

WIP: Teams for Creating Opportunities for Revolutionizing the Preparation of Students (TCORPS) at the Department of Mechanical Engineering, Texas A&M University

This work in progress (WIP) paper describes a National Science Foundation funded RED (Revolutionizing Engineering Departments) Adaptation and Implementation (A&I) grant focused on changing the culture of a large traditional mechanical engineering department at Texas A&M University (TAMU) and is an adaptation of the “Additive Innovations” model developed by Arizona State University in their RED project[1]. The TAMU RED project is focused entirely on culture change via faculty development, with the goal of shifting from a culture where teaching is secondary to research and courses evolve via sporadic, undocumented, individual innovations to a culture that recognizes teaching’s role in both faculty and student success and encourages a sustained process of incremental improvement and responsiveness to student learning through experimentation, measurement, and sharing. Two key levers in this culture change are (a) a faculty development series focused on innovation and data-driven change and (b) the creation of communities of practice[] or “soft wired” teams that support each other and sustain incremental change across semesters as faculty cycle in and out of courses. Ultimately, the goal of this project is to enhance a departmental culture in Mechanical Engineering where faculty regularly discuss current curricular effectiveness and are empowered to develop pedagogical innovations that enable all students and faculty to thrive.

The overarching goal of this project is to create a culture in the Department of Mechanical Engineering (MEEN) at Texas A&M University (TAMU) where faculty form communities of practice (or soft wired teams) to engage in proactive *iterative innovation and sharing* in all aspects of academia, including teaching. Our vision is to evolve the departmental culture from relatively independent and siloed individuals to a bottom-up team structure where the faculty embrace and extend the *iterative build-test-learn-share-modify* method of the maker culture [2] that was formalized by the Lean Startup [3] approach. The core of this approach is the build-test-learn-share feedback loop [4] with an expectation that pedagogical changes will be continuous and based on the notion of a minimum viable product [5] and the measurement of student learning outcomes. A minimum viable product, a development stemming from technology startups, refers to the smallest, simplest product that meets consumer needs. The approach is partly inspired by the “Additive Innovation Model” piloted by Arizona State University [6]. The highlight of this model is the development of a community of students and faculty who are “(1) inspired by shared artifacts/ideas, (2) openly share and learn about the technology and process used to create these artifacts/ideas, (3) design and prototype their own modified version of the shared artifact/idea, and (4) share their modified artifact/idea back with the community” [2]. Faculty already employ investigative and experimentation-driven processes for *research* and we aim to extend their pre-existing expertise to *teaching* to improve curriculum and pedagogy.

Our approach to achievement of this goal is informed by several hypotheses 1) that facilitation of small-batch iterative experimentation and sharing among peers will lower risk and time commitment and increase documentation and systematic implementation of innovations; 2) that change can be better achieved in a large department through the distributed percolation based upon trained facilitators and change agents, supported by departmental resources and revised faculty performance evaluation criteria; 3) that an improved shared vision can be achieved through use of the new Educational Value Canvas facilitated using the Antigua Forum meeting format; and 4) that if we, as faculty, model proactive innovation behavior in both our research and teaching, then we will improve this capability in our students as well.

The fundamental model of change that informs this project is the Prochaska theory of behavioral change ([7,8]), which explains why members might differ in the timing of their initial engagement in the communities of practice developing in the department. The stages of the Prochaska model are briefly described below. Note that although these stages are generally ordered, people are able to skip stages (e.g., no relapse) or return to stages (e.g., recognize a need for additional preparation or action).

1. *Precontemplation*: People lack awareness that there is a problem, a need for change, or change occurring in their community.
2. *Contemplation*: People recognize the need for change and consider the reasons why, but they are not making changes.
3. *Preparation*: People take small steps to move toward change, which could include but are not limited to activities like (a) attending a learning session about change opportunities or (b) developing skills that could help with change.
4. *Action*: People actively engage in change.
5. *Maintenance*: People put in effort to maintain the changes that they have made.
6. *Relapse*: Inevitably, some people revert to their old ways and must relearn or re-engage with change efforts.



With the expectation that the project starts with department members at different stages of readiness for change, we plan to run the project as a cohort model, with the grant team identifying people who are already in the contemplation and preparation (if not action!) stages for the Year 1 cohort. The grant team and the Year 1 cohort's discussion of grant activities are expected to move many department members from precontemplation to contemplation or preparation, thus fueling Cohort 2, and so on, until all members of the department are engaging in action and maintenance activities.

TCORPS Model for Change

To create a culture of proactive, iterative innovation and sharing in teaching, the project seeks to extend the iterative build-test-learn-share mentality of the maker culture that exists for research to curricular and pedagogical improvements. We rely on a “Change Percolation Approach” [9], adapted from the study of social networks, to help team members develop the necessary continuous innovation mindset. The goal is to encourage sharing of hypotheses, experiments, and findings, and thus distribute change both across people and over time. It encourages team members to participate and contribute at their pace and according to their comfort level. To achieve this shift in mindset and to provide distributed training and sustained change, we will recruit faculty change agents to facilitate iterative innovations that are shared and refined by both evidence and peer feedback. Further, we will facilitate the first communities of practice by encouraging team projects in teaching innovation.

To support these innovation cycles, we deployed a summer faculty development program, beginning in the summer of 2021. Content included (a) innovation mindset, iterative innovation cycles, goal setting and measurement, and cultures that encourage innovation; (b) facilitation of the additive innovation process, (c) active learning methodologies and barriers; (d) diversity in the classroom; and (e) the psychology of learning. The summer development program was offered to all applicants who submitted pedagogical innovation proposals. Six workshop classes were offered and facilitated by the grant team, as well as four optional Q&A sessions. The development program is designed to provide formal skills in innovation—skills that might be intuitive in research for many faculty—so the team can communicate clearly about their innovation plans, goals, and evaluations. The program further supports faculty innovation by including information about student learning and diversity. Together, this content is designed to launch innovation

teams into innovation cycles that have good practices and to establish the innovation mentality within the department culture.

Because we bring the necessary training to the faculty, TAs, and peer teachers in regular, distributed, small, informal peer group settings, we anticipate that this will lower faculty perception of risk and the effort required to be part of this TCORPS program and to engage in teaching innovation more generally. Across the three years of the project, we will invite faculty to create a community of practice in each of the major core classes in the second and third years of the curriculum (the first year is shared across all engineering degrees), with the goal of having at least one cycle of the Build-Test-Reflect-Share pedagogical cycle carried out in each of these classes and the results widely disseminated by the end of the grant period.

Additionally, we are conducting at least one educational retreat per year with the aim of further developing a departmental shared vision for teaching innovation. As the project continues, report-outs from established communities of practice will be given. Further, the department provides support for change by providing incentives to encourage early attempts at innovation and dissemination of innovation, including a teaching fellows program at both the faculty and graduate student levels to support these projects. Lastly, annual evaluations of faculty will be restructured to include recognition and reward to pedagogical risk-taking and iterative improvement.

Mapping activities to the Prochaska model of change

PRECONTEMPLATION/CONTEMPLATION: Document the current departmental teaching culture. Our first major step, which feeds into our internal evaluation plan, is the systematic investigation of the current culture. This includes (a) interviews with department members and (b) a department-wide culture survey prior to the launch of grant activities. The goal is to answer the following questions: (1) What are the barriers to pedagogical change in this large ME department? (2) Who is motivated to innovate and why? (3) What are the barriers and stumbling blocks at TAMU in (a) documenting and sharing necessary resources and innovations; (b) institutionalizing successful practices? (4) What are the communication methods between faculty regarding pedagogy and shared vision about training students? (5) What is the faculty perceived timeline to implement a change? (6) What incentives and recognition motivate faculty to implement the changes? Ultimately, we expect to see change on these factors as the project continues.

PREPARATION: Developing a shared vision through Educational Value Canvas (EVC) framework. TCORPS will work towards developing a shared pedagogical vision among faculty a) to better serve the needs of evolving student demographics, b) to better prepare students to face changing real-world expectations, and c) to evolve the department teaching culture. To prompt a discussion on the departmental vision and support this change in pedagogical culture, we employed the Educational Value Canvas (EVC) (Guerra et al, 2014), a strategic planning tool adapted from the Business Model Canvas [11]. This is deployed in an annual retreat to develop teams and shared goals, identify partners, engage in group problem solving, and allocate resources. Our key innovation is the utilization of the Antigua Forum [<http://www.antiguaforum.ufm.edu>], which is a unique meeting format that uses the principles of markets and self-organization applied to problem-solving. Within this format, diverse participants move to various stations and engage in the problem-solving process. Our first EVC was held in March 2021 and the second is scheduled for April 2022. In our first EVC, faculty members reflected upon the current state of undergraduate education within the ME department, the changes expected within education in the next decade, and potential strategies and resources needed for effective adaptation to change.

PREPARATION: Team formation for small-batch experimentation on active learning. Based upon our hypothesis that faculty learn much better from each other's experiences [Schmidt et al. 2016, Bekki et al. 2017], we seek to drive increased incorporation of known innovations in active and project-based learning, inclusive learning environments, a process of small-batch experimentation, learning, and sharing

of pedagogical innovations in a collaborative and fun environment. Faculty teaching the same or interrelated courses were encouraged to enroll as a group in the faculty summer development program and to propose a general goal for their innovation in teaching project. Based on the reported experience of the ASU team, we used an ad-hoc signup basis. Four groups self-organized into teams based on the identification of common student learning outcome needs: (1) Conceptual Rapid Fire Ice Breakers (related to a simple experiment to discover the role of temperature in changing material properties manufacturing); (2) Real World Material Science (related to student engagement in materials science through application focused videos); (3) Music of the Machines (related to improving student insight into data acquisition and signal processing in an inclusive context); and (4) Professional Development (related to improving teaming and conflict resolution skills as a “teaming spine” across many courses). These faculty teams were provided with the innovation training and a facilitated iterative innovation process as described below.

ACTION: Training faculty and change agents in the enabling areas of iterative experimentation, student diversity, student learning outcomes and data, and the psychology of learning. One of the key actions for this culture change is providing information and support on iterative experimentation as well as additional supporting information on student diversity, student learning outcomes and student data, and the psychology of learning. This was deployed in Summer 2021 as a faculty development program and will be redeployed in the following two summers. Major components include an online Innovator Mindset course and assessment, feedback from key grant team members, and formalized training in innovation processes including data scorecards, goal setting, and minimum viable products.

ACTION: Facilitation of the iterative process. During the semester, monthly meetings with all participants were held where each team shared updated progress on their cycle of learning, discussed roadblocks, sought advice on their projects, and committed to activities to accomplish over the next month. Each group completed a presentation template that was provided to scaffold the iterative process. It included the overall student-outcome-oriented goal for the project, the associated key lagging measures, and the key leading indicators (predictive of final outcome). Additionally, the template allowed each team to provide updates on their iterative process and current learning cycle by filling out the following sections: (1) What is the team trying to learn? (2) What is the MVP (minimum viable product)? (3) Experiment status, (4) Key learning from your experiment, (5) Any changes to the hypothesis based on learning, and (6) Next steps.

MAINTENANCE: Sustained engagement in teaching innovation and culture change. The objective of the proposal is to embed goal-setting with the EVC and continuous improvement with the additive innovation process within the departmental processes and culture. To ensure we maintain this process and culture, we plan to organize a yearly retreat to review (a) the efficacy of the soft-wired teams to examine their functionality and identify any necessary changes (b) a review of the EVC to update the strategy (c) a review of the training activities and (d) a review of the pedagogical innovations that are being created, tested and shared to see if they are suitably inclusive and being adopted by others and (f) a review of the research documentation activity to see if we are documenting the findings in suitable venues. Internal and external evaluation focuses both on change in the department as well as the sustainability of those changes. These evaluations are ongoing.

References

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