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Work In Progress: Implementing an Impact Training program that integrates design thinking, communication, and innovation and entrepreneurship into a graduate engineering curriculum

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Work In Progress: Impact Training integrates design thinking, communication, and innovation and entrepreneurship into a graduate engineering curriculum

Traditional approaches to graduate training have a strong focus on technical and research skills but often lack mechanisms to help students frame their work in the context of innovation, translation, and societal impact. To address this need, we designed an "Impact Training" program and integrated it into the core curriculum of our new PhD program in our Department of Bioengineering at the University of Oregon Knight Campus for Accelerating Scientific Impact. The Impact Training aims to: (i) help students visualize themselves as drivers of societal impact from the outset of their training, (ii) engage all graduate students in communication, innovation, and translation activities, (iii) train students to use design thinking to advance their research, translation, and career goals, and (iv) demonstrate that an innovation mindset can fuel basic research as well as translation and innovation activities. This **Work in Progress** paper describes our novel implementation approaches and early indicators of trainee engagement and success.

Our approach to delivering the Impact Training revolves around central tenets of early and continuous engagement applied using a "just-in-time" model. In this just in time approach, trainees learn concepts immediately before they must be deployed to accomplish authentic, meaningful tasks [1], [2]. Examples include workshops on scientific talks and poster design just before a key regional or national conference, or courses and workshops on grant and proposal writing held as trainees are actively writing grants or fellowship proposals. This just in time strategy increases engagement and learning retention because the perceived return on investment is high and the material is not only theoretically learned but implemented in real time [3], [4] towards authentic tasks [1], [5], [6].

Integrating our Impact Training into the curriculum of a graduate program of study offers a strategic advantage vs à la carte courses. Because students are progressing along a common pathway, they encounter key milestones and strategic opportunities at similar timings. For example, they often complete their dissertation committee meetings and exams during a similar timeframe. Similarly, opportunities to apply for funding and fellowship programs, e.g., NSF Graduate Research Fellowship, NIH F31, happen at similar timepoints for students in each cohort. The Impact Training can thus be designed around these types of authentic tasks and milestones to meet the just in time design goal.

The topical content of our Impact Training focuses on the intersection of four key areas: design thinking, communication, innovation and entrepreneurship, and career readiness. These topics are often taught in an isolated, à la carte, approach, or neglected entirely from graduate programs in science and engineering. Instead, we have found that each of these subjects are connected by a Venn-diagram of essential elements that create a throughline towards enhancing overall impact in science and engineering.

As an example, while design thinking was originally conceptualized to ideate great products that meet user needs, the process resonates with best practices in science communication [7]. We therefore strategically walk through the design thinking phases (Figure 1) as we work with trainees on their communication tasks. To illustrate this process in the context of preparing for a

conference talk, we begin by defining our communication goals as well as the needs of our audience. We next apply ideation techniques to identify key messages, generate potential story elements, and create a narrative story arc. Then, we create quick prototypes of our talk using storyboards, which we test in small groups using short "story pitches". We engage in peer feedback and apply newly acquired insights to inform the next iteration of the entire process. With each iteration, we increase in sophistication until the presentation arrives at its final form.

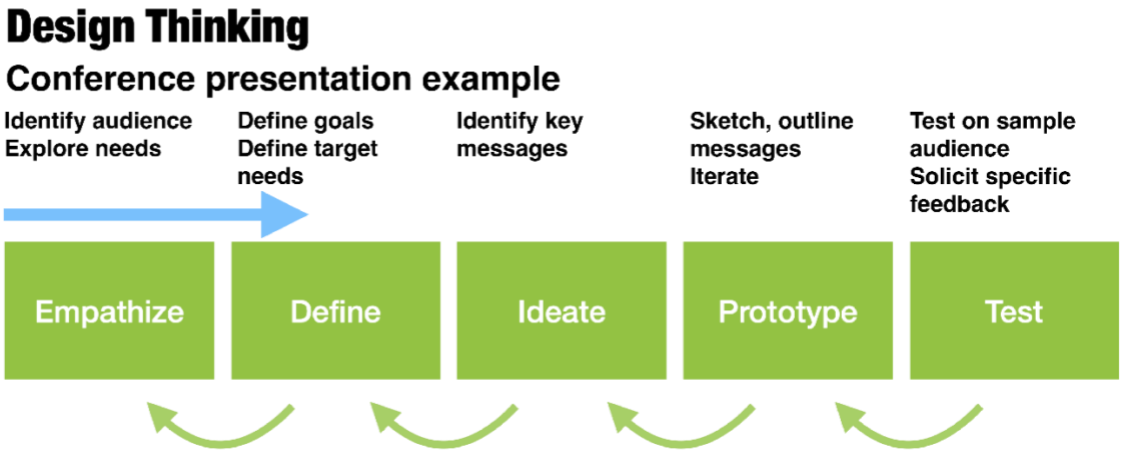

Figure 1. Design thinking applied to science communication to prepare an impactful conference talk

Impact Training Program:

All of our bioengineering PhD students complete a two-year core Impact Training program that integrates with their technical training [8]. The core begins with Impact Week, a weeklong immersive set of foundational trainings in design thinking, science communication, and innovation and entrepreneurship. Impact Week begins on the first day students arrive on campus to begin their PhD training and is a hallmark of our commitment to our early engagement strategy.

During Impact Week, we collaborate with key partners across the university to jump start student success in each of the Impact Training key areas. We collaborate with our university's Center for Science Communication Research to build elements of storytelling in science communication. We also partner with our Lundquist College of Business to infuse innovation and entrepreneurship training, with a focus on assessing societal needs and understanding key concepts such as market pull vs technology push [9]. We translate these fundamental concepts towards the process of designing research projects that can lead to transformative discoveries that have high potential for societal impact and/or market translation. We introduce and use design thinking as a tool to identify and empathize with customer needs and societal stakeholders and think of ways to ideate, prototype, and enhance the ability to give and receive feedback.

We have empirically observed that this early engagement with our trainees allows us to seed key concepts and foundational ideas from the onset of their graduate training. These ideas can later

be reinforced and expanded upon as trainees progress through the remainder of the Impact Training. Further, early engagement ensures students can implement critical skills throughout the duration of their training instead of waiting until they are at their dissertation stage when they have minimal time to implement them [10]. We have also observed the immersive "bootcamp" nature of Impact Week to be a catalyst for students to forge new relationships with their graduate student colleagues, creating the types of supportive networks that have been shown to improve success and retention in graduate school [11], [12].

Following Impact Week, our students complete a two-year core series of required trainings that reemphasize and deepen the key concepts explored during Impact Week. The requirements in this core set of trainings are programmed with just in time opportunities in mind, and consist of:

> **Design Thinking and Science Communication**: 1 credit course taken fall, year 1
> **Ethical Considerations in Research and Innovation**: 1 credit course taken fall, year 1
> **Technology Ventures**: 3 credit course taken winter, year 1
> **Writing for Impact**: 2 credit course taken spring, year 1
> **Grant and Proposal Writing**: 2 credit course taken winter, year 2
> **Individual Development Plans**: IDP workshops with annual update and review of IDP

Continued Advanced Training and Workshop Opportunities
Upon completing the core programming, students may choose to take advantage of multiple advanced training workshops and opportunities designed to continually engage motivated graduate students. In contrast to the core series outlined above, the following opportunities are opt-in and designed primarily for graduate students in their 3rd+ years and for postdoctoral scholars. Below are a few examples of these types of opportunities:

> **Strategic Communication and Branding**: Elective course for 3rd+ year graduate students and postdocs
> **Career workshop series:** 4-part workshop series for graduate students and postdocs designed to help expose and prepare trainees for scientific careers beyond academia
> **Communication Coaching:** 1:1 coaching for students who are preparing to present at conferences or submit publications, grants, and fellowships.

Collectively, this suite of trainings, which we refer to as our Impact Training, guides trainees to learn to identify key societal and market needs, align their research toward discoveries that address those needs, and communicate the value of their research to key stakeholders, including the scientific community, investors, collaborators, and the broader public.

Early indicators of engagement and success
Our PhD program is relatively new - our first cohort enrolled in 2020. As of this writing, roughly thirty students are currently enrolled and two have graduated with their PhD. The limited size and age of both the PhD and Impact Training programs complicate traditional evaluation metrics. However, we have empirically observed several ways that our students are actively engaged in high impact communication and innovation and entrepreneurship activities. Six of our students have declared a graduate specialization in innovation and entrepreneurship through a partner program in our university's business college. Three of our women students have participated in a

local entrepreneurial mentorship program for women, the Women's Innovation Network, and two students have participated in intensive supplementary innovation and translation training such as NSF Innovation Corps and "Lens of the Market" programs.

Additionally, we have early indicators that our students are able to translate their trainings to high impact communication products. The training students receive enables them to prepare successful scientific proposals, entrepreneurial-style pitches, and scientific presentations. Early outcomes of this training include numerous awards in national fellowships and national conferences. For example, our students have a high rate of applying for and being awarded NSF Graduate Research Fellowships (GRFP). To date, 18 of 21 eligible students (85% of eligible) have applied for the GRFP, with six trainees (33% of applicants) receiving the prestigious award, well in excess of national averages. Another student also applied and won a prestigious Natural Sciences and Engineering Research Council of Canada award, which is similar to the GRFP. Another has applied to the HHMI Gilliam Fellows program and yet another to a NIH F31 fellowship – with both of these awaiting decisions. Beyond fellowships, our students have also won awards at national conferences related to successful research and communication, including best poster and three-minute thesis awards and reaching finalist status in entrepreneurship pitch contests at national conferences.

While we have yet to formally assess the Impact Training program, we engage in frequent quick feedback with our students to help us adapt our approach in real-time and iterate and refine our approach from year to year. In addition to formal course surveys collected through the university system, one approach we use to collect rapid feedback is for students to leave an anonymous "2+1" on a notecard as they exit a workshop or a class session. This "2+1" asks for two things the students found helpful and one idea they can think of to "take the activity to the next level". Insights from this feedback are used to continually iterate and improve the trainings.

Implementation Challenges and Considerations

Launching the Impact Training concurrently with a new academic program created an opportunity to integrate the trainings alongside more traditional technical program coursework. Integrating the program into an existing academic program may be more challenging because there would need to be either an expansion of courses/credits that students need to complete or a reduction in existing technical coursework. One compromise may be to offer Impact Training as a set of electives, or as a more specialized, not-for-credit, professional development program that students apply for. In the later approach, in lieu of credit, students who participate could receive a special designation, such as "Impact Training Fellow". These approaches could make the training possible without the need to alter curricular requirements. One consideration with either of these options is that only a subset of students would receive the training. We have observed benefits from providing training universally to all students and even faculty [13]. For example, students have a common language and practice around key skills when engaging in peer feedback in preparation for scientific presentations and writing, etc.

Another approach would be to adopt the Impact Week model for all incoming students and deliver the remainder of the Impact Training program via elective coursework or opt-in professional development programming. This approach might allow for some universal common training and language around key areas of Impact Training and provide motivated students the

opportunity to pursue additional training yet not require significant changes to the course of study in existing academic programs.

Future Work

Going forward, we plan to engage in more formal assessment to measure the effectiveness of the Impact Training program. We anticipate using surveys, interviews, and study groups to measure the student's perceived value and success at achieving learning outcomes. We also plan to collect before and after examples of communication products (science talks, proposals and papers, product pitches, etc.) that demonstrate improvement in specific tasks before and after workshops or coaching sessions.

Another area of future work is to codify learning activities and lesson plans in a format that can be shared with other departments at the University of Oregon and across institutions. Although it may be challenging for other programs to integrate the full suite of trainings into their curriculum, individual modules may be able to be incorporated. With a little customization, these activities are likely to be useful in disciplines beyond bioengineering, especially for programs that already have a focus on communication, innovation, or entrepreneurial mindset.

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