Final accepted version of: Tham, J., Cross, J., Beruvides, M., Polanco-Lahoz, D., Hasan, M. R., & Cook, K. C. (2024, July). A Symbiotic Relationship: Combining User Experience Methods and Systems Theory to Understand Engineering Doctoral Students' Professional Identity Development," 2024 IEEE International Professional Communication Conference (ProComm), Pittsburgh, PA, USA, 2024, pp. 79-83, doi: 10.1109/ProComm61427.2024.00022.

A Symbiotic Relationship: Combining User Experience Methods and Systems Theory to Understand Engineering Doctoral Students' Professional Identity Development

Jason Tham
Texas Tech University
jason.tham@ttu.edu

Jennifer Cross
Texas Tech University
jennifer.cross@ttu.edu

Mario Beruvides
Texas Tech University
mario.beruvides@ttu.edu

Diego Polanco-Lahoz
Texas Tech University
diego.polanco-lahoz@ttu.edu

Md Rashedul Hasan
Texas Tech University
md-reshedul.hasan@ttu.edu

Kelli Cargile-Cook
Texas Tech University
kelli.cargile-cook@ttu.edu

Abstract – Studies about doctoral students' professional identity development as scholars and researchers remain scarce within engineering education literature, and current frameworks for tracing identity development require a more effective longitudinal design to capture development over time. As we apply user experience (UX) methods to document students' identity development, we reflect on the affordances and constraints of qualitative UX methods as a complementary approach to engineering identity research and demonstrate a way of building bridges across disciplines to innovate research methods and scholarly agendas that benefit all partners.

Index Terms – Collaboration, identity development, systems theory, user experience (UX).

INTRODUCTION

As emerging professionals, doctoral engineering students are like most PhD trainees who experience a multi-year journey to learn about research methodologies, disciplinary culture, and expectations for conducting independent as well as team projects. This journey is worthy of a close examination given its eminent impact on students' perception of their own interests and expertise. Yet, studies about doctoral students' professional identity development as scholars and researchers remain scarce within engineering education literature. As identity formation has shown to have significant ties to educational and professional outcomes, a close examination of engineering identity development can benefit programmatic design and student support models. In addition to a lack of focus on doctoral engineering students' identity development, current frameworks for tracing identity development require a more effective longitudinal design to capture development over time.

While engineering systems theory offers a behavior-over-time graphing option, further qualitative attributes need to be included if we wish to learn about factors that contribute to identity development for doctoral engineering students. This NSF-funded project allowed us to bring together industrial and systems engineering researchers with user experience (UX) researchers who offer qualitative coding methods to account for doctoral students' subjective experience in their professional growth. UX can be seen as a distinctive approach to programmatic assessment and curriculum design because it allows a triangulation of data analysis from the participant's own report of experience, researcher's observation of behaviors, and the actual performance or outcomes of a process (in our case, the students' journey through a doctoral program). Using surveys, focus groups, interviews, and journey mapping methods, we collected multiple-staged data to identify what personal, social, academic, and professional factors influence doctoral students' researcher identity development.

In this paper, we emphasize the affordances and constraints of qualitative UX methods as a complementary approach to engineering identity research. We aim to discuss the ways UX—as originated from the intersections of design and technical communication—as a useful

supplement for informing engineering doctoral program design and implementation.

Literature Review

Collaboration has been considered a strategic approach to address interdisciplinary interests. Among the early publications on engineering writing, such as Jack Selzer's study of the composing process of an engineer [1], Dorothy Winsor's examination of knowledge production in engineering through textual mediation [2], and later Julie Dyke Ford's observation of knowledge transfer from technical communication to engineering education [3], and Ann Hill Duin and Lee-Ann Kastman Breuch's explication of technical communication leaders' identity [4], scholars have alluded to the necessity for cross-pollination between professional communication studies and engineering research. Collaborative scholarship can leverage existing strengths within discrete discipline to create new or shared frameworks that refine current practices and result in innovation. Our project originated with such a mindset as a guiding principle, seeking to combine engineering theories and technical communication methods—in this case, UX—to understand how engineering professionals cultivate their researcher identity.

Given the interest in identity development, engineering researchers have focused on engineering student professional maturation primarily at the undergraduate level [5]. Very little attention has been given to identity formation among engineering doctoral students [6], [7]. Our study is thus interested in investigating the development of these very specialized professionals through their coursework and research experiences and their relationships with peers, faculty, and mentors. However, relational variables are usually multifaceted and challenging to map. To address this challenge, industrial and systems engineers have applied systems (dynamics) theory and behavior-over-time (BOT) graphing method to understand the complexity in "interacting, interrelated, or interdependent components that form a complex and unified whole" [8]. Figure 1 shows an example of a BOT graph featuring multiple variables. The value of the y-axis is the performance of the variables (i.e., sales, sales force, profits, and new product releases).

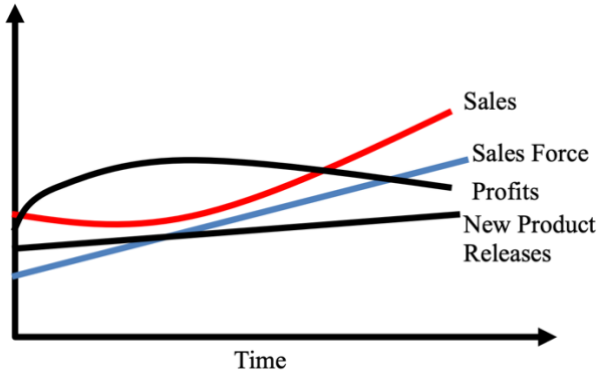

Figure 1. Example of a BOT graph [9].

BOT provides a dynamic view of performance longitudinally, but it lacks qualitative depth. Previously, we reported our inspiration by product development and UX research methods to expand systems methods by visualizing engineering doctoral student experiences and then coding students' experiential and emotional responses [10]. In this paper, we offer a reflection on this collaborative endeavor. Responding to the theme of this year's conference, we work to demonstrate a way of building bridges across disciplines to innovate research methods and scholarly agendas that benefit all partners.

Methods

To evaluate the cogency of our cross-disciplinary research design, we employed a collaborative autoethnographic (CAE) methodology with the following questions guiding our analysis: In what ways have UX methods augmented the study of identity development among engineering doctoral students? What methodological constraints have we observed in the study to date?

CAE is a reflexive methodology that "focuses on self-interrogation but does so collectively and cooperatively within a team of researchers" [11, p. 21]. It involves individual reflections as well as collective analysis of autobiographical materials to gain a holistic understanding of a team process. Figure 2 shows a typical CAE workflow.

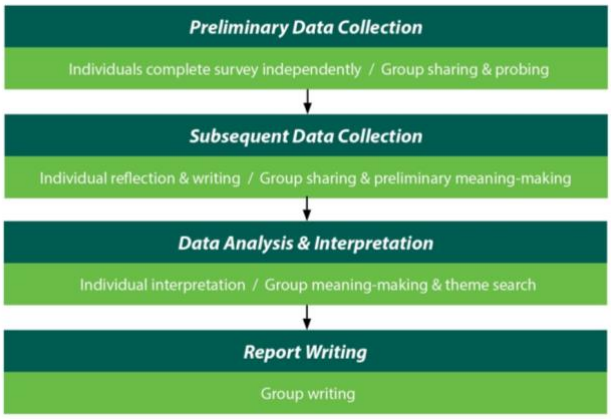

FIGURE 2. A COLLABORATIVE AUTOETHNOGRAPHY PROCESS [12].

Using the standard CAE process, we have individually produced reflections on the application of qualitative UX methods in this engineering identity research, collectively discussed significant observations, and then synthesized major themes together.

RESULTS

Our current team consists of four system engineering scholars (two faculty and two graduate students) and two UX scholars. For this paper, four individual retrospectives were produced. Major themes emerging from the collaborative reflections included 1) **insights**, 2) **validity**, and 3) **clarity**.

First, insights referred to data-driven observations made from the study. All of the retrospectives alluded to the importance of learning directly from students (as users) of the doctoral engineering program. As opposed to building assumptions based on conventional wisdom, or lore, UX methods like interviewing and journey mapping curate actual experiences directly from the students. This allowed the research team to identify issues pertaining to local as well as global conditions. A faculty team member put it this way:

> My experiences with UX and with doctoral students engaging in UX research told me that we needed to hear from our students to develop, implement, and effectively assess the degree we were developing.

Another team member agreed that capturing and coding student experiences in the program was essential because they offer valuable evidence based on lived experience—"it makes a lot of sense to let them talk about how they (doctoral students) lived that experience and [learn about] what was hard, easy, fun, or boring."

Second, while not necessarily inferring statistical validity, the retrospectives included concerns of validity of the research findings due to subjectivity in UX data. A faculty team member explained:

> UX methods that we have employed require retrospective recall, which can be biased. Students may only remember the highlights and lowest points in any given semester of activities. In fact, our journey mapping processes ask students to share only those moments in which their identity as researchers has been encouraged or diminished.

However, team members emphasized the rigor involved in UX methods that could lead to higher confidence in the findings. A graduate assistant on the team mentioned in their retrospective this experience with labor in research: "… UX methods are easy for users, but not for the ones taking the data. Researchers using UX methods need to go through multiple steps to obtain just a single conclusion."

Third, clarity emerged as a topic of interest in the retrospectives. For system engineers, the integration of UX methods helped clarified some aspects of student behaviors. A faculty team member elaborated:

> BOTs (behavior-over-time graphs) can also be used to test whether the developed structure (causal loop diagram) – when not an archetype – can recreate the observed behaviors in the BOTs. However, sometimes it is unclear how the BOT graphs can be developed, since we don't always have longitudinal data. Journey maps are one valid and reliable source of longitudinal data based on user experience. Surveys, focus groups, and other UX methods can also be good sources of data and other modeling inputs – for gathering BOT data, for generating ideas regarding system structure, and for validating system structure.

Another dimension of clarity had to do with the characterization of UX methods. One graduate student team member indicated that it can sometimes be difficult to explain journey mapping to other engineering researchers. A faculty team member said, "the biggest challenges are in the assumptions of the techniques and the disciplinary backgrounds of the researchers" but it provided "an exciting opportunity for growth and learning," in that all team members learned to find a common vocabulary to communicate about the research process.

FURTHER DISCUSSION AND CONCLUSION

In sum, our collective reflections covered mainly the affordances of UX as a supplementary methodology for studying engineering doctoral students' identity development. Given the original motivation of this project, team members narrated primarily the usefulness of UX methods followed by some constraints facing the strengths

of the findings and the process involving the clarification of UX to engineering researchers. One faculty team member produced an expanded reflection on the constraints of UX methods worthy for inclusion here:

> I think the methods are working quite well, but, in an academic setting over time, they present significant challenges. Foremost among these challenges has been motivating and sustaining user/student participation. We have been able to attract students to the research most easily when we ask them to participate in a class setting. When they are outside of a classroom setting, they are harder to contact and engage in the research, even with compensation. When we can engage participants, the data we collect is quite useful and helpful in answering our research questions.

As we consider the symbiotic relationship between engineering research and technical communication, we acknowledge the challenges of collecting data directly from students have been comparable to other research methods. They can be subjective, hard to validate, and difficult to sustain. Yet, our cross-disciplinary effort has proven to be productive for learning about student experience in a doctoral program and it's showing potential for application across disciplinary contexts. As Kelli Cargile-Cook and Kate Crane demonstrated in their collaboration, "taking a UX approach to academic innovation provides teacher-practitioners with a means to articulate the conflict that can exist between student needs or wants and instructor expertise and know-how" [13, p. 36]. We believe our approach is applicable to programs elsewhere that seek to understand how their students' (and other constituents') experience their journey of growth and identity development through completing the program.

Acknowledgement and Disclaimer

This material is based upon work supported by the National Science Foundation under Award No. 2205033. Any opinions, findings and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

References

[1] J. Selzer, "The composing process of an engineer," *College Composition and Communication*, vol. 23, pp. 178–187. 1983.

[2] D. Winsor, "Engineering writing/writing engineering," *College Composition and Communication*, vol. 41, no. 1, pp. 58–70. 1990.

[3] J. Dyke Ford, "Knowledge transfer across disciplines: Tracking rhetorical strategies from a technical communication classroom to an engineering classroom," *IEEE Trans. Prof. Comm*., vol. 47, no. 4, pp. 301–315. 2004.

[4] A. H. Duin and L. A. K. Breuch, "Writer identity, literacy, and collaboration: 20 technical communication leaders in 2020," in *Rewriting Work*, L. Anderson, Ed. Fort Collins, CO: The WAC Clearinghouse, 2023, pp. 113–139. https://wac.colostate.edu/docs/books/rewriting/chapter5.pdf

[5] J. R. Morelock, "A systematic literature review of engineering identity: Definitions, factors, and interventions affecting development, and means of measurement," *European J. Eng. Edu*., vol. 42, no. 6, pp. 1240–1262. DOI: 10.1080/03043797.2017.1287664

[6] A. D. Patrick and M. Borrego, "A review of the literature relevant to engineering identity," 2016.

[7] A. Elizondo-Noriega, N. Tiruvengadam, K. Cargile-Cook, J. Cross, and M. G. Beruvides, "Understanding engineering identity formation mechanisms in graduate and undergraduate education: A state-of-the-art matrix analysis," 2020.

[8] L. von Bertalanffy, *General System Theory: Foundations, Development, Applications*. New York, NY: George Braziller Publisher, 1968.

[9] V. Anderson and L. Johnson, *Systems Thinking Basics: From Concepts to Causal Loops*. Cambridge, MA: Pegasus Communications, Inc., 1997.

[10] K. Cargile-Cook, J. Cross, M. Beruvides, D. Polanco-Lahoz, and F. Carrion-Anampa, "Mapping change in professional identity growth in doctoral engineering students," in *Proc. IEEE ProComm*, Ithaca, NY, 2023, pp. 178–182.

[11] H. Chang, F. Ngunjiri, and K. A. C. Hernandez, *Collaborative Autoethnography*. New York, NY: Routledge, 2013.

[12] J. Tham, *Design Thinking in Technical Communication: Solving Problems through Making and Collaboration*. New York, NY: Routledge, 2021.

[13] K. Cargile-Cook and K. Crane. "Beyond lore: UX as data-driven practice," in *User Experience as Innovative Academic Practice*, K. Crane and K. Cargile-Cook, Eds. Fort Collins, CO: The WAC Clearinghouse, 2022, pp. 25–63. https://wac.colostate.edu/docs/books/innovative/chapter2.pdf

About the Authors

Jason Tham is an Associate Professor of Technical Communication and Rhetoric and Assistant Chair of the Department of English at Texas Tech University. His current research focuses on the application of design-driven methodologies in technical and professional communication. He is author of *Design Thinking in Technical Communication* (2021), editor of *Keywords in Design Thinking* (2022), and co-author of *UX Writing: Designing User-Centered Content* (2024), among other publications.

Jennifer Cross is an Associate Professor in the Department of Industrial, Manufacturing & Systems Engineering at Texas Tech University. She received her BS in Industrial Engineering from the University of Arkansas and her MS and PhD in Industrial and Systems Engineering from Virginia Tech, where she also served as a Postdoctoral Associate in the Enterprise Engineering Research Lab. Her research interests are organizational assessment/performance measurement, teams, performance improvement methodologies, and engineering education.

Mario Beruvides received a PhD in Industrial & Systems Engineering from Virginia Tech and an M.S. in Industrial Engineering and B.S. in Mechanical Engineering from the University of Miami. Dr. Beruvides is the Associate Vice Provost for International Affairs and AT&T Professor of Industrial Engineering in the IMSE Department at Texas Tech University. His professional interests are in engineering economics, education and systems engineering. He holds a professional engineering license in the state of Texas.

Diego-Polanco-Lahoz is a Ph.D. student, from the program of Systems and Engineering Management, in the Department of Industrial, Manufacturing & Systems Engineering at Texas Tech University. He received his BS in Industrial Engineering from the Pontificia Universidad Católica de Valparaíso (PUCV). His research interests are organizational resilience, organizational factors research, organizational assessment/performance measurement, and engineering education.

Md Reshedul Hasan is a master's student in the Systems and Engineering Management Program in the Department of Industrial, Manufacturing & Systems Engineering at Texas Tech University. He received his B.Sc. in Textile Engineering from Bangladesh University of Textiles. His research interests include process improvement, operation research, supply chain management, and engineering education.

Kelli Cargile-Cook is an Emeritus Professor and Founding Chair of the Professional Communication Department at Texas Tech University. Her scholarship focuses on online education, program development and assessment, and user-experience design. Most recently, she co-edited *User Experience as Innovative Academic Practice* (2022) with Kate Crane. She also co-edited two collections on online education: *Online Education 2.0: Evolving, Adapting, and Reinventing Online Technical Communication* (2013) and *Online Education: Global Questions, Local Answers* (2005).