

Design Systems Thinking for Innovation in an Engineering Faculty Development Program

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Work in Progress: Design Systems Thinking for Innovation in an Engineering Faculty Development Program

Abstract

This is a work in progress paper describes design systems thinking as a paradigm for evolving faculty development. Managing organizational change is a difficult task, often dependent on the way ideas are operationalized for effective innovation. Systems thinking leverages value creation across organizational systems to support innovation based on design. This paper explores the utility of design systems thinking for creating innovation in a national engineering faculty development program.

Design systems thinking has been used by Engineering Unleashed as part of a multi-year innovation effort in engineering faculty development. We seek to shift the mindset of traditional engineering faculty development using best practices for relationship building by coaching, mentoring, and through communities of practice. Two outcomes of the systems thinking model from this work include (i) a faculty fellowship program to recognize and reward faculty development of transformational projects and (ii) self-paced learning structures to encourage emergent ideas. This paper addresses the first steps for the following research questions:

- Does a design systems thinking approach create a responsive model for a community-driven faculty development program? Does this model adapt to community needs and individual faculty career needs?
- Will a design systems thinking approach support the community development of a sustainable model for faculty development that thrives outside of the funding organization?

This project is ongoing and this paper reports on the way design systems thinking has been used to create a bottom-up and top-down innovation structure. Preliminary results in this paper include an analysis of growth in the faculty development program, a timeline of expected evolution, and a summary of community engagement structures in place. The poster presentation will focus on the evolution of the faculty development program.

Introduction and Background

The Engineering Unleashed (EU) faculty development process started initially with a faculty development workshop focused on integrating the entrepreneurial mindset (EM) into engineering education. As the EU work expanded, the opportunity to launch additional offerings for faculty development emerged based on analysis of traditional systems. In 2019 the EU program launched a series of faculty development workshops framed with both a systems approach and design thinking. A summary of the program changes over time is shown in Figure 1.

The primary goal of the faculty development program is to foster EM in engineering education by engaging faculty in EM activities and perspectives that they can implement with their students [1]. Faculty needs were mapped to a suite of faculty development offerings that included workshops addressing EM activities and perspectives targeting curriculum, teaching, research, industry, and leadership.

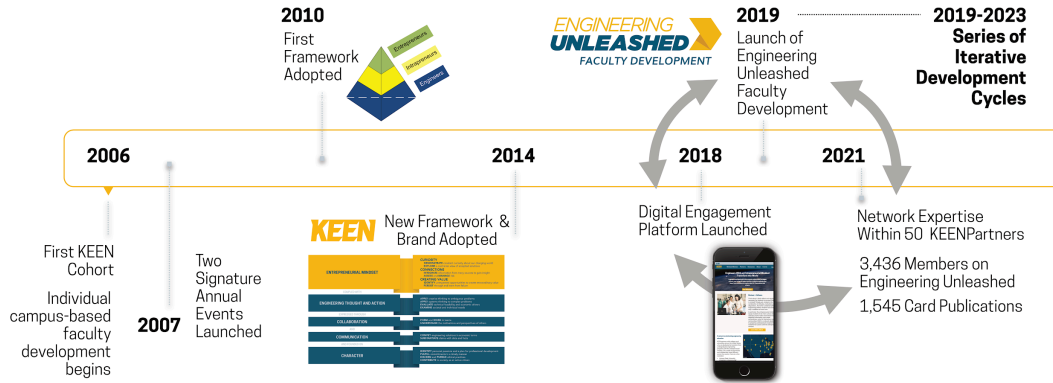


Figure 1. Timeline of EU faculty development; iterative elements are shown for feedback processes.

Design thinking is a systematic problem-solving approach nurturing creativity to solve complex problems [2], [3]. Design thinking is human-centered, meaning it is empathetic and personal in nature, and promotes experimentation, prototyping, and testing with a goal of finding undiscovered possible solutions. A premise of design thinking is the positive nature of early failure, based on the idea that failure teaches much more than could be learned without it. Through failure, weaker areas in designs can be identified and solutions can be found to avoid them. Another premise of design thinking is the importance of understanding customer needs in the path toward appropriate and creative solutions. This method has been used successfully with students to enhance EM [4]. Our adaptation of the design thinking framework in the context of our faculty development project is shown in Figure 2.

In the context of faculty development, design thinking provides a structure for aligning the needs of participants with rapid prototyping. Rarely has an organization tackled rapid prototyping and testing in the context of faculty development because the process is expensive and logistically challenging, making our experiment unique. In 2019 eight different workshops were offered and 2020 ten workshops were offered to 228 participants. In each workshop, feedback from participants, coaches, and facilitators was considered as the next round of offerings were planned.

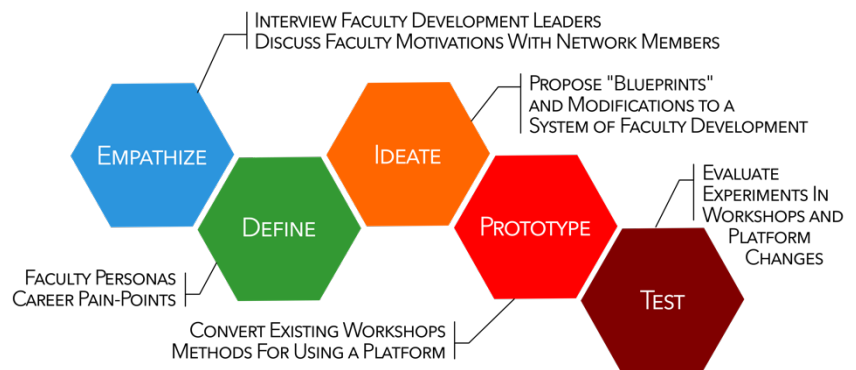


Figure 2. Summary of the design thinking framework, adapted to summarize the connections to EU [2], [3].

Another framework for this structure is tied to **systems thinking**. Systems thinking helps shift our mode of thinking toward a better understanding of how components of the system are interconnected and their influences impact overall system behavior. This includes mapping connections and creating feedback loops, making it useful for engineering and education [5], [6]. Systems thinking also acknowledges that

there are no perfect solutions, as trade-offs always impact the system. Systems thinking is connected to and complements the field of “system dynamics” [7], [8].

Design systems thinking is an amalgam of design thinking and systems thinking encompassing features and perspectives of both modes of thinking [9]. The hallmark of design systems thinking is the mindset of holistic system-level experimental problem solving that is empathetic, personal, and infused with model-building and learn-from-everything thinking, including failures that are part of the process. The openness to effectively solve any problem, including multi-dimensional and fuzzier problems, by broad-reaching non-linear thinking that accounts for system influencers (that may have positive and negative effects) is core to design systems thinking. For faculty development, using design systems thinking to capture both systems thinking and design thinking provides a rich way to consider a complex experimental system with hundreds of individual stakeholders.

Methods

We applied both design thinking and systems thinking in the design of faculty development workshops. Research questions are how these models may assist us in adapting to the needs of the engineering education community and in creating a sustainable model for faculty development programs. In particular, the questions posed are:

- 1) Does a design systems thinking approach create a responsive model for a community-driven faculty development program? Does this model adapt to community needs and individual faculty career needs?
- 2) Will a design systems thinking approach support the community development of a sustainable model for faculty development that thrives outside of the funding organization?

To explore these questions, we used systems thinking to map elements of faculty development (Figure 1) and created robust feedback loops. Feedback mechanisms connect each major component of the program.

- Workshop facilitators are coached and collaborated with prior to the workshop launch, and then provided feedback real-time during the workshops by the leadership team.
- Coaches (peer mentoring) are embedded in the workshop development process and connected directly with faculty participants. Coaches provide feedback to the facilitation teams over the year long process [10].
- Workshop participants are asked for feedback frequently during the workshop, after the workshop, and after the coaching process progresses. Surveys focused on the coaching experience are also part of this loop.
- Participant outcomes are reviewed by the greater EU community as part of a post-workshop fellowship opportunity.

We also used design systems thinking to structure the total programmatic approach. This included rapid prototyping of new workshop offerings, empathy-based design of the program elements, and testing methods. Specific examples for each element of the systems thinking are shown in Figure 3.

Preliminary Results

Applying systems thinking to the EU faculty development program led to the multi-faceted approach shown in Figure 3. Each element of the system model is included in the program with multiple development and feedback opportunities.

The design thinking process was used to focus on key parts of the participant experience. To meet the goals tied to each target group, the design thinking elements are connected to activities in each category, as shown in Table 1. This matrix structure allowed us to identify opportunities for future faculty development offerings that might focus on the department or unit level.

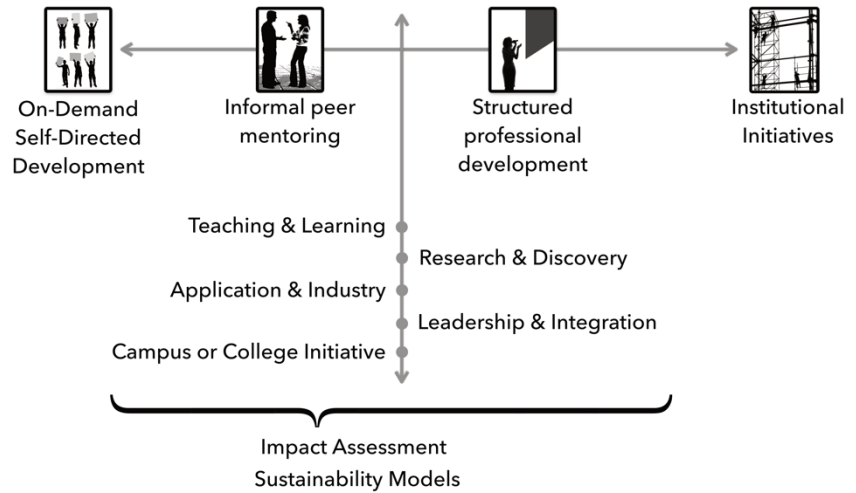


Figure 3. Summary of the way systems thinking influenced the design of the workshop offerings and the elements of the development opportunities.

Table 1. Summary of the way design thinking mapped to specific facets of the faculty development process.

	Individual Faculty	Department/Unit	National Network
Empathize	Individual coaching	<i>[Future Opportunity]</i>	Network Coaching [10] and Mentoring [11]
Define	Workshop learning outcomes	<i>[Future Opportunity]</i>	Overarching goals for faculty development
Ideate	Supporting innovative facilitator brainstorming for workshops. Culture of co-creation.	<i>[Future Opportunity]</i>	Market and model assessment
Prototype	New workshops each year as prototype ideas are generated.	Campus specific workshops are prototyped each year.	Workshops focused on cultural change and leadership have been tested to support national change.
Test	Surveys for faculty	Visibility to Deans and Chairs	Engineering Unleashed Fellows Awards

Empathy allowed a focus on direct peer mentoring with the coaching process. The coaches served an important role providing feedback to workshop facilitators and the leadership team. Our perspective is that empathy includes organizational empathy from one institution to another.

The **define** phase created the need for strong workshop learning outcomes at multiple levels to provide clarity for the facilitators, coaches, and participants. Every EU faculty development workshop was intended to:

- equip and support participants in the application of new learning to their own context,
- create a safe and encouraging space for exchange among the participants,
- challenge participants to examine and leverage behaviors associated with an entrepreneurial mindset so they might better innovate and create greater impact through their own work,
- create additional valuable resources and content for the Engineering Unleashed community through publication of projects,
- accomplish the above in a learning environment that adds inspiration, is dynamic, memorable, and enjoyable — even fun, and
- offer an opportunity to extend and amplify their related work through a potential Engineering Unleashed Fellowship.

The **ideation** phase of the process influenced the way facilitators were encouraged to brainstorm new methods for what “faculty development” might mean for an individual faculty member. At the national level, EU worked with an outside consulting group to ideate ways that the workshops might evolve over time at the national level. The greater EU community is actively providing new ideas as part of an annual summit to identify new workshop ideas that could be prototyped.

A four-month study was commissioned to evaluate the business sustainability of various delivery models. Some models included one-year development of engagement and interaction with facilitators and coaches. Other models relied upon more scalable on-demand resources for delivery. Based upon economic drivers, the findings favored models that leverage on-campus faculty development initiatives for delivery, e.g. centers of teaching and learning and those housed within colleges of engineering. These initiatives vary widely and may benefit from outside resources and expertise. An initial period of philanthropic support enables intercollegiate collaboration, creating a coherent and coordinated collection of offerings that yield reusable resources. The on-campus initiatives benefit by adapting these resulting resources and engaging the growing body of subject matter experts that lend themselves to faculty development.

The **prototyping** process is still underway. Each year new workshop and facilitation teams are added. Existing workshops are evaluated, improved, and evolved based on the feedback loops established. At the individual faculty member level, one workshop Integrating Curriculum with Entrepreneurial Mindset (ICE) focused on helping an individual faculty member change classroom practice. At the department or unit level, new workshops have been tested that focus on the needs of a specific school or unit. An example is a workshop for Montana State University in 2020 that took elements of two other workshops and structured the material in the context of the institutional focus. At the national level the prototyping includes workshops focused on leadership and culture change.

The **testing** process is ongoing. Survey and feedback results are collected at multiple levels and examined to determine how the workshop outcomes are met. This process is tied to the systems aspect of the project. Results have created dramatic shifts in some workshop content and some changes in offerings. At the unit level we have focused on sharing visibility about all the layers back to deans and chairs, including both the faculty participants, facilitators, and coaches.

The Engineering Unleashed Fellows program has provided an important way to assess the program outcomes, and provides incentive for the participants. The EU Fellows program recognizes participants for their contribution to engineering education, and specifically engaging students in projects and activities that promote the entrepreneurial mindset. Selected participants are provided with funding following the year of coaching to advance their work. Coaches nominate a select number of participants, based on their exemplary work and potential for significant impact with students. Approximately 10 percent of workshop participants are selected for this honor.

The changes developed in the program confirm that using a system thinking approach is helpful for creating an adaptive faculty development program. Over time, the adaptations of the program will help us address the second research question, will design systems thinking help the program become sustainable?

Future Plans

Table 1 provides an overview of the impact and growth opportunities that the faculty development program. Future work may focus on supporting the unit level impact in new ways to address our second research question. This layer may be an opportunity to infuse sustainability for some of the workshops as EU Faculty Development transitions the prototype workshops to new homes. A conceptional idea of this future work is shown in Figure 4, including the possible repurposing of the workshops inside departments and teaching centers.

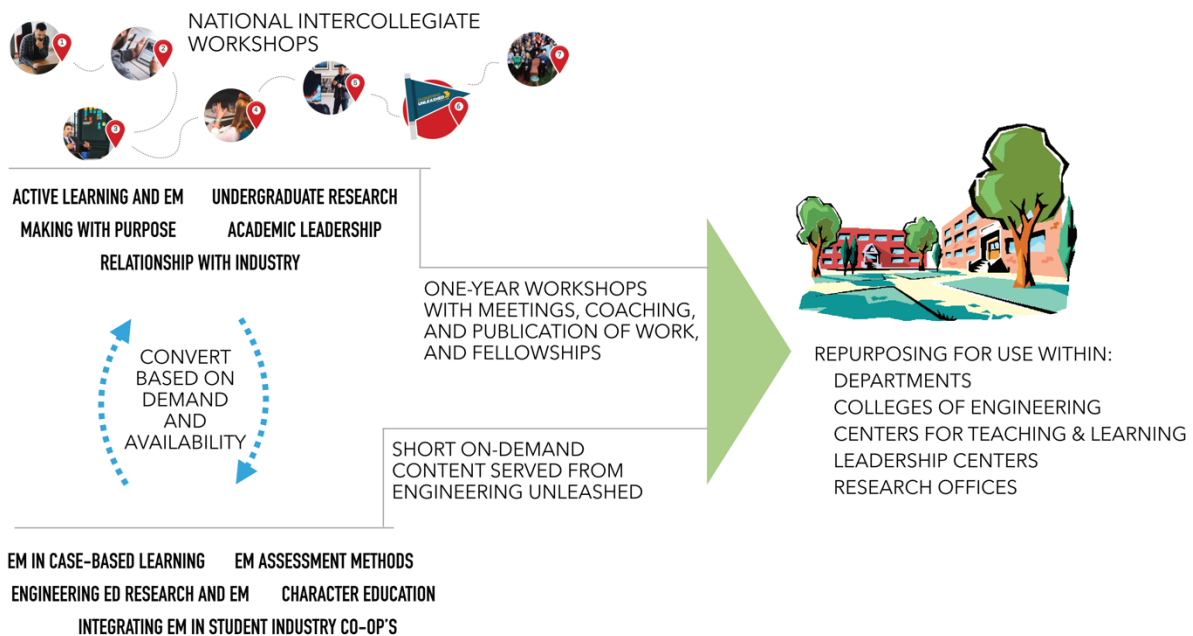


Figure 4. Summary of the changes and the iterations in EU Faculty Development due to design thinking and systems thinking frameworks.

The design systems thinking approach to faculty development has created a rich iterative process that continues to evolve. Feedback from participants, coaches, and facilitators has been incorporated into decisions about future faculty development offerings, including the format of each workshop. This feedback has driven new innovation, including the fellow awards program that launched in 2020. The 2021 workshops new offerings have been developed based on empathy for faculty participants. The testing process continues to guide our process and evolve the workshops. The design systems model

reported here promises to revitalize (or reshape) faculty development offerings, ultimately transforming student experiences in and outside of the classroom.

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