Vocation In the Engineering Curriculum: Challenging Students to Recognize Their Values

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Dr. Diana A. Chen is an Assistant Professor of General Engineering at the University of San Diego. She joined the Shiley-Marcos School of Engineering in 2016. Her research interests are in areas of sustainable design, including biomimicry and adaptability in structural, city, and regional applications. She earned her MS and PhD in Civil Engineering from Clemson University in South Carolina, and her BS in Engineering from Harvey Mudd College.

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Mark Peters received a Bachelors degree in Economics from Georgetown University and then pursued a business career in New York City, working in many of the major business disciplines. Over the past twenty years, Mark has worked and consulted for large corporations, professional organizations, hospitals, churches, and universities.

Dr. Peters earned a Masters Degree from the Boston College School of Theology and Ministry and a Ph.D. in Leadership Studies from the University of San Diego. He has taught in a variety of disciplines including: Business Management, Organizational Leadership, Economics, Ethics, and Leadership Studies, at the undergraduate and graduate levels. Dr. Peters has twice served on the Faculty of Semester at Sea teaching courses in Social Entrepreneurship, Global Development, and International Management.

Mark enjoys integrating travel into his teaching and research, most recently designing study abroad courses in Latin America and Africa in sustainable development and social entrepreneurship. After completing his dissertation study on creating a culture of vocational exploration on college campuses, Mark completed a world tour researching micro-finance institutions and visiting universities in Latin America, Africa, and Asia. During previous world travels, Mark has worked in Italy, Mexico, El Salvador, and Costa Rica, and spent a summer traveling through India.

His most recent teaching and research combine his love for the Catholic Intellectual Tradition and his passion for economic justice. Mark has worked in the Division of Mission and Ministry at the University of San Diego since 2001, now serving the role of Director for Mission. The pride and joy of their lives, Mark and his wife Danielle are privileged to raise a three-year-old daughter named Barbara Patricia, who commutes with her Dad to attend USD's Manchester Child Development Center, preparing herself to join the USD Class of 2039!

Prof. Gordon D. Hoople, University of San Diego

Dr. Gordon D. Hoople is an assistant professor and one of the founding faculty members of integrated engineering at the University of San Diego. He is passionate about creating engaging experiences for his students. His work is primarily focused on two areas: engineering education and design. Professor Hoople's engineering education research examines the ways in which novel approaches can lead to better student outcomes. He is the principal investigator on the National Science Foundation Grant "Reimagining Energy: Exploring Inclusive Practices for Teaching Energy Concepts to Undergraduate Engineering Majors." He has also co-developed a unique interdisciplinary course, Drones for Good, where engineering students partner with peace studies students to design a quadcopter that will have a positive impact on society.

Dr. Joel Alejandro Mejia, University of San Diego

Dr. Joel Alejandro (Alex) Mejia is an assistant professor of Integrated Engineering at the University of San Diego. His current research investigates how the integration of the historically and culturally accumulated wealth of knowledge, skills, and practices - also known as funds of knowledge - and engineering design can serve as a pathway to and through engineering. Dr. Mejia is particularly interested in how Latinx adolescents bring forth unique ways of knowing, doing, and being that provide them with particular

ways of framing, approaching, and solving engineering problems. Dr. Mejia's primary research interests lie at the intersection of engineering education and social justice. He is particularly interested in the integration of Chicanx Cultural Studies frameworks and pedagogies in engineering education, and critical consciousness in engineering through social justice.

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Susan M. Lord received a B.S. from Cornell University and the M.S. and Ph.D. from Stanford University. She is currently Professor and Chair of Integrated Engineering at the University of San Diego. Her teaching and research interests include inclusive pedagogies, electronics, optoelectronics, materials science, first year engineering courses, feminist and liberative pedagogies, engineering student persistence, and student autonomy. Her research has been sponsored by the National Science Foundation (NSF). Dr. Lord is a fellow of the ASEE and IEEE and is active in the engineering education community including serving as General Co-Chair of the 2006 Frontiers in Education (FIE) Conference, on the FIE Steering Committee, and as President of the IEEE Education Society for 2009-2010. She is an Associate Editor of the IEEE Transactions on Education. She and her coauthors were awarded the 2011 Wickenden Award for the best paper in the Journal of Engineering Education and the 2011 and 2015 Best Paper Awards for the IEEE Transactions on Education. In Spring 2012, Dr. Lord spent a sabbatical at Southeast University in Nanjing, China teaching and doing research.

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Abstract

This work-in-progress paper describes a new initiative at the Shiley-Marcos School of Engineering to help our students integrate, and sometimes reconcile, their personal values with their engineering identity. In this paper, we describe how we are collaborating with the Office for Mission and Ministry on our campus to use the language of vocation in an engineering context to help our students develop a critical awareness about the choices they will make upon graduation. We present a brief introduction to the literature on vocation and reflection in higher education, discuss our approach to teaching this material in our first-year User-Centered Design course, and examine the impact of the activity on students through preliminary analysis of survey data. We find that students value discussion of these topics, but more work needs to be done to connect the concepts of vocation and engineering.

Introduction

We have seen students on our campus operate with a split identity: they are engineers-in-training on campus, but may think of themselves as musicians, surfers, or political activists outside of the classroom. The disconnect between engineering curricula and personal experiences can lead to students choosing a career path that they eventually discover is unfulfilling. Indeed, three of the authors on this paper took industry positions they later discovered were deeply at odds with their personal values. A recent study of engineering graduates highlighted the importance of aligning personal goals of helping people with engineering careers [1]. For respondents that had left engineering as a career, 40% indicated they were dissatisfied with service elements of their jobs.

To address these concerns, we have incorporated the idea of vocation into one of our educational outcomes for our Integrated Engineering program at the University of San Diego. We aim to train students who have developed a critical awareness of their personal attitudes, behaviors and values and the ways in which these align with their professional aspirations. Notably, including this as a program goal means that we need to address and assess this outcome for ABET accreditation. As our program continues to develop, we are exploring ways in which we can build vocation into our curriculum. We hypothesize that this approach will help students develop the skills needed to choose career and life paths that are both professionally and personally fulfilling. In this paper, we examine our students' reactions at our first attempt to incorporate this material into engineering education.

To help our students develop this critical awareness about the choices they will make upon graduation, we are collaborating with the Office for Mission and Ministry on our campus using the language of vocation in an engineering context. This paper will begin with a brief overview of literature describing how vocational exploration is being reintroduced into higher education in creative ways that speak to the challenges posed by our increasingly complex and rapidly changing world. This will be followed by a discussion and analysis of how we have integrated vocational exploration into our curriculum thus far by describing an activity implemented in our first-year course, User-Centered Design.

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Education about Vocation

Our Roman Catholic university promotes a broad and deep understanding of vocation. Rather than a strictly religious definition, our campus emphasizes that each person has a unique calling discovered through attentive listening to the deepest desires of their hearts, leading them to compassionately serve the world. Taking its cue from a range of authors writing about vocational discernment [2]–[4], we follow Buechner's definition: "Vocation is the place where your deep gladness meets the world's deep needs" [5]. This education has historically occurred in co-curricular spaces, but the university at large is now exploring how to integrate these concepts more directly into the curriculum.

Defining vocation is itself a monumental task. Vocational decisions include making choices about work, community, and relationships. Indeed, vocation goes beyond questions of work and career. Vocation manifests itself in lasting commitments to family and friends, and to communities and causes. Broadly understood, vocation encompasses virtually all aspects of the human quest for meaning and purpose in life.

While there is no consensus on one definition of vocation, there is a generally accepted assumption (implicit in the root meaning of vocation coming from the Latin word – *vocare* – to call) that all people have a unique call in their life [4, pp. 5–6]. Situating vocational discernment in the context of the developmental challenges faced by young adults in contemporary American society, Sharon Daloz Parks has this to say about vocation:

> The (young adult) dream in its fullest and most spiritual sense is a sense of vocation. Vocation conveys 'calling' and meaningful purpose. It is a relational sensibility in which I recognize that what I do with my time, talents, and treasure is most meaningfully conceived not as a matter of mere personal passion and preference but in relationship to the whole of life. Vocation arises from a deepening understanding of both self and world, which gives rise to moments of power when self and purpose become aligned with eternity. [6, p. 148]

For Daloz-Parks, vocation is broadened beyond just a set of career objectives that can be pursued at one's pace and pleasure, but rather a more mysterious process of becoming, grounded in authentic, lifelong discernment that is, at once, both intensely personal, and profoundly communal.

We are not aware of other studies incorporating instruction around vocation (as we defined it above) into engineering education. Note that the word sometimes is used to describe technical training or "vocational education" -- this is not the focus of our efforts. There have, however, been efforts related to reflection, which is closely related. Sepp, Orand, Turns, Thomas, Sattler, and Atman provide a systematic review of reflection in engineering education [7]. Mina, Cown, and Heywood's overview of the use of reflection in engineering education includes theoretical foundations and distinguishes between two different contexts for reflection -- to explore larger questions such as "Who am I?" and to explore the method of engineering to improve design [8]. The former is most related to our work on vocation. Turns, Sattler, Yauhara, Borgford-Parnell, and Atman describe examples of integrating reflection into engineering education with a focus on

helping students intentionally make meaning and enhance learning [9]. The Consortium to Promote Reflection in Engineering Education (CPREE) aims to "address the need for a broader understanding and use of reflective techniques in engineering education" [10] including a website with examples of activities for engineering classrooms. Our work was informed by the efforts around personal development and discovery and personal inventory where students examine their values and personal and career goals [11].

Teaching Vocation in User Centered Design

Our first foray into integrating vocational education into the curriculum has been in User-Centered Design, a course taken by all engineering students in their second or third semester in college. This course focuses on the engineering design process with an emphasis on users. Unique to our version of user-centered design is that interwoven throughout the semester are issues of diversity, inclusion, and social justice. We highlight the importance of unequal power relationships, particularly relating to how engineers are often the designers and decision makers of technology that impact a wide variety of people.

Following course content about the privilege that can come with social identity, and its difference from personal identity, we conduct an activity in class using "value cards" to help students reflect on their personal values. Our goal is to help students think early and deeply about how the ways they may want to live as a person may differ from how they are leading their lives as engineers. We conducted this activity for the first time in Fall 2018 with 40 second-year students in two sections. Each student was provided deck of 83 cards with values on them [12]. The cards each have one value printed on them, such as "authority", "fitness", "non-conformity", "responsibility", "self-acceptance", and "wealth", followed by a short description of the value. For example, "purpose" is followed by "to have meaning and direction in my life". Students were asked to sort their deck of cards into various piles based on how much they cared for that value. In the original New Mexico study through which these cards were created [12], the sorting categories are pre-set by the activity and students sort the cards into piles of "very important to me", "important to me", and "not important to me". In this iteration of our activity, students were asked to identify cards with concepts that they valued and believed they were living out, and group these values into approximately five piles based on their similarity. For example, if a student valued family and relationships and believed they were actively living out these values, these similar cards were grouped into one pile. Values that they were not enacting (even if those values were important to them) were set aside.

After the activity, we conducted an online survey asking students for their thoughts and feedback on the activity. No incentive or compensation was provided. The survey took less than five minutes to complete and included six Likert scale questions (strongly agree, agree, neutral, disagree, strongly disagree) and three open-ended questions. Twenty-six (26) of 40 students responded to the survey (65%). The survey questions are listed as follows, with statement-type questions indicating a Likert scale response.

1. The values cards activity was useful to me.
2. Please describe how or in what ways the activity was useful to you.
3. The values cards activity helped me to think deeply about certain values that I typically do not consider on a daily basis.

4. The values cards activity was memorable and is something I will remember in a few years.
5. I see my engineering identity as separate from my personal identity.
6. Previous to this activity, I believe I was living out the values that are important to me.
7. This activity helped me to evaluate if I have a gap between my personal values and my engineering identity.
8. What did you like about this activity?
9. What could be improved about this activity?

We were pleased to see that of the students who responded, 50% agreed or strongly agreed that the activity was useful to them (Q1). Furthermore, 73% agreed or strongly agreed that the activity helped them to think deeply about certain values that they typically do not consider on a daily basis (Q3). Student data from the open response survey questions support the conclusion that at least some of the students' engaged with the activity in a meaningful way. For example:

> *"It made me think about what I find to be important to me, and what values I apply or not even when I hold them."*

> *"I was honest with myself about what I wanted but wasn't carrying out in my life."*

> *"It forced me to consider what I believed and what I actually did"*

Our assessment did reveal one substantial challenge -- it appears we did not adequately facilitate the activity to explicitly tie back to student's engineering identity. Only 38% agreed or strongly agreed that the activity was memorable and thought it was something they would remember in a few years (Q4); and only 38% agreed or strongly agreed that the activity helped them evaluate if they had a gap between their personal values and their engineering identity (Q7). This may have been due to their perceived baselines, which were already high: only 23% saw themselves as having split engineering and personal identities (Q5), and 65% believed they were already living out their values previous to the activity (Q6). While these percentages suggest that we need to make the connection more explicitly in the future, it was encouraging to see that students found value in the activity. In fact, one student insightfully pointed this out in their comment: *"The boundary between engineering identity and personal identity could be examined more."*

To address this disconnect, in future iterations of this activity, we plan to tie this personal values activity to "resume values" following the engineering career fair. As first- and second-year students, attending the engineering career fair pushes them to think critically about what sort of future they are seeking as professional engineers, and how they should begin constructing their resumes to reflect their skills and objectives. By helping them construct their "engineering resumes", we can then directly compare and contrast students' professional values with their personal values. This direct comparison of types of values can be one way to emphasize that we should live fully, undivided between our different identities and values. In addition, in response to Question 9, multiple students commented that there were too many cards to sort, and that the activity was confusing due to many similar values. Future iterations could also be adapted to merge two similar activities from the Consortium to Promote Reflection in Engineering Education (CPREE) on values and reflection that include more detailed instructions, specifically designed for first-year students [13], [14].

Conclusion and Future Work

In this work-in-progress, we described how we have started to incorporate the idea of vocation into engineering education. For our Integrated Engineering program, these are required elements which will support ABET accreditation. A personal values cards activity implemented with 40 students in our lower-division User-Centered Design course is our first attempt at creating opportunities throughout our curriculum to help students achieve our educational objective to "develop a critical awareness of their personal attitudes, behaviors and values and the ways in which these align with their professional aspirations." Students were asked for their feedback on the activity for future improvements and better integration into the engineering curriculum.

For future work, we plan to continue to refine this value cards activity and to also implement other types of vocation-based introspection throughout our curriculum. Our next efforts will be in our upper-division engineering courses including our junior level course *Engineering and Social Justice* and our senior level course *Capstone Design*. We plan to continue exploring and assessing the best way to fully integrate this content into our curriculum. Thus, we hope to help students develop the skills needed to question, explore, and choose career and life paths that are professionally and personally fulfilling.

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