

Board 196: An 'Inspiration Kit' for Building a Culture that Fosters Engineering Identity

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Introduction

The Mechanical Engineering Department at Seattle University was awarded the National Science Foundation (NSF) Revolutionizing Engineering and Computer Science Departments (RED) grant in July 2017 to support the development of a culture that fosters students’ engineering identities. This culture of “engineering with engineers” was built through a strong connection to industry and through changes in the four essential areas of *a shared department vision, faculty, curriculum, and supportive policies*.

During the last year of this project, we conducted an audit of our activities taken during the six-year project to identify which were most impactful for the culture building in the department and were relatively easy to implement and adopt by other departments. We shared our audit process and results at the 2023 ASEE conference [1]. This audit process helped us identify ten significant endeavors, each of which included multiple activities. These ten endeavors include *creating a mission statement to drive culture change, fostering the new culture in retreats, improving diversity, equity and inclusion (DEI) in the program, hiring staff to support DEI, teaming to build trust, including students in curriculum design, positioning seniors as professionals, developing innovative teaching, and changing the annual performance review (APR)*.

To investigate how to share these endeavors effectively, we invited engineering educators, the potential adopters of our endeavors, to three successive virtual co-design workshops. Each workshop was attended by over 40 participants, representing nearly 70 different educators. During each of these workshops, the participants served as co-designers and engaged with the endeavors through listening, viewing, free-writing, and discussion. The idea of an “inspiration kit” emerged. Based on the co-designers’ collective feedback, a dedicated website, SURED.org, was built to share these endeavors.

In this paper, we summarize the ten endeavors in our “inspiration kit” and present key activities and artifacts crucial to each. We share the process of how we co-designed and constructed SURED.org. We hope that sharing our experience and inspiration kit provides transferrable knowledge that other departments may use to improve their programs and change their cultures.

Project Background

The theoretical background guides us throughout the project and remains unchanged; hence, this section combines content from our previous ASEE papers [1] - [6] to summarize our project background.

Identity influences who people think they are, what they think they can do and be, and where and with whom they think they belong [7] - [10]. People’s identity shapes the experiences they embrace, and reciprocally, those experiences shape their identities [11] - [13]. People behave consistently with their identities [14], [15], choosing behaviors with meanings that match their

self-conceptions [16], [17]. When people identify with an esteemed group, they feel better about themselves and, in turn, feel better about the group [18], [19]. If people strongly identify with a group, they steadfastly defend the group, stay in it, and support it [20].

In education, identity influences whether people feel they belong in a program and what they believe they can achieve. It has been shown to influence what goals are pursued and the level and type of effort put toward those goals [15]. Research also shows that identity and fit are important factors affecting persistence in STEM fields [11]. When people perceive a fit between themselves and their fields, they persist longer in those fields [21] - [23]. Hence, identity is a determining factor in one pursuing, persisting, and persevering in engineering [14], [24].

The development of identity is a social process. People's thoughts and behaviors are shaped through relationships and reflected appraisals with others [8], [20], [25]. Identities are further derived through associations, affiliations, and identifications with groups [21], [24]. Tonso [27] observes that identity development is an enculturated process where identities are acquired through "community-based interactions," and Beam et al. [24] concur that social contexts affect identity. In engineering education, situated learning is central to identity development [27]. Therefore, this social process of identity development can be realized through the culture of an engineering program. Cultivating a culture of doing engineering can result in graduates who not only are prepared technically and professionally with a practical, realistic understanding of what it is to be an engineer but also who identify with and are committed to the engineering profession.

Culture is shaped, in part, by the identities of those in the culture. It is negotiated, co-created, and reinforced through communication and social interactions [28]. It develops organically from the behaviors of a group through association and shared experiences [29]. The culture of a program plays a significant role in effective, innovative STEM education [30], [31]. It is also important to know that the priorities of the institution and department influence culture in an educational setting.

Our RED project aimed to develop a mechanical engineering program where students and faculty are immersed in a culture of doing engineering with practicing engineers that, in turn, fosters students' engineering identities. This culture of "Engineering with Engineers" is built through interactions of students, faculty, and industry, participation in engineering-related activities, and reinforcement of shared experiences in our program.

Summary of Project Audit

During the six years of the project, we took numerous actions to build this culture of "Engineering with Engineers". Following the best practices recommended by Henderson et al. [32], which came from an extensive review of articles on facilitating change in STEM education, these actions can be characterized in four areas: *shared vision, reflective faculty, relevant curriculum and pedagogy, and supportive policies*. In our previous ASEE papers [2]-[6], we chronicled actions we took in these four areas of change. Last year, an audit was conducted to review all of our activities. In Ref. [1], we shared the audit process and the ten most impactful

endeavors (groups of items or actions) that resulted from the audit. In this section, we briefly review the auditing process and these ten endeavors.

The goal of the audit was to identify activities we thought were the most critical to the changes we have seen in our program, and that might be valuable for others seeking to change the culture in their academic unit. The audit began by summarizing all the activities, as shown in Ref. [1]. All five RED PIs reviewed and agreed on the list of activities. Each of the five RED PIs then individually rated these activities, *based on the accumulative efforts in the five years of the project*, using H (high), M (medium), or L (low) to respond to the following three questions:

- *How critical (impactful) was the activity for the culture change to happen in the Department?*
- *How easy was the activity to materialize or use?*
- *How likely would other departments adopt the activity? (Consider limitations on finance, dept size, etc.)*

After collecting responses from all PIs, results were assembled and shared with all PIs. In subsequent PI meetings, results for each item were discussed. Through discussion of how impactful an activity was for the culture change we observed in the department, ten endeavors (groups of activities) were identified. In alphabetical order, these ten endeavors are summarized below.

1. *Annual Performance Review (APR)*: Faculty and staff should be recognized and celebrated for the efforts they put into creating a more inclusive department, changing the curriculum to develop a culture of “Engineering with Engineers,” contributing to the creation of the shared vision, improving pedagogy, and many other actions that led to the sweeping culture change. Faculty generally appreciated such recognition of their work, which otherwise would be ignored. APR could be used as a motivator towards initiating and sustaining culture change [4]-[6].
2. *Curriculum*: To prepare students for engineering practice, the main objectives of the new curriculum were to get students more comfortable with uncertainty and help students identify themselves as engineers. Students were included in the new curriculum design when the faculty was stuck. With students’ feedback, the resulting curriculum incorporated a new vertical design experience course (Integrated Design Projects, IDP) and a new integrated EE (Electrical Engineering) and DAQ (Data Acquisition) course sequence [3, 4, 33, 34, 35].
3. *Diversity, Equity, and Inclusion (DEI)*: Helping women and underrepresented minorities feel identified and one with the program was at the heart of our RED project. The initial report from the project’s external evaluator revealed that some female students (anonymized) felt excluded and diminished, occasionally by faculty and staff and sometimes by classmates. Therefore, the program undertook several actions to address DEI in the four areas of change [2]-[6].

4. *Engineers in Training (EIT)*: The senior capstone sequence, connecting seniors and the industry, was pivoted away from academic language and schedules to language and schedules more indicative of engineering practice, with the goal of better preparing graduates for their engineering careers. Results from the *Senior Growth Survey* indicate significant development in senior's growth as professionals [4, 5].
5. *Industry Connection*: The program used various means to connect with the industry, including hiring a resident industry advisor, strengthening faculty's connection with the industry through summer immersion experiences, and infusing industry practices in IDP and senior design courses [2]-[5].
6. *Innovative Teaching*: The department promoted and encouraged innovative teaching. Teaching innovation was driven by the COVID-19 pandemic, by feedback from constituents, and by funds from the RED grant. Innovations included the adoption of flipped classrooms, industry projects in classes, recognition of the importance of DEI in an engineering curriculum, and lessons learned from remote teaching during the pandemic [4, 5, 6, 36].
7. *Mission Statement*: At the beginning of the RED project, we needed to establish a shared understanding of the department's goals. We crafted a process inspired by co-design to revise the current mission statement. In addition to producing a collaboratively created revised mission statement, the process also resulted in a shared memory of how the mission statement had come about, renewed commitment to the mission statement, an experience of having worked together, and trust that the group can succeed when it works together. Co-designing the mission statement early in the RED project set the stage for other successful endeavors. [3].
8. *Retreats*: Departmental retreats are customary across Seattle University and a tradition in the ME Department. These retreats, which typically occur in the fall before the start of each academic year, are important in connecting faculty and staff and allowing departments to make plans. As part of the RED grant, the department changed how they prepared for and conducted retreats [1]. Instead of focusing on administrative details, the RED PI team spent time establishing retreat goals and activities that involved all faculty and staff. These retreats moved the department's culture change forward and brought faculty and staff together.
9. *Staff*: Staff play an important role in student experience. This fact was supported by both the ME Student Advisory Council and by student interviews conducted by our external evaluator. Armed with a new appreciation for student-staff interactions, the department assigned new expectations during the hiring process and placed a greater emphasis on the lab manager and senior administrative assistant staff positions during conversations regarding curriculum change, retention of students, and other matters [1].
10. *Teaming*: As our RED project transitioned into its fifth and final year, we recognized that the dynamic discussion that had come with the creation of the RED initiatives might fade away. Hence, "teaming" was created as a way to continue discussions. *Teaming*, as

defined by us, is a form of group discussion that requires no preparation for the participants, starts with a simple prompt that can be answered by everyone present, and helps the group build trust through dialogues [6, 37, 38].

These ten endeavors offer a glimpse of the efforts put into our RED project and highlight key outcomes that led to our culture change. Many actions were not limited to our unique setting (i.e., a small, teaching-focused mechanical engineering program) and could be adopted in different settings. We also realized that sharing these actions (or results) alone would not tell the whole story and that sharing the nuances of our experiences would be more meaningful to others seeking change. Thus, we wanted to disseminate our work beyond traditional academic publications to tell our stories better.

Co-Design Workshops

Inspired by the work of Arif and his colleagues [39], we pursued the concept of building a “toolkit” that would address our dissemination goal while also respecting the agency of those for whom this toolkit is intended [40]. A toolkit, as defined in the dictionary, is “a collection of expert skills, knowledge, procedures, or information for a particular topic or activity” [41]. Although the description of a toolkit is clear, there is limited academic literature on how to build one. While we had established the basic items that would form the toolkit, we had not established how each item would be shared, the appropriate level of detail, or the amount of context needed for each item. Through exploring how to build this toolkit, we found that the toolkit designers often co-construct their toolkit with the intended users through methods like co-design [40], a collaborative design approach that involves multiple stakeholders, such as end-users, working together to develop a solution [42].

A co-designed toolkit involves the eventual users of the toolkit in the design and development of the toolkit. We aimed to solidify the toolkit's content through three co-design workshops. Rather than engaging in speculative co-design (an inspiring use of co-design in which participants speculate on possible and desirable futures), our co-design workshops were instrumental [43]. We wanted these workshops to help us understand our toolkit users' needs and to help us design the items' presentation in the way most beneficial for our users. The goal was to solidify the contents of a toolkit at the end of these co-design workshops.

We conducted three co-design sessions via Zoom. Around 40 educators attended each session, with significant overlap between sessions. Details on the design and observations of the co-design workshops can be found in Ref. [40], and below is a brief summary of these workshops.

In the first session, we shared our overall story and focused attendees' attention on four of our endeavors, one each of Henderson et al.'s areas of change [32] that we had selected for inclusion in the toolkit. We invited attendees to think individually about one of these endeavors and then work with a few others in a breakout room to create a scenario featuring someone coming to the toolkit to learn more about the endeavor. These scenarios gave us insight into who might use the toolkit and what should be in the toolkit. Lessons learned from the first co-design session made us realize that participants needed rich context and sufficient background on each item presented in order to contribute to the co-design work. In the second co-design session, we shared those

observations, presented a low-fidelity prototype of the toolkit, and invited reactions to the content of two additional endeavors. Through the reactions and comments from participants, we realized that participants' hope for 'silver bullet' solutions meant that our toolkit needed to manage expectations. During the third and final co-design session, in addition to sharing the content of the final four endeavors, we asked the participants to respond to the questions, "How can these stories make you think about things to do differently? Do they inspire such thinking?" Based on responses and reactions from participants, the eventual audience of our dissemination, a significant framing change occurred: we turned to describing our kit as an *inspiration kit* rather than a toolkit.

The "Inspiration" Kit

The final stage of this dissemination effort was to bring the inspiration kit to life. First, we iterated on the content based on detailed analyses of what was learned in the co-design workshops. We then considered resources and ease of access to choose a development platform; *durable.co* was selected to host our inspiration kit for these reasons. The first author then assumed the responsibility of visual design to match the content appropriately in presenting the kit. The kit was populated with related artifacts and links for each item with the intention of sharing more details of our experiences and providing users with additional resources. We integrated the story of the grant into the kit to provide context, as well as the story of building the kit.

The Seattle U (SU)-RED inspiration kit is implemented as an independent website, which can be accessed at <https://SURED.org/>. The core content of the kit is a set of 10 key stories from our practice (*Our Endeavors*), background on the overall project in which these endeavors were situated (*Our Project*), and information on the process we used to create the final inspiration kit, including details of the co-design workshops (*Our Journey*).

Conclusion

Our RED project aimed to build a culture that fosters engineering identity. To build this culture, we took action in the four essential areas of shared vision, reflective faculty, relevant curriculum and pedagogy, and supportive policies over the five years of our project. In the project's final year, we conducted an audit to identify the most impactful actions we took that contributed to the culture change we observed in our program. We summarized those actions into ten endeavors for dissemination.

To disseminate these endeavors, we collaborated with our target audience through the co-design workshop to determine their interests, questions, and paths for adaptation of our experiences for culture change, and to identify content that would be meaningful to them. Through feedback collected from the co-design workshop participants, we built an inspiration kit with the core content of 10 key stories that we called Endeavors. These endeavors highlight how the story starts, show solutions, and include links to reference information and artifacts (documents, processes, measures, images, etc.). We hope that through the stories we shared and tools we have developed this kit will inspire those who embark on the journey of culture change.

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