misconceptions the students may have, which can often be glossed over in a data- and math-heavy lab report. For example, in writing the magazine article about batteries, many students realized they did not have a deep conceptual understanding of the redox reactions involved in cathode-electrolyte-anode interactions, but only came to this realization when they were required to write a comprehensible explanation for a non-specialist audience. Each assignment led to similar metacognitive moments of realization of gaps in understanding of the topic at hand.

Finally, these assignments were intentionally designed to lead students to incorporate life cycle analysis as a natural and logical part of engineering projects. Sustainability is a topic of great interest to many engineering students, and the natural connection between materials selection, materials innovation, and more sustainable engineering is an important recruiting tool for MSE departments. However, students sometimes struggle to see how to connect their regular coursework to sustainability. By situating our assignments in real-world contexts with diverse audiences, on topics that transparently address problems of energy availability and environmental justice, we are scaffolding the growth of students' ability to apply LCA methods and ethical judgement to solving engineering problems.

Discussion and Conclusions:

The paragraphs below provide an overview of our initial observations, conclusions, and plans for future work.

Does this sequence of assignments work?

The sequence of assignments certainly accomplishes the goals we set initially, of engaging students with a variety of writing tasks for different audiences, and thinking critically about ethical, sociocultural, and environmental circumstances that inform or shape their engineering practice. If students had written standard lab reports across all three lab projects, this kind of thinking likely would not have been as prominent, meaningful, or well-developed. Students also were encouraged to exercise agency and creativity in the 'world-building' of fleshing out their scenarios and making them realistic. Several student teams improved the verisimilitude of their created scenarios by conducting research on real-world locations and situating their imagined employers or clients in those locations. A few even went as far as to research real local variables such as zoning restrictions and taxes and incorporate those into their reports.

That said, we encountered at least two challenges in centering non-traditional writing tasks in a traditional lab course. First, we note that some students struggled to integrate their lab data into documents meaningfully. In some cases, a dataset seemed arbitrarily placed into the document, and not strongly tied to narrative or relevant arguments. In other cases, students made arguments that could have been supported by their data, but they seemed to miss that opportunity. It is clear that our students, despite their previous successes in using data in formal scientific communication genres, need additional support for linking data to argument and policy in non-academic scenarios.

Second, writing these kinds of deliverables tends to be more time-consuming than writing a traditional lab report given the extra research needed to develop a cohesive story or find supporting resources. The creative aspect of these assignments also requires additional time and bandwidth for most students. We note that some students really leaned into their creativity and did excellent work while others were essentially "checking the boxes" of completing assignment criteria for a grade.

The following academic year, we asked the students to reflect on their experiences and perceived learning in these activities. Two students particularly noted that learning to read and write SOPs benefitted them in professional settings as well as future courses:

"*The DSSC SOP assignment majorly benefited me by forcing me to explain difficult concepts in a concise and understandable manner. I used these skills when I learned new machines/processes in my summer internship.*"
and
"*A writing assignment that benefitted me was the Standard Operating Procedure for Dye Sensitized Solar Cells (DSSC), which made me interact with the material in a deeper way than writing a report…allowing me to learn the material through teaching others. Writing an SOP helped me grow my communication skills, and I have directly benefited since I have done more coursework requiring SOP writing and also had a better understanding of SOPs when interacting with them at my internship over the summer*."

Recommendations and future work:
In sum, we would recommend adopting this approach in upper-level lab classes, noting that it may be challenging for just one instructor to accomplish on their own. Providing meaningful feedback about writing quality and needed revisions is time-consuming and may not be an area of comfort or expertise for some instructors. For students, it is important to get formative feedback on all aspects of their writing, not just the raw science or technical components. A co-teaching structure where technical and writing faculty teach the course in tandem is ideal so that students can benefit from diverse opinions and different disciplinary perspectives.

Looking ahead, one important teaching challenge is to determine how to teach students to better integrate experimental and computational data into these different writing assignments. In some cases, students struggled to see the relevance of their data to people and contexts outside the lab. We would often say, “But what does the data *mean*?” One possible strategy could be to take a student-led approach to selecting a project deliverable. For example, in the case of their solar panel project and experimentation, students could be prompted with the following questions: “Who would benefit from knowing about the data you’ve collected in lab? What would be the best way for them to learn about it?” Given those questions, choose a genre might successfully connect the audience with the information. These kinds of questions would need to have follow-on prompts inviting to think about what “benefit” means, who is an audience they might have overlooked, what if the environment or “nature” were your audience, and how might this project work impact or be meaningful to people across deep time?

Future work may also include administering pre- and post-semester surveys and/or surveys of students graduated and are several years into their professional careers to better determine the impact of this course. The university already conducts graduate surveys that routinely indicate “communication” as the most important or most used skill new engineers use in their professional context. We would like to test whether students who have taken this course feel better prepared for their communication tasks other students without this kind of preparation.

In summary, teaching non-traditional writing assignments in a junior-level lab course proved successful in helping students think more deeply about social, ethical, and environmental impacts and constraints surrounding their work as material scientists and engineers. While more labor-intensive than a traditional lab course (for both students and instructors), we feel the benefits are robust and enduring in terms of better equipping engineering students to grapple with the complexities of engineering work and communicate more effectively in that context.

References

[1] E. Koromyslova, C. Steinlicht, M.K. Peter. *Closing the professional skills gap for engineering graduates: Recent trends in higher education* Paper presented at 2023 ASEE Annual Conference & Exposition, Baltimore, Maryland. 10.18260/1-2--43338

[2] M.S. Kleine, K. Zacharias, and D. Ozkan, D. Contextualization in engineering education: A scoping literature review. *Journal of Engineering Education*, 2024.*113*(4), pp.894-918.

[3] J. Goggins, M. Hajdukiewicz. The role of community-engaged learning in engineering education for sustainable development. *Sustainability*, 2022. *14*(13), p.8208.

[4] M. Mosleh, K.A. Shirvani, K.A. Design, Build, and Test Projects in an Engineering Materials Laboratory. In *2017 ASEE Mid-Atlantic Section Fall Conference*.

[5] A. Verma, K. Snyder. Integrating community-engaged research and energy justice in design pedagogy: Reflections on a first-year undergraduate design course. 2024 ASEE Conference Proceedings.

[6] W. Booth, G. Colomb, J. Williams. *The Craft of Research*. 3rd Ed. 2008. U of Chicago P.

[7] M. Foucault. *Technologies of the Self*. 1988. U Mass P.

Appendix A

MSE 365 - Lab 1 Deliverable - Batteries
Winter 2024

With your team, develop a magazine article with readers of *Scientific American* as the target audience. Imagine, for example, that *Scientific American* is putting out a special issue: *Emerging Research in Battery Science: Data & Perspectives.* This issue will feature three different types of articles: 1. Speculating on the future of battery development. 2. Dispelling myths and misconceptions (or worse, "myth-conceptions"*) 3. "Tales from the Trenches": stories of working in battery R&D.

In each case, your article should be informed by the data you generate in lab and the research you have done to support your lab work. Not all of your data from lab will likely make it into your article, but it's also expected that you find creative-yet-meaningful ways of integrating your lab work to support the content in your article.

As you develop your article, keep the following questions in mind:

1. Why would it make sense for someone in the battery prototyping and new horizons space to write a magazine article?
2. How might skeptics respond to my claims and supporting data?
3. What can I say about battery performance (quantitatively and qualitatively)? Make sure to consider engineering design principles/constraints, not just raw technical performance.
4. What do I need to say in terms of "How does this work?" to engage (not patronize) my audience?
5. What evidence do I have to support my claims? How do I know the evidence is "true"?
6. What type of data have I collected (knowing that not all data are equally valued or understood)
7. What are the broader global implications of your work? How does it intersect with political, economic, environmental, and societal issues?

Ideally, you could coordinate with the other teams in your section to write about complementary topics such that each section produces a complete series of feature articles. This is not required, but it would be cool if you do it.

Deliverables:

- Magazine article
    - 2000-4000 words
    - 3-4 useful visuals

    - Collaboratively written by all members of your team

- Pitch meeting. Pitch an article idea to fake magazine editor, Dr. Snyder. We will run this session as a structured brainstorming session. **Each team member** should come prepared for a 2-3 minute individual pitch for their proposed magazine article topic. The team will then in dialogue and debate to select a single topic.

Timeline:

Week 1 - An introduction to the final deliverable. Here you will begin to develop questions and identify the puzzle pieces you will need to complete this task.

Week 2 - The pitch meeting. Pitch your magazine idea to Dr. Snyder … remember that a pitch is argumentative (claims, evidence, reasoning). Use your whiteboard skills.

Week 3 - Begin this meeting by saying, "We are going to tell the story in this way – we are envisioning these visuals … for these reasons." Then we will workshop your ideas. Whiteboard skills may also be relevant but other communication technologies are invited.

—

*Myth-conceptions," per Tim Chambers. Feel free to hashtag (if people still do that kind of thing):

1. Beliefs people hold that used to be true but no longer are. There are often sociocultural motivators causing people to not update their information rather than a simple lack of (access to) information.

2. "You're not wrong but …" Partially true misconceptions can be particularly stubborn and difficult to dislodge, especially for complex sociotechnical problems that lack a single correct answer. For example, there are serious problems with the way batteries are made and used … but do the pros outweigh the cons?

Scoring:

Final deliverables will be graded holistically by both lead instructors. This means there are not specific points/penalties attached to different components of the article, but rather the impact of the entire work will be evaluated as an integrated whole.

A score out of 5 points will be given for overall technical accuracy and quality on the MSE side. A second score out of 5 will be given for the quality of the technical communication. The overall assignment score will be the average of these two scores. **Individual students may receive adjustments to their individual grades relative to the team score based on peer evaluation data.**

Appendix B

MSE 365: Standard Operating Procedures (SOP) for a Solar Panel

"This assignment is like an onion."
-*Tim Chambers*

Procedures are official guidelines for people who probably have expertise in how to do a given task but perhaps work for an organization that needs to ensure their work is safe, accurate, and consistent across time and from person to person.*

A *standard operating procedure* (SOP) serves as an *official record* of how to complete a task in a way that protects the health and safety of users and other rightsholders.** An SOP may also provide contextual information to help users understand key concepts and manage unexpected circumstances.

For this assignment, you are taking SOPs a step further by including a section that tells the story of the materials involved in the creation of this product. Specifically, you should draft an SOP for your solar panel that includes the following components:

1. **Literal instructions.** How do you build this solar panel?
2. **Conceptual information.** From a pure science standpoint, how does this work? In other words, explain concepts that will be important for users to understand as they build their solar panels and/or that will help them make decisions as they execute the procedure.
3. **Sociotechnical narrative.** For each layer of your solar panel, tell the story of the components and materials involved in its creation. Where did they come from? Who retrieved them? How? How much did it cost? What are the environmental costs? You **do not** need to answer all of these questions for every material in every layer. Choose what interests you and create a coherent narrative.

Audience: Students in next year's section of MSE 365 will test your instructions and write usability reports about their experience. Fun!

Recommendations & Additional Guidelines

- Err on the side of proving too much information, knowing that users can choose how they engage with the document. It can be a good idea to explicitly indicate which content is most critical and what is optional.
- Your dye-sensitized solar cell will have six*** layers. Aim to write three pages per layer. Specifically, write one page of instructions, one page of conceptual explanation, and one page of sociotechnical narrative.

Grading stuff:

Grading details will be released Later™.

**Instructions* are different from procedures in that they often (but not always) have inexpert or novice users in mind. More specifically, instructions provide step-by-step explanations, but they do not typically serve as official guidelines in the way that procedures do. In other words, instructions are less formal and used in lower-stakes situations.

**The word *stakeholder* has colonial origins. My preference is to use *rightsholder* instead.

***maybe plus or minus one or two depending on how you count them.

Appendix C

Magnets Grant Proposal
MSE 365 - Deliverable #3

For this project, imagine you work at a start-up materials supply company trying to secure funding to help expand your reach into new markets. You discover that government grants are available to support new companies looking to develop or supply “quantum materials” tech applicable to problems of national interest, including climate change, environmental justice, national security, and/or energy independence. The granting agency is most interested in funding projects where some R&D/prototyping has already been conducted, and resources are now needed to mature the technology toward a viable product.

Your company is developing new magnetic materials technologies, and the CTO believes some of the company’s in-development products could be competitive for the above grant programs. Your team is tasked with writing a grant proposal based on the magnetic materials you’ve investigated this month in the lab. **In short, you will need to explain how your lab work informs and can be applied to the development of new technologies that could address the interests of the granting agency.**

Keep in mind that you are not trying to sell your lab work as some sort of finished product or technology here. Your objective should be to use your knowledge, experience, and data to support an argument that continued work in the area can reasonably be expected to yield fruitful results and that your team is the best choice of whom to invest in. Your audience is going to contain a mix of technical experts and policymakers.

Details matter

Read the grant narrative and specifications very carefully. Grant proposals often have very specific and strict requirements. In many cases, if a proposal fails to meet even a minor formatting requirement, reviewers will not read it.

Be persuasive

Your attention to detail can also be persuasive or part of a greater strategy to convince your audience to choose you over other applicants. Remember, at base, a grant proposal is just an ask for free money. So …

- Pay close attention to what’s being asked of you, and be strategic about how you make your case to your target audience.

- Show a clear link between need, objectives, method, and budget.

● Use your data from lab and analysis thereof partly to demonstrate your value as a subject matter expert and be persuasive about your ability to accomplish interesting and/or meaningful work in the field.

While we will not be choosing a “winning” grant proposal, keep in mind the competitive nature of these documents. To have a shot at winning, you must use suasive strategies to move your audience. Toward that end, use rhetorical appeals thoughtfully (ethos or credibility, logos or logic, and pathos or emotion). Pathos is the most powerful appeal, but if overused, it can backfire. Rely on the strength of your data (logos) and make the data clear, accessible, and relevant.

There is also the super secret fourth logical pillar - kairos. This has to do with timeliness - the right moment in which to accomplish something. If you can tie your work to current events or present-day problems that will make your proposal stronger.

Be confident

No one wants to give free money to someone who seems uncertain, wishy-washy, or is generally unclear about what they plan to do (and why they plan to do it). Draw on the strength of your lab work and showcase your knowledge throughout the proposal.

Your use of language can also convey your confidence (or lack thereof). Use precise and specific language – avoid words like “things,” “stuff,” “some,” etc. Quantify whenever possible. Use an active voice. Avoid “if” and “hope” statements (as an aside and as a personal pet peeve of Dr. Snyder’s, do not use the words “passionate” or “nowadays” in the proposal).

Nobody knows your work better than you! Own it.

Please explain

Present your data analysis clearly and rigorously. Use descriptive language and draw comparisons when appropriate. Always keep your audience in mind as you think about how to balance technical detail with clarity and concision. Over-explaining can be as problematic as not saying enough.

Always justify

If you get past the preliminary reviews, one of the primary questions grant readers will ask is, “Does this proposal seem reasonable?” Use your subject matter expertise to justify the need for funding your work, the expenses you are requesting funding for, and timeliness of the project. While the reasonableness of your proposal may seem very clear to you, make sure you have provided enough evidence to make it clear to your audience; they are less familiar with the details of your work than you are, and what is obvious to you may not be so obvious to others.

Document Specifications

- Cover page with professional names (senders and recipients), date, and document title
- Summary - 400 words (strict limit)
- Background - 300 words plus one visual
- Need - 300-600 words (one visual permitted but not required)
- Objectives - 200-400 words (one visual permitted but not required)
- Methods - 200-400 words (one visual permitted but not required)
- Technical Evaluation - 250-500 words plus 1-2 visuals
- Sustainability Evaluation - 250-500 words plus 1-2 visuals
- Budget & Budget Justification/Narrative - 1-2 visuals (a table, for example) + 200- 400 words
- Conclusion - 200 words (strict limit)
- 12 pt Helvetica, black
- 1” margins
- Single-spaced

Grading - Rubrics for communication and MSE content are included below.

Communication content

5 - is an example of highly effective writing. It makes its purposes clear, reflects concern for its audience's needs and responses, and is detailed, persuasive, effectively organized, exhibits appropriate format and tone, and is grammatically correct with few typos.

4 - work is successful but lacks the polish or effectiveness of a 5.

3 - work is effective though it lacks the features necessary to succeed completely with its designated audience. Its purpose may not be entirely clear, it may not be effectively organized, it may not exhibit an appropriate tone or format, or it entails grammatical errors that make it more difficult to read or understand than necessary.

2 - work does not communicate effectively for several reasons. It may display an inadequate understanding of purpose or audience. It may lack information or be unpersuasive. Its organization may be confusing or misleading, and its tone or format may be inappropriate. It may be difficult to understand or contain serious errors in grammar.

1 - work does not satisfy requirements

MSE content

5 - Uses experimental, theoretical, and literature information as a coherent whole to address all required aspects of the assignment. There are only a few minor issues with accuracy that do not impact the accuracy of the overall conclusions of the work. Holistically addresses both technical (material properties, data handling anderror analysis, experimental design/methods…) and non-technical factors (e.g. societal, environmental, economic, cultural...) in making claims and reaching conclusions.

4 - Mostly achieves the overall requirements of a 5, but lacks polish, clarity, or completeness to a degree that negatively impacts the audience's confidence in the work/conclusions presented.

3 - Addresses the main requirements of the assignment. Uses at least two of experiment, theory, and literature, but may not integrate all three effectively. Incorporates both technical and non-technical factors but does not consistently/effectively balance them. Or, attempts to meet all the assignment requirements but contains enough substantive errors in accuracy/correctness that the conclusions of the work are significantly negatively impacted by the lack of accuracy.

2 - Fails to address the main requirements of the assignment, but does contain some relevant and technically accurate work.

1 - Does not meet the requirements of the assignment, and/or contains many serious factual errors to the point where the work is “just plain wrong.”