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Implementing Grassroots Initiatives of Change: The Combined Perspectives from Psychology and Anthropology in an Engineering School*

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Efforts to introduce and evaluate change in engineering education have focused primarily on pedagogical change. Our article examines organizational-culture change within a U.S. Engineering School of a large R1 university in the U.S. Midwest. It integrates elements of organizational change (primarily from psychology) and cultural transformation (from anthropology) to demonstrate their combined usefulness for engineering educators. The broad change effort, structured as 12 grassroots problem-solving teams, was organized to solve specific issues that were expected to have a positive influence on student outcomes, as well as on the Engineering School culture; the teams chose projects whose outcomes did not rely on approvals from department, school, or university leadership. Through interviews, observation, survey data, and participant observation, we document team formation, implementation of their initiatives, and their outcomes. Individual agency and leadership play a critical role in launching initiatives. Initiatives grow and develop with alignment between team goals and day-to-day work roles on campus. Institutionalization of change into programs, practices, and policies occurs when individuals are responsible and accountable for them. Our findings reflect a raw, realistic form of organizational change where change and continuity are intertwined with cultural alignment, clashes, and individual agency and where no single trajectory of change dominates.

Keywords: organizational culture; change; psychology; anthropology, grassroots teams, institutionalization

1. Introduction

1.1 Pedagogical Reform in Engineering Education

Calls for change at U.S. universities emphasize research on and support for innovative pedagogical practices to improve teaching in higher education [1]. In engineering education, calls for reform since the 1990s have focused on changes at the curricular level such as implementation of new course material, revision of existing class content, and modification of teaching techniques [2]. In 1991, for instance, the U.S. National Science Foundation (NSF) funded engineering school alliances for up to a decade to create, test, review, and disseminate new pedagogical strategies, reformed curricula, and new class formats [3, p. 393]. Similarly, in the early 1990s, the Accreditation Board for Engineering and Technology (ABET) began to revise their evaluation criteria to support curricular improvement. ABET's new focus promoted the establishment of well-defined learning goals, strong evidence that both faculty members and industry representatives would contribute to outlining these learning goals, and evidence that such goals were attained as reflected in the work of engineering graduates [4, p. 315; 5, p. 318–319].

1.2 Growing Interest in Cultural Reform in Engineering Education

In the late 1990s through 2010s, several reports in the U.S. and Europe emphasized more comprehensive approaches to improving engineering undergraduate education, including its culture. The American Society for Engineering Education (ASEE), in conjunction with NSF, developed a "who/what/how" framework for addressing culture change in which faculty and administration would lead change initiatives [6, p. 2–9]. Indeed, the

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Jamieson and Lohmann report emphasized the word "culture" in its subtitle: "Creating a Culture for Scholarly and Systematic Innovation in Engineering Education." Besterfield-Sacre et al.'s [7] analysis of the survey reports from the ASEE project argued in favor of creating a shared vision for education innovation – a critical feature in cultures exhibiting cohesion.

Goldberg & Somerville [8] put culture at the center of engineering education reform in their comparison of two engineering programs, finding that emotional and cultural factors (e.g., trust, openness, connectedness) were more important to reform than other elements (e.g., pedagogy, curriculum). That same year, NSF issued a solicitation to "Revolutionize Engineering Departments" (RED) by involving social scientists who could help guide and implement change processes "through the development and engagement of the entire faculty" to build student capacity in "professional skills, including design, leadership, communication, understanding historical and contemporary social contexts, lifelong learning, creativity, entrepreneurship, and teamwork" [9].

We report results from a series of change initiatives taking the form of grassroots teams in a U.S. Engineering School (ES). We define change, following Malinowski, as the "process by which the existing order . . . is transformed from one type into another" [10, p. 1]. Thus, the pattern of change would be "cohesive . . . integrated into the firm's organizational structure, beliefs and expectations, and behavior rather than being a 'cosmetic' or transitory change" [11, p. 8]. The teams were organized to solve specific issues that were expected to have a positive influence on student outcomes, as well as on ES culture. We focus on how the teams were formed, implementation of their initiatives, and their outcomes. We not only illustrate the change patterns and processes at work in grassroots change initiatives, but we also document the value of studying ES culture using concepts and methods from both psychology and anthropology. We propose this combination of disciplinary approaches as a model to extend the psychological-oriented research conducted by many U.S. engineering education scholars.

2. Theoretical Frameworks of Change

Culturally, research continues to play a core role in universities [12–15], particularly at research universities. Acquisition of external funding and criteria for promotion and tenure have reinforced this emphasis on research over teaching [12, 13, 15–17]. As the status of teaching relative to research declined at large universities, questions emerged about the faculty's pedagogical role and responsibility to students.

2.1 Focus of Engineering Education Reform

Changes in pedagogy, especially curriculum, have been among the most popular areas of research focus in engineering education. Some writers emphasize instructional change or educational development [18–22], while others examine curriculum change [2, 23–24], and still others emphasize both [25]. Numerous attempts have been made to identify indicators of successful pedagogical efforts of change, with calls for "long-term and context-based research" issued [26, p. 132]. Increasingly, studies are situated within a broader conceptual framing of the institution or educational system [7, 27] and some in engineering education advocate for using or adapting change models from fields beyond STEM [24, 28].

Henderson et al.'s [29, p. 132] literature review identifies four change strategies including "disseminating curricula and pedagogy, developing reflective teachers, developing policy, and developing shared vision." Disseminating and implementing effective teaching practices has generally been elusive [30]. Other research extends the four-quadrant typology [27, 29, 31] and/or targets systemic change [19, 21]. Besterfield-Sacre et al. [7, p. 193] argue that shared vision holds the "greatest promise for transformative change." While shared vision is valuable for organizations seeking or engaging in planned change, it represents only an initial step. Many other follow-up decisions and actions – the focus of this article – will be necessary during the cultural transformation process.

2.2 Rising Influence of Organizational-Change Studies

Fields such as psychology, sociology, and management have influenced research on organizational change, subsequently adopted by engineering education. Two elements stand out: process models and salience of the individual.

2.2.1 Process Models of Change

Lewin [32, p. 35] is well-known for introducing a three-stage model of change to improve group performance consisting of "unfreezing (if necessary) the present level L^1, moving to the new level L^2 and freezing group life on the new level." Future iterations of his model expanded into multiple stages [33, 34]. These time-based models have been borrowed, adapted, and woven into selected engineering education studies [24, 35]. Clark et al. [36, p. 44] illustrates a four-phase model: "develop the curriculum; pilot it and persuade colleagues to adopt it; implement it in a form that works for all

students and faculty; (and) devise structures and mechanisms to sustain its continuous growth.'' Such models prescribe the sequence of activities, a useful starting point for exploring change in organizational settings. They also incorporate the concept of readiness for change as used by organizational change scholar Armenakis and his colleagues [37, 38].

2.2.2 Salience of the Individual

Schein, a social psychologist, calls attention to the individual by referencing selected attributes in his change model: ''motivation,'' ''internalizing,'' and ''self-concept'' [39, p. 300]. Rogers [34, p. 281] categorizes individuals by how quickly they adopt an innovation (e.g., ''early adopters,'' ''laggards''). Similarly, engineering education studies highlight the individual's motivations and choices as individual ''beliefs and behaviors'' and ''behavior or mental states'' [31, p. 19]. A focus on individuals can help signal the importance and relevance of particular viewpoints and actions in a given context.

When individuals collaborate ''simultaneously and cooperatively,'' the likelihood of developing new ideas is augmented [40, p. 43]. Leaders can disrupt existing patterns, enabling innovation [41]. Small, problem-solving teams, using a Strategic Doing approach, for example, come to rely on their ''shared leadership'' to address complex problems [42, p. 118]; a facilitator guides the discussions and assists the team in learning and applying 10 skills (e.g., frame the conversation with the right question, identify your assets). Facilitators essentially help teams to ''organize themselves'' and ''become more independent and responsible'' [43, p. 418]. These two elements derived from psychology – the individual and process models of change – intersect. Individual leaders, whether formally designated or informally emerging, play critical roles in organizational change (e.g., establishing goals, guiding change process, serving as role models). Our results and synthesis presented later leverage this understanding of change.

2.3 Anthropological Perspective on Change

2.3.1 Cultural-Change Mechanisms

Until recently, anthropological research on change was comparative across societies, rather than explored in organizational settings. Anthropologists focused attention on mechanisms of change including invention/innovation, cultural loss, and diffusion of ideas, practices, and people [10, 40, 44, 45]. Yet, these mechanisms are shaped by ''determinants of change'' (e.g., technologies, environment) and ''agency'' – the capacities of people to affect their future [46, p. 6, 3]. Cultural change is a difficult area of study, in part, because it is continually ''in flux'' [10, p. 9].

Innovation, diffusion, and cultural loss evoke certain reactions in both organizations and people (e.g., rejection, modification). The ways in which cultural practices are intrinsically bound together (exemplifying holism, or attention to culture as a whole) has been used to explain resistance to change: ''practices . . . considered hopelessly retrograde and inefficient can be maintained indefinitely simply because to change them would threaten the balance of the social whole'' [47, p. 113]. System stability is favored over instability [48]. Situational conditions including supporters of the innovation's acceptance or rejection have been emphasized [40]. ''Frequently overlooked'' in this literature is an investigation of the ''actual ongoing process of change'' [46, p. 31], which does not assume a simple, prescriptive model (as in the organizational-change scholarship).

2.3.2 Cultural Transformation in Organizations

Anthropological research in organizations targets the ''behavior in and around any organization or the behavior of the consumers of products and services provided by an organization'' [49, p. 3]. Within the burgeoning literature is a focus on understanding and improving organizational effectiveness, including laying bare the responses to changing circumstances [50–52]. An historical context, an analysis of the present state, and ways to create a better future are brought to life through a descriptive and explanatory analysis of ethnographic evidence. For example, [53] identified outcomes associated with paths of innovations, or trajectories, within siloed organizations. Anthropologists name the change process underway (e.g., innovation, diffusion) and then focus on the patterns of behavior associated with it. They also consider the impact of the change on an organization or community.

Anthropologists have contributed to cultural transformation in engineering education. Baba and Pawlowski [54] developed a model of the curricular-change process highlighting (1) culture as a dynamic process with numerous interacting elements, (2) a holistic consideration of all parts of the culture, and (3) use of an ethnographic methodology. Yet, according to Godfrey and Parker [55, p. 7], ''mainstream engineering educators'' have not continued Baba and Pawlowski's line of research. In fact, it was not until the 2010's that there was any substantial scholarship related to engineering education change or reforms using anthropological theory and methodology [56-59]. Contributions to this revitalized disciplinary emphasis have the potential to bring culture and cultural change into focus.

This article integrates elements of organizational change (primarily from psychology) and cultural transformation (from anthropology) to demonstrate their combined usefulness for engineering educators. The broad change effort we examine within a U.S. Engineering School (ES) is structured as grassroots problem-solving teams; earlier conference publications by members of our research group serve as a useful starting point [56, 59]. We anticipate that the cumulative effect of these grassroots teams will lead to a cultural shift away from preservation of the status quo to some embrace of transformation. We focus on how the teams were conceived, implemented, and modified over a five-semester period and ask the following research questions (RQs):

- RQ1. What is the role of individual agency and leadership in innovation and change initiatives?
- RQ2. How can change patterns and processes be described and explained?
- RQ3. What can be learned from combining individually- and culturally-oriented approaches to change within organizational settings?

3. Data and Methods

3.1 Data Collection

Ethnographic research uses a multi-method approach [60] and captures the emic (i.e., insider) perspective in participants' own words, using their "categories, concepts, and perceptions" [44, p. 15–17]. Grassroots teams, convened to address ES issues that team members cared about, represented our unit of analysis. Table 1 illustrates the number of teams that nine members of our research group studied over a five-semester period. The first group of grassroots teams (Teams 1.0) convened in Spring 2017 while the second group of teams (Teams 2.0) began one semester later in Fall 2017. Faculty and staff participated in these 12 teams along with some students whose involvement was limited due to scheduling commitments (See Sections 5 and 6); staff refer to those individuals who support ES through academic advising, lab instruction, administrative tasks, research, and management and supervision. The ES had only one full-time administrator who was not involved on a grassroots team because he was part of our research group, while part-time administrators continued to perform their faculty role. We recruited team members, which varied in number by semester, via outreach at departmental presentations, email invitations, one-on-one conversations, word of mouth, and posted flyers. Individual interest was the key motivator for participation, and team initiative ideas were solicitated from ES personnel. Team members opted in to participating, and no monetary incentives were offered. Our understanding of these teams and the outcomes they achieved were based on a combination of methods.

3.1.1 Participant Observation

Participant observation helped us to learn about and understand issues and reactions to the change initiatives, conduct our data collection, and inform our analysis. Members of our research group, with knowledge of ES organizational culture, often conversed with team members directly – during and around team meetings. Our research group leader, in particular, was continually engaged in the ES (e.g., through teaching, meetings, research) which enabled him to gather critical insights.

3.1.2 Team Observations

Pairs of trained anthropology observers attended 45 grassroots team meetings in Spring and Fall 2017. They recorded attendance, team composition (e.g., participant role, status), facilitator role, participants' degree of engagement, dynamics among members, and outputs. They also compared notes for validation purposes and identification of salient themes.

3.1.3 Interviews

Our research group conducted 19 semi-structured interviews ranging between 15–60 minutes in Fall 2017; they were audio recorded and transcribed (See Table 2). Some brief conversations with a few interviewees occurred in 2017 and 2019. All interviewees signed consent forms prior to participating. Our questions probed participants' experiences: When/how did you hear about [this change initiative]? Why did you decide to get involved? What was your role and level of involvement like? How did the process work? How well did the team function? What did the team accomplish? What was your view of the team facilitators? How were the teams different from other departmental (or external) committees? (If participant dropped off a team) Why did you decide to disengage?

Table 1. Data collection timeframe by number of grassroots teams

	Spring 2017	**Fall 2017**	**Spring 2018**	**Fall 2018**	**Spring 2019**
Teams 1.0	5	2	2	2	3
Teams 2.0	0	7	7	3	4

Table 2. Interview characteristics

	ES Faculty	ES Staff	Non-ES Staff	Total Interviews
Individual Interviews	12	5	2	19
Average Interview Duration (in minutes)	35	60	41	42

3.1.4 Exit Survey

We administered an exit survey to team members in December 2017. Fourteen individuals from five Fall 2017 teams responded to the survey (41 percent response rate) including five ES faculty members, eight staff, and one student. The survey included 31 open-ended, numerical rating, and Likert scale questions. It elicited information about participant role, team membership, meeting techniques used, satisfaction with the experience, and recommendations for improving future meetings.

3.1.5 Documents

We gathered documents including emails, team leader and facilitator notes, team goal statements, and charts depicting teams' work throughout the data collection period. We used these documents to complement our understanding of team tasks and accomplishments.

3.2 Data Analysis

We used content analysis to identify themes and patterns in our data [61, 62]. We reviewed our analytical memos of the codes which allowed tracking our reactions to the data and a reflection on potential patterns and connections. We also investigated team activities defined as "any action or coordinated grouping of actions that is aimed at affecting existing arrangements in the phenomenal world in some way" and which may be "material, social, or psychological" [45, p. 323]. Examples included meeting attendance, pilot implementation, and initiative expansion or contraction, among others. Close attention was paid to the specific contexts as well as the interactions, relationships, and actions associated with them, enabling us to develop an analysis consistent with "thick description" [63, p. 30].

Notes from the anthropology observers and interview transcripts were coded using NVivo 12. Two different researchers coded the data to ensure analytical validity and resolve any discrepancies. Coding the observational data led to developing a chronology of events for each meeting and an analysis of team dynamics for all teams, enhanced by visual material (e.g., photographs, drawings) and anthropology observer perceptions. Interview codes revealed aspects of team functioning, insights on member involvement, perceived barriers to change, along with faculty expectations, job responsibilities, priorities, and rewards. The open-ended survey data was coded manually. We summarized the quantitative data using descriptive statistics.

We present our results as a step-by-step process of discovery. Our analysis is partly conditioned by the chronology of the data collection. We began our initial analysis of Teams 1.0 shortly after their work began. We conducted a subsequent analysis of Teams 2.0 following their first semester of collaboration. It was helpful to examine the two sets of teams separately and then compare them for similarities and differences. As such, the analysis is reflective of the journey we took to understand and explain the emerging patterns, as well as the journey that the teams experienced over the course of multiple semesters. We also had additional conversations and email exchanges with team leaders to validate our findings after the formal data-collection period ended in Spring 2019.

4. Engineering School Context

4.1 The Setting

We conducted our study at a large, public university in the midwestern U.S. with over 30,000 students. The Carnegie Classification of Institutions of Higher Education has designated this university as an R1 doctoral institution credited with widespread research activity. ES has about 80 tenured/tenure-track faculty members and 1,400 bachelor students. According to the ES webpage and admissions recruitment materials, students acquire hands-on and problem-solving skills through coursework, and global perspectives through study abroad programs. Internship and co-op placements enable students to put classroom-learned skills into practice.

4.2 Birth of a Grassroots Change Effort in ES

Our approach to planned change was to build small grassroots teams to improve student learning experiences and encourage faculty, staff, and students to interact and collaborate more, thereby stimulating organizational-culture change within ES. Team topics emerged from conversations with ES members and earlier results from this research project. These topics were targeted for exploration at the intersection of faculty and staff, faculty and

students, and staff and students, as well as those crossing all ES roles. Each team's goal was to identify and experiment with a solution to an organizational issue (e.g., improve student mentoring). These teams were expected to be time-limited to one semester and involve less than five hours/month of each participant's time.

Faculty members were introduced to the concept of grassroots teams at the Fall 2016 faculty retreat. There they self-selected into one of nine possible teams for roundtable discussions lasting about 30 minutes. The teams with the highest number of participants at the faculty retreat launched formally in Spring 2017, though one team, Community Culture, got a head start by meeting in Fall 2016. Team members were almost exclusively faculty since we hoped to build on the exposure that the faculty retreat afforded. The teams were also structured around a teamwork technique known as Strategic Doing (SD) which trains individuals in ten different collaborative skills [64, 65]. An SD facilitator, a member of our research group, coached the 1.0 Teams in Spring 2017. He introduced a limited amount of SD training during team meetings, calling attention to 10 skills for productive teams [42] (See Section 2.2.2). SD relies largely on team self-management and anticipates a capacity among team members to volunteer for team tasks. Our research group built on the SD facilitator's inspiration and familiarity with grassroots-team organizing to innovate in ES organizational culture.

By Fall 2017, we altered our approach with the 2.0 Teams in two ways. Our research group created more diverse teams (i.e., faculty, staff, and students) since we believed the teams would benefit from different perspectives. We also used a combination of SD, per the "guidelines for grassroots teams" [56, p. 3], and project management methods [59] with most of the teams. This hybrid approach, which we called agile facilitation, emphasized the value of collaboration in a networked environment, but steadfastly kept the team focused on its particular meeting goals. It was less self-directed than SD since it relied heavily on the role of a project manager who had joined our research group. She was responsible for coordinating the meetings (e.g., team communication, logistics), guiding the team discussions, identifying tasks for team members to complete, and keeping a record of team discussions and decisions [59]. Her capabilities helped to refocus and manage the grassroots teams differently in the hopes that they would lead to more piloted experiments, and ultimately, solutions.

5. Grassroots Teams 1.0

5.1 General Characteristics

Since we are structuring the presentation of our data as an analytical journey, we begin with data from the first group – the 1.0 grassroots teams. Five of them launched in Spring 2017 based on participants' individual interests (See Table 3); two emerged from our research group's preliminary findings (Faculty Office Hours and Tutorial Rooms) and the remaining three were suggested by faculty. The teams ranged in size from one to six members and attended meetings lasting between 30–60 minutes. The teams were composed almost exclusively of faculty. Only two of the 16 meetings had representation beyond faculty: a staff member participated in Community Culture in early March and four students joined Undergraduate Research in early April. Two anthropology observers documented the team meetings. By the semester's end, Faculty Office Hours and Community Culture successfully piloted potential solutions to an issue identified in their teams. Specific details on outcomes are presented later

5.2 Strategic Doing Facilitation

The theme of facilitation, which entails designing and managing productive meetings, emerged from our initial analysis. As one of the first themes we identified on our analytical journey, it was not immediately apparent to us how it related to the

Table 3. Selected initiative characteristics (Spring 2017)

Team Name	Team Focus	Number of Meetings	Average Number of Participants	Outcome at Start of Next Semester
Undergraduate Research	Improving ways of matching qualified students with research opportunities	3	6	No pilot implemented
Faculty Office Hours	Exploring what would happen if more students attended faculty office hours	4	1	Successful pilot
Community Culture	Developing a stronger ES community through creative media (i.e., the arts)	4	1	Successful pilot
Lunch with Students	Building informal relationships between faculty and students	4	1	No pilot implemented
Tutorial Rooms	Increasing faculty-student interactions during homework and study sessions	1	0	No pilot implemented

RQs. We learned that the SD facilitator framed his facilitator role in this way: "You need leadership asking questions, setting the agenda, and guiding discussion." Indeed, we observed the SD facilitator acting accordingly – both in explaining the SD principles and serving as a coach during the team's discussion.

At the same time, however, team member comments and body language suggested a lack of engagement with the SD process. The excerpts below from two of the trained anthropology observers offer an orientation to facilitation challenges and team dynamics; they are based on reviewing, reflecting, and lightly editing their raw notes for our research group. Their observations revealed little direction or expectations setting, paralleling the lack of focus and engagement from team members. Little substantive work was accomplished.

Observational excerpts of undergraduate research team, early March 2017

- Attendees: 6 faculty, 1 facilitator, and 2 anthropology observers
- Meeting Length: 4:00-4:36 p.m.

There was no general introduction to begin the meeting and no agenda was used by the team. Conversation was fast-paced, and the team switched topics often and unpredictably, often revisiting parts of past topics in a big confusing circle in which topics were rarely discussed in depth. (Anthropology Observer A)

The participants in general appeared disengaged in the conversations occurring and indicated refusal to respect each other through constant interjections and talking over one another. (Anthropology Observer B)

While [the facilitator] often attempted to make eye contact with the team members, they were often distracted by their phones, tablets, or laptops and did not return his gaze. (Anthropology Observer A)

Observations about facilitation effectiveness from the Undergraduate Research team are congruent with assessments from other teams. Anthropology observers of a Faculty Office Hours team reported confusion about the facilitator's role: "We also noticed ambiguity in authority and leadership, specifically the decision-making process. The faculty seem to think of [this facilitator] as the leader, so no one is taking independent action." Survey comments suggested some degree of frustration, in this case by a staff member:

> I have no issue with Strategic Doing but I would assume most academic professionals – most of us – have graduate degrees, know how to effectively run a meeting and plan. That is what I do all day as an academic advisor. So, it was weird being lectured on that structure at the beginning. I think we could have jumped right in.

Later in the month with a different facilitator, the team continued to experience decision-making challenges through repeated requests for the team to take action. Only in the meeting's last minutes did team members make a decision (as described in the excerpt below).

Observational excerpt and observational summary of undergraduate research team, late March 2017

- Attendees: 7 faculty, 1 facilitator, 1 assistant facilitator, and 2 anthropology observers
- Meeting Length: 4:00-4:45 p.m.

Excerpt

*The facilitator asks a closing question "What do we want to do next?" Professor A leans forward and appears interested. Professor B introduces some concrete needs such as getting the website up and students into the group within the next 2–4 weeks. Professor C also suggests Baja people, and Professor D [indicates] website design persons. The facilitator restates the question again, and adds "Do we want to bring students?" Professor C is hesitant. He states he is unsure if they are prepared and is in some way supported by Professor E who states there need to be a majority [of students] for them to feel comfortable. (**Anthropology observer note:** I feel like this is a cop out.) Professor C suggests going to a [particular student] meeting as the students would be more comfortable, and himself and Professor A have attended them. Professor A and C agree to reach out and attend one of their meetings. . . At 4:40 Professor A leaves for another meeting, and Professor D, C, and E along with F agree to invite students.* (Anthropology Observer A)

Summary

Everyone was seated around the table for the entirety of the meeting . . . there was less use of technology such as laptops and phones...when group members spoke, almost everyone made eye contact or shifted their body language to indicate engagement and attention . . . and talk time was distributed among group members. (Anthropology Observer B)

5.3 Personal/Professional Interest

A second salient theme emerging from our analysis of 1.0 teams was individual interest in joining a particular team; this theme had the potential to be pertinent to RQ1. One reaction was captured in an interview excerpt from a Faculty Office Hours participant:

> *Interviewer*: "Why is it that you are interested in these [grassroots-team] meetings? What are the benefits to you?"
>
> *Faculty*: "It's the reason I became a professor. I wanted interactions with students. At the end of the day, that's what satisfies me. I think it is fulfilling on both sides."

This faculty member had a personal interest in exploring ways to expand student-faculty relationships. He was one of two faculty who experimented

with holding office hours outside his office to encourage greater faculty-student interaction.

Anthropology observer notes from the Community Culture team validate this individual-interest theme by capturing nonverbal enthusiasm as evidence:

> "She uses her hands to point towards her own chest while describing faculty time limits for commitments . . . [Yet, she] becomes more animated about this [idea and her] body language changes drastically at this time with her uncrossing her arms, leaning forward and pulling her legs to cross one another over the knee. . ."

These shifts in body language indicate engagement in the conversation and enthusiasm for its execution. Some team members are willing to advocate for and participate in activities that bring personal satisfaction, address a key issue, and contribute to greater ES cohesion.

Our interviews and observations illustrate a cultural dilemma in which opposing forces compete for faculty attention and energy. An interviewee from Lunch with Students asserted that he would continue participating "As long as it doesn't take too much time." Another remarked, "Lots of them (faculty) are busy. And everyone has to prioritize. When push comes to shove, some people have sponsored visits, proposals [for research funding] due, or [research] papers they are submitting. That is the biggest challenge for [grassroots teams]." These statements parallel instances captured by the anthropology observers. Facilitators would ask team members to complete a task, but faculty would usually not commit to the request. The facilitator described one situation this way:

> "It is really hard to get them (faculty) to do any work. Two weeks ago, I asked them to take five minutes. I drew a wireframe on the board and asked them to draw a wireframe and fill it in. Then I asked them to take a picture of it and send it to me. There was only one of eight faculty members that sent in a picture."

Our analysis of the 1.0 teams led two preliminary results. First, we discovered that SD facilitation was yielding neither the energy and enthusiasm that we expected nor a robust number of pilots. Team members seemed reluctant to learn and use SD principles, including taking on tasks outside team meetings. Instead, it appeared that personal/professional interest had the potential to power a team forward. Although it was too soon in our journey to answer specific RQs, we decided to modify the facilitation approach for the 2.0 Teams based on these results.

6. Grassroots Teams 2.0

6.1 General Characteristics

Exploring the 2.0 teams happened next in the chronology of grassroots-team creation. Seven new teams launched in Fall 2017; participants self-selected into them based on their own personal/professional interests. More team meetings occurred, lasted longer, and had more participants than the Spring teams (See Tables 3 and 4). Staff contributed to six teams, corresponding to over 47 percent of all meeting attendees (N = 158). Faculty were members of five teams (35 percent of attendees), staff were members of six teams (48 percent of attendees), students were members of two teams (15 percent of attendees), and university partners represented the balance. Some limited survey data

Table 4. Selected initiative characteristics (Fall 2017)

Team Name	Team Focus	Number of Scheduled Meetings	Average Number of Participants	Outcome at Start of Next Semester
Flex Co-Op	Increasing the number of students who participate in Co-Op and their completion rate	7	9	No pilot implemented
Alumni Mentoring	Exposing students to additional mentors who can help them grow professionally and offer advice tailored to their specific career interests	5	7	No pilot implemented
Student Assessment	Helping students understand and reflect on common problem-solving mistakes	6	4	Successful pilot
Intercultural Competency	Assessing students' intercultural competencies during their 2nd and 4th years at university, as well as faculty and staff	4	3	No pilot implemented
Professional Skills/ Teaching Assistant (TA) Training	Enhancing workplace skills (e.g., communication) and Teaching Assistant effectiveness	5	4	No pilot implemented
Diversity and Inclusion	Identifying collaborations between our research and other ES diversity projects	2	4	No pilot implemented
Conceptual Understanding	Increasing students' conceptual understanding of fundamental topics as well as student collaboration	1	2	Successful pilot

revealed that eight of the 14 respondents attended SD training at the time the teams were formed. Two anthropology observers documented all 30 scheduled team meetings, often alongside another research-group member. Two of the seven grassroots teams completed pilot tests of possible solutions by the semester's end.

We found that it was useful to compare what we learned from the two sets of grassroots teams. Indeed, our research had an iterative component in which we identified two themes from the 1.0 teams (facilitation and personal/professional interest), and then attempted to validate them with themes from the 2.0 teams. Analyzing the second set of grassroots teams helped clarify and expand what we were learning from the 1.0 teams.

6.2 Agile Facilitation

The facilitation theme surfaced again, despite using a different facilitation approach which we called "agile facilitation." This hybrid SD-project management approach resulted in clear goals at the beginning of meetings and improved team engagement. It also relied to a greater extent on the role of an agile facilitator, in contrast to SD where the intent is for team members to rely more on each other. This shift also set up a comparison between teams 1.0 and 2.0, a difference not lost on our study participants. A summary of semester-long team observations by one of the anthropology observers illustrates the differential effects of the SD and the agile facilitation approaches.

Compiled anthropology observer summary of Flex Co-Op team, September – December 2017

A facilitator from Spring led the first meeting, spending significant time talking about SD principles and eliciting little input from team members. The agile facilitator intervened stating it would be useful to brainstorm project goals. Almost immediately, team members began to engage in conversation. The agile facilitator led the next five team meetings. She always began by reviewing progress from the last meeting. She let the participants drive the discussion, only stepping in to interrupt heated debates and guide the conversation back to accomplishing the team's goals. She also ensured that all members, particularly students, offered their input.

At the December meeting, the team successfully designed the Flex Co-Op pilot project, discussed marketing it to industry, and scheduled a final meeting to launch it in January. Team members reviewed a registration packet to place ES students with 34 companies.

Interviewees noted the benefits of agile facilitation, as stated by a Flex Co-Op staff member:

> ". . . it was genius, but we didn't know it, in terms of how we formed the team . . . I think we suspected we were doing the right thing, but I don't think anyone could have predicted that . . . [agile facilitation] would work out as well as it did . . . Everyone is willing to share their opinion, and everyone has equity of voice, and we have students, and we have employers, and we have all the campus people . . . and because we have that kind of diversity across the team, it's getting us to better solutions faster – which is fantastic."

A professor pointed out: "I think [agile facilitation] worked pretty well . . . [It] kept you moving forward towards actually doing something, not just talking about it . . . [the facilitator] has been part of our meetings and he's been pretty good keeping us on track."

Team members who experienced both approaches indicated a preference for agile facilitation over SD. Agile facilitation pared down the emphasis on learning and implementing the 10 SD skills so that team members could start working on their issues faster. Team members expressed an eagerness to begin problem solving immediately so as not to "waste time." The agile facilitator also took on all the coordination and administrative tasks (e.g., planning logistics, recording decisions), making it possible for team members to focus on their goals.

Survey results were mixed. Eight of the 14 respondents indicated that agile facilitation "helped us get things done more quickly than would have been the case otherwise." Frustration appeared in some responses: "valuable time was sacrificed in the first few meetings to items not pertinent to the Co-Op program," or "a little too guided at the start," or "I sometimes get impatient with the pace of progress and wish we could move faster." These latter comments referenced the time it took to learn SD skills which survey respondents appeared not to value. In general, the observation, interview, and survey data were internally consistent and validated each other.

6.3 Work Role Alignment

We noticed a new theme with the 2.0 teams, *work role alignment* – perhaps because they had greater role diversity than the 1.0 teams. This theme involves the degree of consistency between the team's purpose and individual job duties. Work role alignment was linked with five of the seven 2.0 teams. Flex Co-op, Alumni Mentoring, and Intercultural Competency teams were composed largely of staff whose job responsibilities coincided with those initiatives. For example, staff job duties positioned them as content knowledge experts in Flex Co-Op, which was managed fully by ES staff, not ES faculty. An anthropology observer wrote: "It seems like [staff person X] . . . is the one answering everyone's questions . . . He is the one who knows the most about the eligibility and expectation require-

ments for co-ops." Similarly, staff participating in Alumni Mentoring already helped selected students find alumni mentors on a small scale before the grassroots team launched.

Student Assessment, Conceptual Understanding, and Intercultural Competency involved in-class exercises designed and evaluated by instructors, some with staff support. (Instructors may be staff [i.e., lecturers or graduate students who teach courses] or faculty.) In these three initiatives, instructors served as team leaders and appeared highly energized by their pilots. The professor from Conceptual Understanding stated, "I gave them (students) 10 conceptual questions and answers from an exam. I told them all the answers were wrong and they had to explain why. They loved this (in-class assignment)!" The lecturer leading Intercultural Competency had hopes of integrating such content into ES courses generally. These pilots were connected directly to teaching, instructors' primary role.

Work role alignment emerged as another signpost on our journey that helped us address the role of individual agency and leadership in grassroots initiatives (RQ1). We reasoned that a tight connection between team goals and team member work role would increase the likelihood of empowered team leaders as well as successful outcomes. Without that linkage, the initiative might get underway but would lapse before any pilots were implemented.

7. Team Evolution Since 2017

7.1 Patterns of Change

Once the thematic analysis was completed, our attention turned to grassroots-team *activities*, previously defined as actions targeting existing conditions or arrangements. We knew patterns (i.e., configurations occurring with regularity) would help us understand how change transpired across the grassroots teams. We compiled and delineated key activities by stages (i.e., semesters), with configurations of activity representing examples of patterns (RQ2). Fig. 1 illustrates the non-linear and complex patterns of initiative change associated with the 12 teams. The icons signify not only what activity or action was taken (e.g., meetings initiated), but the pace of the activity (e.g., project scale diminishes). In seven teams, two or more icons appear together indicating that multiple activities occurred during the same semester.

The 12 initiatives can be categorized into three distinct change trajectories:

(1) *Continuation:* Faculty Office Hours, Community Culture, Flex Co-Op, Alumni Mentoring, Intercultural Competency.
(2) *Revitalization:* Undergraduate Research.
(3) *Termination:* Lunch with Students, Tutorial Rooms, Student Assessment, Professional Skills/TA Training, Diversity and Inclusion, Conceptual Understanding.

Teams can persist or regenerate with no specific end date in mind. Indeed, six of the teams are currently active (i.e., continuing, revitalized). Four teams continue to tackle issues that are offshoots of their initial goals (Community Culture, Flex Co-Op, Alumni Mentoring, Intercultural Competency). For example, Alumni Mentoring expanded to include Peer Mentoring and later changed its name to ES Mentoring. Two of these six teams continue to be focused on specific goals that either were not achieved (Undergraduate Research) or were not fully established as a routine practice (Faculty Office Hours).

Initiatives also terminate. For example, Diversity and Inclusion ended before any experiment occurred. The participants decided it was not possible to achieve their goals which involved integrating and scaling the results (from two previously-funded efforts) into practice in the ES. Other initiatives ended after successful pilots – such as Student Assessment which ended because "the team seemed to lose steam after the first very ambitious semester." When teams lapse, it means priorities have shifted – particularly those of team leaders. Consequently, the "stop" patterns typically reflect a lack of direct connection of the work of that team to faculty member's primary responsibility (i.e., research) in an R1 University.

7.2 Team Trajectories

The next step in our analytical journey entailed examining possible connections between the salient themes (facilitation type, personal/professional interest, and work-role alignment) and the stage-based activities (meetings attended, pilot planning and execution). We examined the trajectories of the 1.0 Teams followed by the 2.0 Teams.

7.2.1 Teams 1.0

Team members commented on SD facilitation, expressing frustration with its structured approach. Their statements and non-verbal behavior about SD referred primarily to team dynamics. While team members noted that facilitators helped team members stay focused and encouraged them to think about change, SD facilitation seemed to have had little effect on team outcomes (i.e., pilots). Teams that pursued pilots (Faculty Office Hours, Community Culture) operated largely independently of formally-scheduled SD team meetings. Team members conferred with one another infor-

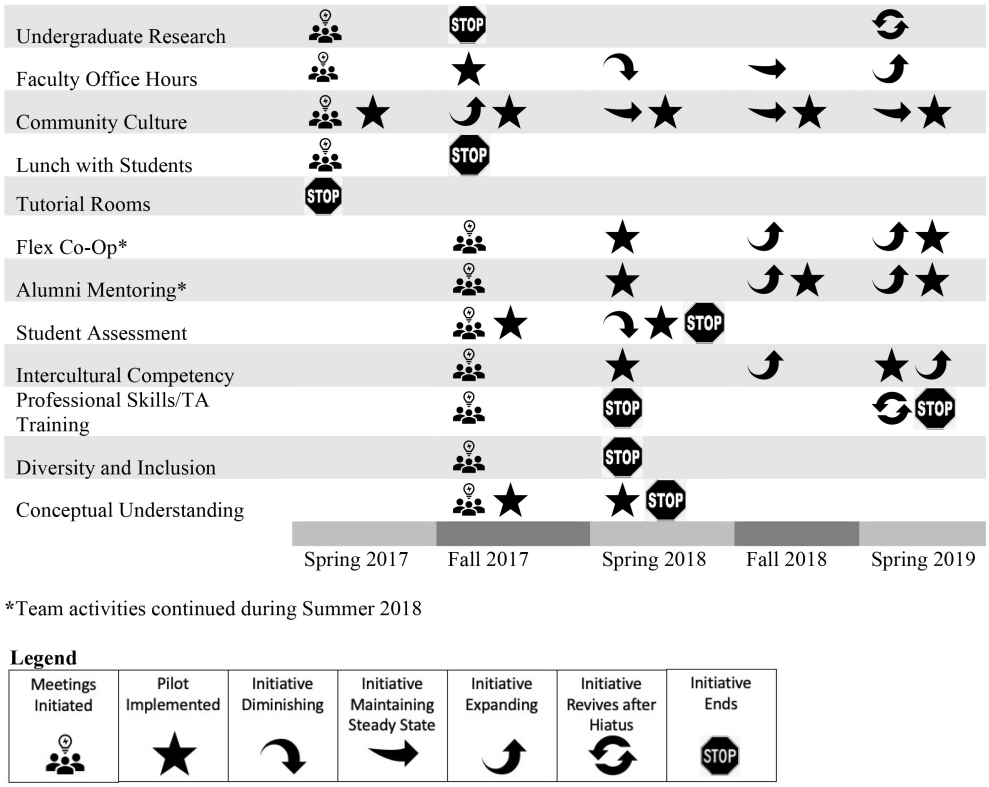

Fig. 1. Change patterns by initiative and semester.

mally and then worked to get their initiatives implemented. Strong personal/professional interest by key team leaders appeared to be the critical factor in implementing those pilots (RQ1). That same spirit carried forward to rising interest in Faculty Office Hours two years later in Spring 2019. Community Culture also had determined leaders. It initially conducted a few pilots (e.g., ES talent event, photo contest) which received accolades across ES, and continued with the talent event over the next four semesters.

The remaining three initiatives ended without implementing pilots.

- Lunch with Students experienced some early interest – even to the point of holding four meetings – but had difficulty making decisions. Discussions shifted from an informal lunch get-together to a formal career event with speakers. The team deliberated over whether to hold the lunch on campus or in a nearby restaurant; failing to make a decision, the initiative ended.
- Tutorial Rooms fared even more poorly. While five professors participated in the faculty retreat roundtable event, no one attended the initial meeting scheduled in Spring 2017, despite having signed up to be present.
- Undergraduate Research experienced the highest attendance among the 1.0 initiatives (6.3 faculty on average), as well as at the 2016 faculty retreat (11 faculty attendees). Yet over time, team members have expressed concerns about whether undergraduates have the appropriate knowledge and skills to work on faculty research projects. Moreover, developing a process for students to learn about and be selected for such research opportunities involves a complicated and ongoing set of administrative tasks. After Undergraduate Research disbanded, it suffered a three-semester hiatus before being revitalized in Spring 2019 due to student demand. However, it has yet to implement a pilot, making its future unclear.

SD facilitation was not able to help resolve the difficulties in these three teams. Personal/professional interest seems to have mattered at the outset (RQ1) but was insufficient to sustain the team. We suggest that misalignment between the grassroots-team focus and team-member work role explains these failed outcomes. Teams 1.0 were composed almost exclusively of faculty whose jobs are dedicated primarily to research, with limited time to devote to such collective efforts. The time required to develop and implement a pilot on these three teams would take effort and attention away from their technical work, a choice to which they were unlikely to commit indefinitely.

7.2.2 Teams 2.0

Our analysis expanded with the inclusion of the trajectories of the 2.0 Teams. With this group of teams, we discovered that agile facilitation and work role alignment were linked by notions of time and efficiency. Preference for agile facilitation over SD among almost all of the 2.0 Teams related to the perception that agile facilitation was *agile*. In fact, some teams (e.g., Student Assessment) reported being astonished at accomplishing a pilot in one semester. Agile facilitation quickly encouraged active team engagement, the establishment of project goals, and leadership responsibilities. This dual emphasis on time and efficiency, combined with personal/professional interest, appealed to 2.0 Teams generally. However, work role alignment exhibited the greatest influence over whether pilots were implemented. For example, Professional Skills/TA Training was unable to reach consensus on its scope – as evident in its complicated team name – and disbanded in Spring 2018. When it was revitalized one year later with a narrower focus on TA Training, no team members were willing to take on the effort, so it lapsed again. Similarly, Diversity and Inclusion did not lead to a pilot because its team members could not figure out how to accomplish the goal of synthesizing the findings of two grants; appropriately, there was no reason to continue meeting.

By contrast, three of the teams (Flex Co-Op, Alumni Mentoring, and Intercultural Competency) carried out multiple pilots and continued throughout the five semesters of our study.

- Flex Co-Op, involving staff, faculty, co-op students, and employers implemented its pilot in Spring 2018 with two other engineering schools. It revised the co-op program to allow more flexibility in student placement and program length. A second pilot occurred across all schools of engineering in Spring 2019. Future goals are to "revamp entire (university) co-op program to operate under Flex Co-Op rules."
- Anthropology observers noted that Alumni Mentoring team meetings "[functioned] very efficiently and there was not one minute wasted. . .People know what they are doing and what they want to achieve." The team of staff and students received positive feedback on the "formation of strong relationships" among student and alumni pairs, but "overwhelmingly negative feedback" on its electronic platform. Consequently, in Summer 2018, the team transitioned to Peer Mentoring, which successfully resolved its own platform issues. By Summer 2019, the team was managing both mentoring programs.
- Intercultural Competency consisted only of staff, though the team leader was an ES instructor. It created and integrated cultural learning activities into several ES courses. The instructor continues to partner with campus staff in international programs to refine an Intercultural Teamwork Certificate for ES students and is working with ES faculty to design intercultural activities into other ES courses.

Notable about these three teams is that they were staff-led. The day-to-day job responsibilities of each team leader and a number of team members were directly tied to the teams' work. Individual agency and leadership were apparent in the work of staff team leaders (RQ1).

Two other 2.0 Teams (Student Assessment and Conceptual Understanding) also resulted in multiple pilots. By that criterion, these two team were successful. However, they were only active through Spring 2018 when they encountered issues that were difficult to solve. In Student Assessment, the professor found that one class exercise "required the whole class [period]" and concluded he would have to "pare it down" so that students got experience (i.e., by grading and learning from their peers' work) without lagging behind in new technical material. He has not taught the course since Spring 2018. In Conceptual Understanding, a professor found that identifying materials for the in-class exercises (e.g., specialty rubber) "would take a lot more time . . . that's the hold up." The professor has not used these exercises since then. Both initiatives were negatively affected by additional time and energy required. Academia's expectations of prioritizing research over teaching are likely to have led both professors to discontinue these initiatives, although faculty choice and priorities (e.g., mentoring) may have played a role in shifting their interest away from these initiatives.

7.3 Zooming In and Out on Change Processes

Ethnographic data enables us to focus on a particular change trajectory in detail and to identify broader trajectory processes. Fig. 2 depicts the processes linked with Faculty Office Hours. It reveals that some faculty are open to innovation, a process that includes experimentation, resistance, cultural drift (i.e., slippage away from the innovation), diffusion, and/or adoption (RQ2). Four semesters after its pilot, this initiative continued along with one of the original innovators from Spring 2017 and diffused to three new faculty. As a result, the practice of holding office hours outside faculty offices has accelerated within ES.

Ethnography also permits a holistic examination of changes tied to all of the trajectories. We developed Fig. 3 as a heuristic device to illustrate a

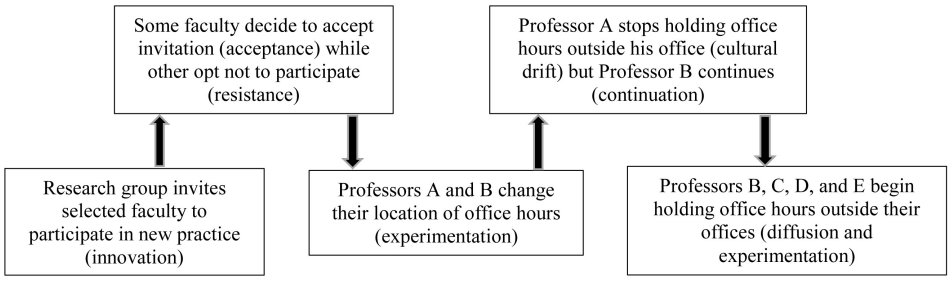

Fig. 2. Selected elements of a complex initiative change path.

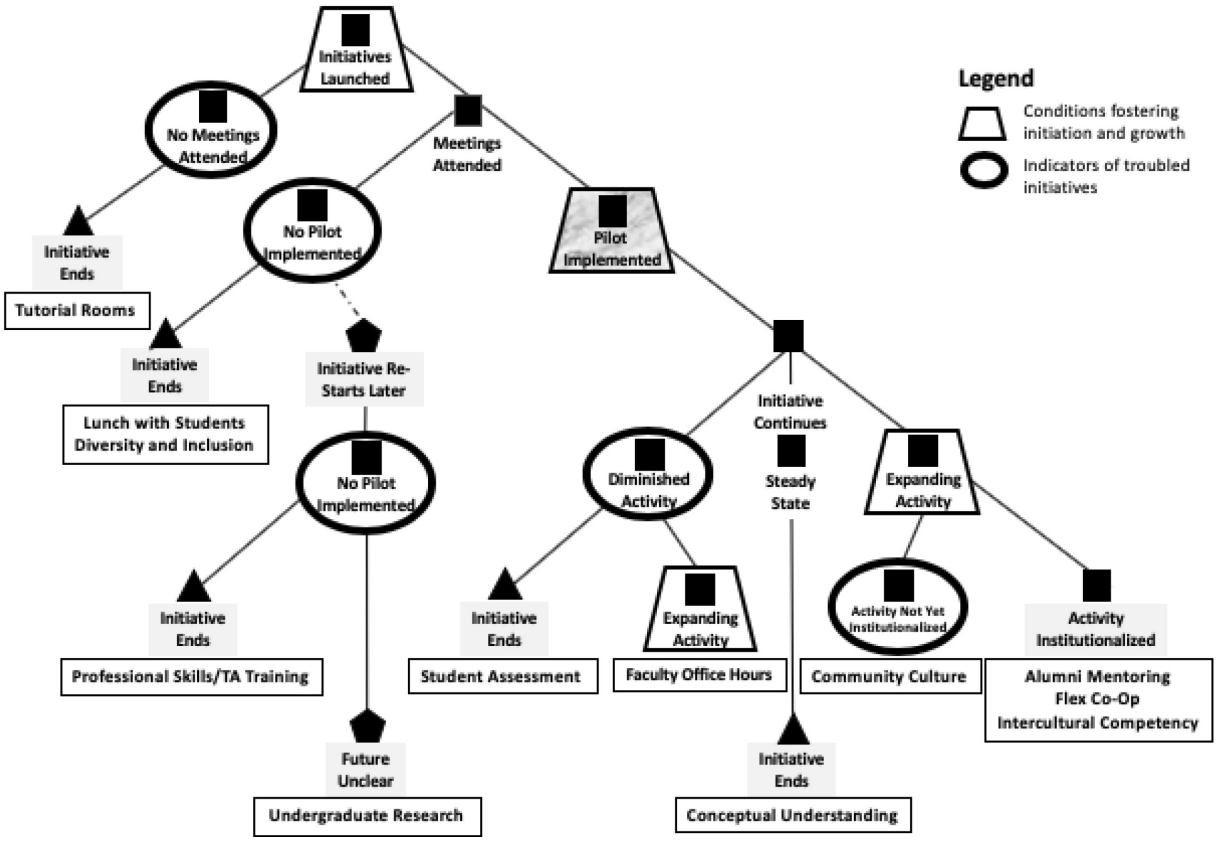

Fig. 3. Cascade of initiative activity and innovation indicators.

cascade of change paths (RQ2). The trapezoids specify conditions affecting initiation and growth of grassroots initiatives: initiative launch, pilot implementation, and initiative expansion, which typically involves diffusion to and acceptance and use by others. Conversely, the ovals foreshadow likely initiative difficulties such as initiative contraction/diminishment and activity not yet institutionalized.

Fig. 3 can be divided into two sections: outcomes lying above the trapezoid labeled "pilot implemented," and those lying below it. Five initiatives above that trapezoid do not pilot a solution. An initiative usually ends under two conditions: when an oval is labeled "no meetings attended" (Tutorial Rooms) or "no pilot implemented" (Lunch with Students, Diversity and Inclusion, Undergraduate Research, and Professional Skills/TA Training). Under both circumstances, the failure to agree on a goal and act in accordance with that goal is the culprit.

Seven grassroots teams appear below the trapezoid labeled "pilot implemented." These teams created new objectives – evident in the trapezoids labeled "expanding activity" (Faculty Office Hours, Alumni Mentoring, Flex Co-op, and Intercultural Competency). Additional pilots were implemented successfully such that multiple, tangible gains have been realized. Returning to the ethnographic data on Faculty Office Hours, we found that instructors teaching multiple sections of the same course agreed to hold their office hours out of their offices. Thus, it benefited from faculty consensus on supporting,

and thereby expanding the practice to others. In Alumni Mentoring, Flex Co-op, and Intercultural Competency, "institutionalized" activity resulted in which the teams' work was integrated fully into the organizational culture.

The prospective for lost potential also emerges, depicted in ovals marked "diminished activity" (Student Assessment) or "activity not yet institutionalized" (Community Culture). These two teams, along with Conceptual Understanding, enjoyed successful outcomes, though none was institutionalized. Community Culture, in particular, seems to be in a state of limbo, despite its continuation through the five semesters. In a recent discussion, we learned that it is unlikely to persist since its future rests on a single staff person. For these three initiatives, pilot implementation is a necessary but not sufficient condition in a change trajectory. The cascade suggests that initiatives need to continue to experiment, implement, and evaluate their activities. They also must strategize how to embed their activities into the organizational culture for the long term (RQ2).

8. Discussion

Much of the engineering education literature emphasizes transformative teaching practices [2, 20, 27, 25]. By contrast, our emphasis is on changing the organizational culture through initiatives at the intersection of faculty and staff (e.g., Tutorial Rooms), faculty and students (e.g., Undergraduate Research), and staff and students (Flex-Co-Op), as well as initiatives crossing all roles (e.g., Community Culture, Professional Skills/TA Training). While our work is aligned with a newer, systems focus in engineering education [19–21], including teaching-related activities among our 12 grassroots initiatives, we examine and analyze innovation and change across a range of organizational activities not limited solely to teaching.

In engineering education, "developing shared vision" among stakeholders is identified as a key change strategy [20, 27, 29, 31], though it has been "relatively unexplored in STEM education change" [31, p. 20]. The concept behind shared vision is congruent with grassroots teams in which team members collaborate in the hopes of developing a shared vision. Similarly, engineering educators have emphasized the importance of readiness for organizational change [25], consistent with the idea of accepting and adopting a particular organizational change [37, 38]. Yet, developing a shared perspective or indicating organizational readiness are only *initial* steps in the change process, with the change agent and empowered stakeholders playing key roles [27, p. 245]. The effort continues, moving beyond discussions to action. Thus, our research includes, but extends beyond developing a shared perspective, to explore the interactions, decisions, and outputs of team members over time.

8.1 Psychology's Contributions

Psychology influenced to our design and analysis (RQ3). First, our study represents an *intervention*, a key feature of psychology's methodology. We purposely introduced grassroots teams as an experiment or innovation to tackle organizational-culture issues [43]. The teams were voluntary and focused on issues pertaining to students, which held broad-based appeal. Jamieson and Lohmann [6, p. 6] argued that increased performance is contingent on "continual innovation that is motivated by the desire to solve important problems." Our findings demonstrate that these problem-solving groups collaborated to address issues of relevance to students. We argue that in doing so, they began to knit together a more cohesive organizational culture. They were able to find some agreement among their team members to focus on student learning, enhance that commonly-shared vision that students merit their attention and value it, and acknowledge the relevance of relationships despite the pervading influence of the technical focus in this organizational culture.

The teams were also experimental, with distinctive attributes and start dates in sequential semesters. We intervened again by modifying the facilitation approach and the teams' composition when we discovered that three of the five 1.0 teams did not pilot any solutions. Experimentation and trial-and-error methods are inherent in grassroots teams; Schein's second stage of "learning/change" signals the value for "individual members" in "learning new concepts, new meanings for old concepts, and new standards for judgment" [39, p. 300].

The seven grassroots teams whose innovative pilots were implemented aligned with Barnett's theory: cultural change practices that survive are those that do not pose a threat to the stability of the "social whole" [40, p. 113]. None of these initiatives clashed strongly with core cultural practices and expectations – either because they were relatively contained efforts involving just a few team members (Student Assessment, Faculty Office Hours, Community Culture, and Conceptual Understanding), or were able to augment or extend existing programs and policies (Alumni Mentoring, Flex Coop, and Intercultural Competency). Initiatives that did not lead to pilots tended to confront particular constraints; the most common obstacle was faculty's research priorities, a byproduct of the primacy of research in large institutions [12, 13, 15].

Second, the ***individual is central*** to psychological research and therefore, to its process models of change. Individual motivation, beliefs, and actions, for example, can help shed light on the change process and its dynamics. Individual interest by team members, evident particularly during team observations and validated in interviews, emerged as the critical condition for launching change initiatives. Exemplary team members offer inspiration and motivation. In fact, sharing a common interest may have hastened the development of a shared team vision and readiness for change. Personal/professional interest was present in four of the five 1.0 teams and all seven 2.0 teams (RQ1).

Third, ***leader role and vision*** are critical in organizational functioning and to the workings of grassroots teams. Leaders are expected to motivate, guide, and reinforce the value of change in and for an organization so that "their organization is at the forefront of change, not reacting to it" [43, p. 690]. In doing so, leader encouragement of disruption fosters innovation [41]. One formal and visible type of leader is a facilitator. Our 1.0 and 2.0 teams were coordinated by facilitators representing distinctive approaches. A second type of leader operates informally in the organization. The success of some initiatives can be attributed to the agency, creativity, resourcefulness, and energy of individual team leaders. The combination of interest in and relevance of an individual's work role to a particular initiative appeared in our 2.0 findings and could be applied to the 1.0 findings (RQ1). In some cases, the goals originated with and were driven by team leaders (e.g., Community Culture, Intercultural Competency), while in other cases, role models emerged over time; their actions or practices, exhibiting individual agency, diffused and were adopted by others (e.g., Faculty Office Hours).

Our research group's leader played a key role. He introduced the concept of the problem-solving teams into ES, solicited team participants, worked closely with the facilitators, assisted with operational issues, and was involved in data collection and analysis. As the "engine" behind the entire project, he used his understanding of the context to innovate in an organizational culture known to be difficult to change [7].

Finally, the how-to approach found in ***process models of change*** serves as a mental model to help people move away from the present circumstances toward some future state. In the organizational-change literature, an "ideal" process constructed as a stage-based roadmap is typically employed. It is valuable from at least two vantage points. First, it allows those leading the change process to see the direction and focus of the change [11, 32]. Second, it targets specific areas for attention at each stage to make them relatively straightforward to implement [33, 40].

Yet, the patterns exhibited across the 12 initiatives in Figs. 1, 2 and 3 demonstrate that change is neither clear-cut nor linear (RQ2); our analysis of team activities was critical in ascertaining key steps toward team goals [45]. We observed starts and stops, slow-downs and expansion, and revitalization as well as ongoing activities. Twists and turns emerged along with layers of complexity. These patterns represent what Erwin [46] called for: the *actual* process of change. Our findings reflect a raw, realistic form of organizational change where change and continuity are intertwined with cultural alignment, clashes, and individual agency. Consistent with innovation paths identified in siloed organizations [53], our initiatives suggest that change processes are complex with no single dominant trajectory (RQ2).

8.2 Anthropology's Contributions

Four contributions from anthropology stand out (RQ3). First, the ***ethnographic methodology*** brought together various data in the form of "thick description" [63, p. 30] – observation, interviews, surveys, and participant observation – to describe and explain the introduction and development of the grassroots team concept. Not only did each method provide insights into the process of change (e.g., observed reactions to SD, viewpoints of grassroots teams via interviews), but high levels of validation across these methodological techniques emerged (described in Sections 5 and 6).

Second, just as the individual is central to psychology, the ***group or community*** is core to anthropology. People are the focus, rather than disparate individuals. Attention is directed to their interactions and activities in the nested groups and units of organizational culture [49, p. 56]. Because people are part of that culture, they typically share a set of beliefs and expectations related to organizational functioning. It is critical to capture the perceptions and behaviors of the organization's stakeholder groups. Faculty represent one, but not the only, stakeholder group. Our initial recruiting efforts for 1.0 team members primarily involved faculty, though one team had staff and another had students. The composition of the seven 2.0 teams consisted of faculty *and* staff, with students active in two teams. We expected, and then found, that team diversity as reflected in multiple voices, contributed to team success. We found that most of the engineering education literature does not include staff as study participants [cf. 25], because change efforts have been confined largely to the domain of teaching rather than the organizational culture overall.

Third, since ***holism*** is a cornerstone of an anthro-

pological approach, attempts are made to describe and explain patterns of change comprehensively and in an interconnected way. Therefore, we focused attention both across space (i.e., teams operating simultaneously) and time (i.e., teams compared across semesters). A longitudinal examination of innovative change processes, largely missing from the engineering education literature, enabled a characterization that extended a snapshot-in-time investigation into the future; Kezar [26] voiced this concern for a longitudinal focus almost two decades ago. The resulting set of change paths, portrayed both verbally and visually, provides a robust understanding of change (RQ2). With seven of the 12 initiatives currently active (See Fig. 3), change as a somewhat expected, continuous, and acceptable force may find its way within ES, though a follow-up confirmation study would have to corroborate.

At the same time, stasis (i.e., constancy of the current state) entails less energy and effort and has a more powerful influence on the organizational culture than change [47, 48]. Change processes continue to be subject to acceptance, modification, and resistance. Such reactions may be linked with particular team members or to particular teams. While our data signals the growing strength of grassroots-team innovation over time, it is too early to determine its overall long-term impact. The proportion of organizational members participating in these teams remains small, especially as the number of faculty, staff, and students continues to grow. Open questions remain about why many have not been involved in these initiatives, what reactions newcomers might have, whether past participants might reengage in future teams, and how durable the changes are.

Fourth, the ***dynamics of change*** vary [54], as illustrated in our differentiated change trajectories – continuing, revitalized, and terminated – and characterized by many perturbations (RQ2). Participation was generally high at the outset of an initiative, with involvement decreasing over time. Initiatives are particularly vulnerable when (1) no action is taken to initiate and pilot a particular change, and (2) when the initiative does not lead to new efforts to address related issues, involve new people that reinforce the initiative's value, or become integrated into the organizational culture (e.g., via practice, policy). Our data reveal that efforts to create change are susceptible to indecision and the failure to act. Missteps resulted less from imperfect experiments and more from inaction generally. This finding is consistent with [59] where we reported a mismatch (meaning, an incompatibility) between faculty and project manager's roles, which accounts for a general lack of experimentation among the 1.0 teams. It is also consistent with Romer's rule in which system stability is favored over instability [48]. Attempted change in an organizational culture involves confronting opposition, lack of awareness, and inertia [2, 11].

Sustaining change so that it becomes a routine part of the culture is more difficult. Some research has shown that five elements must be in place for innovations to diffuse throughout the culture and endure: collaboration, leadership buy-in, process change, practice change, and evidence of benefit [53]. While we view these elements as necessary to long-term change, we extend this literature by underscoring organizational innovation and change as a *process* (See Table 5). Based on our data, this grassroots-team change process encompasses three identifiable stages of activity from individual involvement to group participation to organizational institutionalization of an innovation (RQ2).

Personal/professional interest in the issues helped launch the 1.0 and 2.0 teams. As the teams progressed into the development or proof-of-concept stage, it became clear that key team members took on critical team-leader roles and that those roles aligned well with their day-to-day work on campus. Team leaders exhibited a vested interest in implementing pilots, and then modifying their piloted solutions after securing feedback. For grassroots teams operating post-pilot (i.e., maturity stage), the initiatives expanded in scope, size, and impact. Yet even initiative expansion, like implementation before it, may not result in lasting change. Instead, institutionalization or routinization in daily prac-

Table 5. Stages of the change process by selected initiative characteristics

	Launch	**Growth and Development**	**Maturity**
Who is engaged?	Individuals	Group	Organization
What do they do?	Agree to participate in initiative	• Implement pilot project • Gather feedback • Revise pilot project as appropriate	Routinize innovation into the organizational culture, including its practices, policies, and processes
How can we explain involvement?	Individual personal/ professional interest	• Work role alignment • Team leaders take action	• Tight coupling with job responsibilities • Individuals are accountable

tices, work processes, and/or organizational policies became the marker of successful and durable innovations.

Institutionalization relies on expectations and consistent reinforcement of cultural rules that people follow and for which individuals are held accountable. It is tightly coupled with job responsibilities in an organizational culture. Three successful initiatives, Flex Co-Op, Alumni Mentoring, and Intercultural Competency, developed new plans and programs embraced by ES and/or the university. These initiatives succeeded because they fell into domains of activity for which staff were accountable; their success was reinforced as other ES and/or university leaders vetted the pilot activities and their outcomes.

The other expanding initiative, Faculty Office Hours, shows promise due to the increased number of faculty experimenting with it. This initiative might be successful if enough faculty establish and reinforce a new cultural rule about "the way we do office hours around here." However, it is more likely that this initiative will not display the same staying power. While it is directly linked to teaching, a duty faculty perform, research is prioritized over teaching at this university. Consequently, the coupling between Faculty Office Hours and faculty's overall work role is much weaker. This same argument can be made for the revitalized Undergraduate Research initiative. If led by faculty, it would be unlikely to succeed due to faculty's competing research priorities [16, 17]. However, if coordinated by staff with faculty participation, its future potential would likely be assured.

8.3 Addressing our Research Questions

8.3.1 RQ1: Role of Individual Agency and Leadership

Individual agency and leadership play a critical role in launching initiatives. Individuals, characterized by their perspectives, interests, and actions represent baseline ingredients. Yet by virtue of the surrounding culture, individuals are in relationship with others, shaped by their expectations, interactions, and experiences. Individuals, whether formally-defined team members or informally present, can effect change through their actions or innovations just as culture can leverage or constrain such innovations. Faculty and staff react differently to change initiatives – primarily because their incentives are different. Faculty incentives prioritize autonomy and individual work (research) while staff incentives emphasize the collective with the focus on the department, school, or university as a whole. Outcomes vary as well. Staff quickly and effectively decide to implement potential solutions; based on their pilots, they work to funnel their tested solutions into university policies, practices, and programs. Faculty, by contrast, may commit to piloting some implementation, but do not typically take the next step to institutionalize their efforts. Key lessons are to be drawn here: recognizing and harnessing points of leverage, including work role-initiative alignment, and strategizing around innovation obstacles are essential when implementing planned change.

8.3.2 RQ2: Change Patterns and Processes

Numerous innovative efforts launch, fewer develop and gain traction, and fewer still result in routinization within the organizational culture. Innovations with sticking power are built on (1) the interests of individuals (2) whose job responsibilities are tightly coupled with the vanguard endeavor, (3) who collaborate with and gather buy-in from others across organizational boundaries, (4) test the innovation's benefits, (5) and institutionalize new practices and policies. We view the change process in stages from innovation launch to growth and development (implementation and testing) to maturity (institutionalization). These stages may not occur at the same pace and some projects may experience periods of inactivity and regenerate at a later time. Institutionalization of the innovation must be the overarching goal or cultural slippage sets in. Organizations, including academic ones, are susceptible to innovation failures due to one or more of these five elements; planned change efforts need to incorporate all five of them.

8.3.3 RQ3: Individually – and Culturally-Oriented approaches to Change

Five elements stand out in our integration of psychological and anthropological approaches to change as we reflect back on our investigative journey of change (See Table 6). Our study considered grassroots teams as the unit of analysis but brought to bear a focus on individuals, especially leaders. To make sense of the *particular* choices and actions of a given team, we examined them within the broader ES cultural context as a *whole*. The grassroots-team innovation was informed by its experimental aspects as well as ethnographic data collection. Moreover, the teams initially relied on a prescriptive approach (i.e., SD) but were bolstered by an emergent approach (i.e., agile facilitation) made possible by both team member and facilitator flexibility. By recognizing the value of each element, and its specific components, we found that we were able to present and explain our results of planned change in a robust and compelling way (RQ3). We believe this combination of approaches is well suited to engineering education as it attempts to understand organizational culture and plan for future

Table 6. Integrating psychological and anthropological approaches

	Psychological Focus	**Anthropological Focus**
Unit of Analysis	Individual	Group
Context	Particularistic	Holistic
Methodology	Experimental	Ethnographic
Process Model of Change	Ideal and Prescriptive	Actual and Emergent

transformations, while accounting for the perspectives of the individuals within it.

9. Conclusions

Significant benefits to the field of engineering education accrue when psychology and anthropology work hand in hand. Studies of organizational culture and change necessarily focus on the group in its context, though individual leaders often play a critical role. Combining distinct disciplinary approaches adds richness to the data set by enlarging the overarching methodology and incorporating specific concepts and research techniques. Comparing prescriptive and emergent models of change positions researchers to critique and refine findings, explore alternatives, and develop new insights. Organizational culture change is complicated and messy, often with unexpected and unintended effects. Deploying the intellectual resources from multiple disciplines enhances our understanding and explanations of innovation, implementation, and preservation of change.

10. Limitations

Our study was conducted at a large, public research university in the U.S. Midwest. Future studies might employ the same methodology but involve samples from other institutions (e.g., small, private, liberal arts; mid-size, public, sciences) in the U.S. or elsewhere. Including a larger sample of students in the research design would allow their perspectives to be highlighted, along with those of faculty and staff. Our participants self-selected into grassroots teams while a future project might compare the relative success of grassroots teams and teams assigned a particular mandate. Our study relied neither on the participation nor approval of departmental, school, or university leadership because the teams were intentionally designed to be grassroots teams. A future study might entail a close collaboration with the administration in establishing and overseeing team activities.

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