

DESIGN THINKING METHODOLOGY

A case study of “radical collaboration” in the wearables research laboratory

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In this research article, we share a case study of the Wearables Research Collaboratory (WRC, wrcollab.umn.edu) showcasing how we came to apply design thinking methodology to the development and deployment of a technical and professional communication experience designed to enable cross-cultural, innovative insights and solutions. Over 12 weeks, our diverse team of eight applied design thinking methodology to our individual and collective investigations of wearable technologies, emphasizing culture and pedagogy, ability to shift perspective and better understand one’s position in the world, and the challenges and opportunities posed by these devices. Our discussion includes focus on the cultures of seniority and academic position as well as the importance of learning experiences that reveal the true complexity of problems and that support sustained periods of question finding, ideation, and visualization. We conclude with discussion of radical collaboration as a model for the application of design thinking.

Keywords. Design thinking, Technical and professional communication, Radical collaboration, Wearable technologies, Pedagogy.

The majority of technical and professional communication curricula includes content and assignments designed to meet student learning outcomes that include the ability to critically examine technology, identify cultural and social impacts of writing, and create and maintain content. Assignments associated with these learning outcomes provide important practice in learning processes integral to future work (e.g., usability testing protocols or use of content management



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systems). However, technical and professional communicators increasingly are called upon to address ambiguous and ill-defined problems, such as how to appeal to multidisciplinary audiences and cross-functional teams, how to accommodate users of new apps and new communication devices, and how to adapt to emergent contingencies, understandings, and expectations; i.e., situations in which competencies associated with design thinking are most needed. Pedagogy associated with design thinking includes building prototypes and sharing these with other people; working together across cultures and/or across academic position; and embracing a non-sequential (cyclical) process as a means to develop multiple solutions to problems.

As experiences designed to build competencies associated with design thinking are rare, here we share a case study of the Wearables Research Collaboratory (WRC, wrcollab.umn.edu) in which we came to apply design thinking methodology to a technical and professional communication experience that we designed to enable cross-cultural, innovative insights and solutions. This case study focuses on a period of 12 weeks in which eight of us—two faculty, two PhD candidates, and four undergraduate research assistants—applied design thinking methodology to individual and collective investigations of wearable technologies.

The suite of investigations centered on uses and implications of wearable technologies in terms of culture and pedagogy, ability to shift perspective and better understand one's position in the world, and the challenges and opportunities posed by these devices. Together we deployed devices across undergraduate writing courses, examining the cultural and social dimensions of wearables including Google Glass, Google Cardboard, Oculus Rift, Pebble Watch, and Leap Motion. These studies expanded from our previous work, described in *Wearable Computing*, *Wearable Composing*, and evolved concurrently with our discovery of design thinking. The undergraduate students serving as research assistants identified emerging wearables, prototyped methods for studying the devices, and shared their discoveries along with the full team. Together we worked to address ambiguous, ill-defined, and tricky problems as we

collaborated across disciplines and/or across age groups; moreover, we embraced a non-sequential process as a means to develop multiple solutions.

In this article we document our discovery of design thinking methodology during our collaborative process and the resulting impact of this direction on our investigations. We reflect on the cultures of seniority and academic position as well as the importance of learning experiences that reveal the true complexity of problems and that support sustained periods of question finding, ideation, and visualization. We conclude with discussion of radical collaboration as a model for the application of design thinking.

In this article, we focus on communication and design across academic cultures rather than across international cultural boundaries. In an article titled “Intercultural Connectivism,” two of our authors previously proposed “to shift focus away from building environments that accommodate different cultural values toward building ecologies in which participants create and share knowledge and make their cultural values toward knowledge, information, and learning as transparent as possible. We are interested in moving beyond awareness and tolerance of cultural complexities and toward pedagogies for knowledge creation in culturally diverse, networked learning environments” (Duin & Moses, 2015, p. 32). The design thinking framework of the Wearables Research Collaboratory is one such ecology—in this case, for collaborating across academic cultures. It is a test case, one iteration, comprised of knowledge, information, and learning among participants across the academic spectrum of experience.

The evolution of design thinking

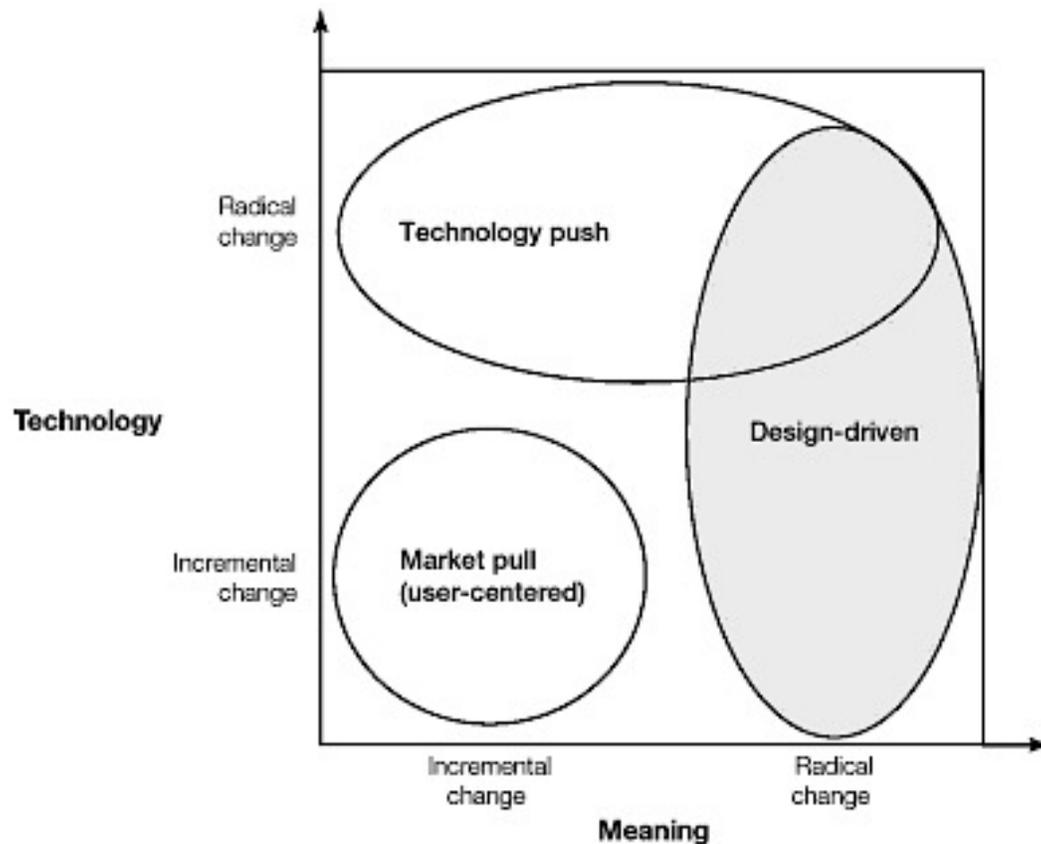
Innovation expert Verganti (2009) in his book, *Design-Driven Innovation*, articulates the strategy of design-driven innovation as one involving radical change. As shown in his figure 1-1 below, more traditional user-centered approaches largely result in incremental change; in contrast, design-driven innovations take a broader perspective, exploring both socio-cultural and technical dimensions. In particular, the process of design-driven innovation involves listening to interpreters or what Verganti refers to as “forward-looking researchers

who are developing, often for their own purposes, unique visions about how meanings could evolve in the life context we want to investigate” (p.13).

Our field of technical and professional communication embraces user-centered approaches to design, and the resulting methods lead to useful, incremental change. In this project, however, we are interested in how design thinking methodology might be applied to the development and deployment of a technical and professional communication experience designed to enable cross-cultural, innovative insights and solutions. By so doing, what design-driven, radical change might result?

Figure 1

From Verganti (2009), Figure 1-1, The strategy of design-driven innovation as the radical change of meanings.

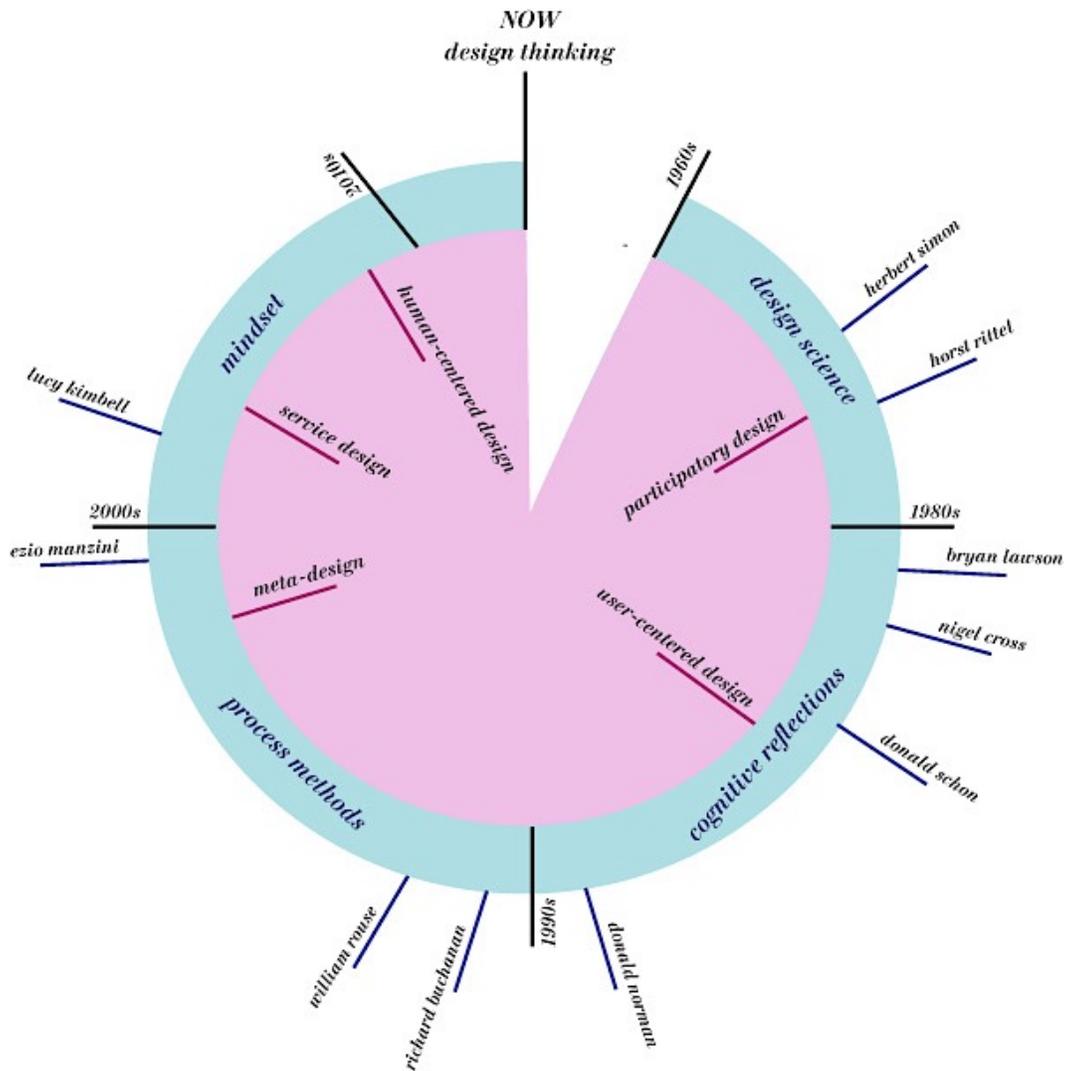


For a more specific definition, Di Russo (2016), senior consultant of design strategy at Deloitte Australia, defines design thinking as “a term widely used outside of the design industry to describe the innovative and human-centered approach used by designers in their practice... [It] has erupted outside of design practice as a new approach for innovation and transformation, piquing the interest of leaders from business, education, government, through to not-for-profit organisations” (p.3). The following illustration from Di Russo’s (2012) blog post, A Brief History of Design Thinking, chronicles the development of design thinking. Di Russo describes how in the 1960s *participatory design* focused on integrating end-users into the development (prototyping) phase of projects. The next most significant contribution to design thinking was introduced in the 1980s by Donald Norman who re-defined participatory design into *user-centered design*. A few years after the millennium, *service design* emerged in which attention shifted to an understanding of “the use, interaction and journey of [the] product/service after it has left the hands of the provider.” Rather than focusing on the end user, service design emphasizes collaboration with all users and the importance of building relationships and opening up communication. Most recently, *human-centered design* has continued the shift from technological systems to social systems, engaging users, and designing methods to gain direct understanding of audience.

In terms of pedagogy, Razzouk and Shute (2012), in their review of research on design thinking, state that “Helping students to think like designers may better prepare them to deal with difficult situations and to solve complex problems in school, in their careers, and in life in general” (p.343). And Glen, Suci, Baughn, and Anson (2015), in their work on teaching design thinking in business schools, provide faculty with guidance on implementing six phases for such assignments: problem finding, observation, visualization and sense making, ideation, prototyping and testing, and the design of a business model for innovation.

Figure 2

From Di Russo (2012). *A Brief History of Design Thinking*.



Arguing for the use of design thinking in composition, Leverenz (2014) defines design thinking as “a human-centered approach to designing innovative solutions in response to wicked problems” and calls for “dramatic change if we want writing to be important in students’ lives long term” (p.1). One such challenge is to resist the impulse to “take the wickedness out of writing assignments” (Leverenz, p.7),

which ill prepares students for the the contemporary workplace, where our students increasingly will be called upon to address ambiguous and ill-defined problems. Leverenz argues for, instead, interdisciplinary writing teams to foster divergent thinking and to treat drafting more like prototyping. In her conclusion regarding the risks of using design thinking in writing, she emphasizes that “for design thinking to thrive, it must take place in a culture that supports it” (p.11).

Therefore, contemporary design thinking methodology is both a mindset and a method (Di Russo, 2016); furthermore, it requires a culture to support it (Leverenz, 2014). In terms of mindset, for this project we used materials provided by the Stanford Design School (see Appendix A for two excerpts from these materials) to better understand and practice core attributes of design thinking: ambiguity, collaborative, constructive, curiosity, empathy, holistic, iterative, nonjudgmental, and an open mindset. We practiced a participatory mindset in which others (team members, academic technologists, users, students) were all seen as partners, as active co-creators.

Over a 12-week period, we discovered and applied this design thinking mindset and method to a technical and professional communication experience designed to enable cross-cultural, innovative insights and solutions. The “wicked problem” emerged as follows: At a time when professional communicators are called upon to address ambiguous and ill-defined problems, our curricula and associated courses provide ordered, well-defined processes for arriving at solutions for argumentation, critical thinking, structure, focus, analysis, editing, and rhetoric. Rare are the opportunities for students to practice design thinking or to develop new approaches and share these with other people; to work together cross-functionally across cultures and/or across academic designations; and to embrace a non-sequential (cyclical) process as a means to develop multiple solutions to problems. In short, how might we use design thinking to create a technical and professional communication experience to enable cross-cultural, innovative insights and solutions that reflect the perspectives of all participants?

In the remaining sections of this paper, we share a case study of our collective “radical collaboration” as part of the Wearables Research Collaboratory (WRC).

Case Study

At our first full team meeting, we shared introductions, gave each undergraduate Research Assistant (RA) a Google Glass device as a means to begin experimenting with wearables, and provided details regarding planned investigations centering on the uses and implications of wearable technologies in terms of culture and pedagogy, ability to shift perspective and better understand one's position in the world, and the challenges and opportunities posed by these devices. We held additional meetings to introduce the RAs to the college's academic technology unit where they would experiment with emerging technologies. This collegiate academic technology is known as LATIS, the acronym for Liberal Arts Technologies and Innovation Services (<http://latis.umn.edu/>). We also met in sub teams (RAs and faculty/grad students) each week to share findings and coordinate the investigations.

During the second full team meeting, a former RA who served during our previous set of Google Glass investigations, Brittah Springer, returned to campus to share with our team about the impact that working with wearables had on her work. As we reflect back, this meeting in which Brittah shared her insight into how this unique blend of cross-cultural faculty/grad students/undergraduate student collaboration had led her to experiment and innovate in ways she had never attempted before, represented a key point in our team's journey toward better understanding the potential use and impact of design thinking methodology.

Another key point came at our third meeting as we determined design principles for the project's web site. This discussion prompted Ann to develop a workshop on design thinking and "radical collaboration" as part of our fourth meeting. This workshop included reference to Introduction to Design Thinking and practice with materials from the Stanford Design School. We also used the diagnostic tool—Plan Your Collaboration—included at the site, A Designer's Guide to Collaboration, to compare our values regarding teamwork, decision-making, leadership, motivation, and diversity during each of four stages of work as defined by the framework: 1) discover, 2) define, 3) develop, and 4) deliver.

Interestingly, while seven of us depicted our collaboration as a very open process, one RA (Linus) indicated a clear difference regarding stage 4) deliver. Linus emphasized that from the point of view of a business major, the CEO has the final say on whether or how to deliver a final product. Linus elaborated on the importance of hierarchy and closed systems in business culture.

Throughout these and discussions that continued throughout the remainder of the project, we focused on this question: How are we applying design thinking principles to our work? And we came to define the project as follows:

This project is a case study of applying design thinking principles to the development and deployment of a technical and professional communication experience designed to enable innovative insights and solutions. Students involved in the collaboratory develop new approaches and share these with other people; learn to address ambiguous, ill-defined, and tricky problems; work together across disciplines and/or across academic positions; and embrace a non-sequential (cyclical) process as a means to develop multiple solutions to issues.

Reflections

Shortly after the workshop on design thinking, our full team discussed the importance of providing reflections on the project. The following three reflections illustrate a person's or team's ongoing work; together they provide the core of this case study as they detail our discovery and practice of radical collaboration.

Jason Tham, Ph.D. candidate

With an eye toward the pedagogical affordances of wearables and virtual and augmented reality devices—namely Google Glass, Google Cardboard, and Theta 360 cameras—in writing instruction, I deployed these technologies in a first-year composition course designed for non-native speakers in Spring 2016. My research question was informed by literature from intercultural professional communication as well as the rhetoric of technology design for global users.

The goal of my study was to investigate non-native speaking students' perception of the use and design of popular wearable technologies, and to collect their recommendations for re-envisioning and improving the development of wearable technology in the future.

As part of my study, I provided classroom demonstrations of the deployed devices when introducing the devices to my students. Given the novelty of these technologies and the constraint of class schedules, I realized that it was not enough to simply run workshops in the class and expect students to learn how to work with the devices within a short timeframe. Thus, with the help from the RAs, several video tutorials were created and provided to students so they could have quick references to the nuts and bolts of the devices deployed. While it may seem self-evident that the RAs were appropriate for providing solutions in this task, one of the challenges facing the situation was the need for the RAs to understand the context of the study and the specific needs of the students. To ensure that these were achieved, one of the RAs responsible for producing the video tutorials actually volunteered to attend a handful of the class sessions during the semester and spoke with my students before deciding the kind of video to produce. Such intervention was new to my instructional operations as it required coordination between the RA's visitation to the class as well as my lesson plans. And because the RA had little background in writing studies, it was necessary for some theoretical calibration between us to ensure coherence in the overall pedagogical philosophy of teaching writing with technologies and attending to critical questions of the technology use in educational contexts. Such calibration often took place at the weekly WRC meetings, and one-on-one discussion sessions helped shape the unified tone and delivery in the classroom.

Another cross-cultural challenge experienced during my project was managing the plurality of my own identities as a researcher, a teacher, an advisee, and a student during the time of this radical collaboration. During the time of his project, I was a second-year doctoral student. Among the members of the WRC team was my academic advisor (Ann), a senior lecturer from the department (Joe), a fellow classmate (Megan), and four undergraduate RAs. While being the principal investigator of my own study, I reported my progress to as well as

required research support from Ann during WRC meetings. The negotiation of such roles also happened in my actual deployment of the wearable devices in my class, when Ann came to offer deployment assistance during a class session while also observing my teaching. Ann later provided observational notes about my teaching methods and how the class session went overall. This radical configuration of roles and identities between an advisor and advisee shakes up what I used to know as graduate education and professional development.

Further, my role as a student in Ann's research methods seminar during the same academic year as well as a fellow classmate and WRC member (Megan) complicated my relationships with Ann and Megan during the project deployment period. Often during the seminar I was asked to provide instances of research and research methodologies to other classmates, and teamed with Megan in class assignments. Such complications were indeed desirable as I learned to interpret and assume autonomy over my professional identity as a graduate student and researcher in the process of graduate education. The authenticity between an advisor and advisee, and between colleagues of different cohorts, has helped me define my role in the research process and in relation to WRC as a collaborative unit.

My project involved not only academics but also those providing services to the university. Our college's academic technology unit, LATIS (discussed earlier in this paper), provided most of the devices deployed in the project as well as pointers to how to use or make the most of their functionality for instructional purposes. Besides these technicalities, LATIS also helped me to design my research schematics—from narrowing the research question to defining sample subjects to validating data collection and analysis methods—which in part shaped my overall project outlook. Furthermore, LATIS offered its workspace and staff support to me and the RAs during the period of the study, making it convenient for ad hoc meetings and impromptu technology demos to take place. Adding these together, LATIS was a major factor in the completion of my project. What's exceptional in this experience is that LATIS's involvement was truly germane and ground-up. There was no pre-engineered operational procedure that had defined LATIS's role in my project—and those of other researchers as well—thus allowing each project to

specify individual needs as it proceeded. The cross-cultural (academic and industry) interplay between LATIS and myself was one cause; the extempore, iterative collaboration was another that indeed enriched my project.

Overall, my radical collaboration experience can be summed up with three lessons in professional communication: First, I have learned to empathize with users and focus on their needs. For instance, working with WRC and its RAs has allowed me to better address the concerns of my students in the project. Particularly, the RAs' intervention during the deployment period helped locate the challenges faced by users and devised solutions that are timely and relevant. This puts users at the center of research and avoids structural and ethical manipulation of them by the researcher. Second, my radical collaboration experience with WRC and LATIS has also been constructive in nature. From the beginning of the project, all meetings and conversations have been centered around productivity and invention. As design thinking methodology propels a *doer* philosophy, it complements greatly a graduate education that mostly encourages its students to be *thinkers*. While not being tied to a specific meeting place (we have convened in multiple conference rooms, classrooms, and offices), the WRC manifests as a makerspace that constantly promotes creative problem-solving and discovering new approaches of doing something (i.e., teaching, learning, researching). Given these benefits, this kind of experiential activity should be integrated into the core curriculum of a technical and professional communication graduate education as co-curricular learning.

Last but most importantly, working in a cross-cultural and cross-disciplinary team has helped me learn a key feature of collaboration that is the ability to communicate with different audiences. Such a feature is one of the critical competences that most graduate programs strive to emphasize, but it is often overlooked. A quick survey of PhD level courses for a professional communication degree from around the country yields an apparent observation: No PhD curriculum (including our own) requires its students to work with their advisor or faculty members on any sustained projects. Many programs encourage students to pursue these scholarly activities on their own initiative, but without any integrated support system to promote collaboration. Working with individuals

of varying academic status and industry experience has allowed me to practice communicating my research with specialists and non-specialists. From meetings (with information technology directors and staff) to informal presentations (at departmental parlor events) to public dissemination of findings (via local and national conferences), I have adjusted this delivery for varied audiences. This radical collaboration experience has and continues to provide me with a kind of learning that, cliché enough, may not necessarily be practiced in graduate seminars within a classroom setting.

In this reflection video, Jason shares his thoughts about deploying Google Glass and then Google cardboard in the classroom. Note his discussion of the difficulty with designing this assignment and discovery of his next steps as part of recording this reflection. Jason does not want to limit student opportunity and asks others in the WRC team to help him with the final design of his research project. Jason also shares about this collaborative experience and design thinking. He encourages the WRC team to develop the web site as a collaborative space to put all the work together in one place, as a way to see progress and reflect more on the “behind the scenes” work.

In this second reflection video, Jason shares about his experience with immersive video and themes that he collected from the cultural video project. Note how he calls Linus (undergrad RA) his “partner” on this project. Jason shares about his uncertainty in delivering on the initial goal of the project. Instead of having students do a full immersive presentation, note the change to include a 360 video as part of a larger presentation. With this change, the overall aim of the project remains the same: to have students experience a new environment for persuasion.

Jason also reflects on coding themes inherent in his research: limitations of the devices; social awkwardness with using the devices; cultural differences in using technology. Jason talks about how he will incorporate the students’ different cultural views into his research and teaching. He also shares about the multiple venues where he will be sharing his research.

Megan McGrath, Ph.D. candidate

The abilities to shift perspectives and to understand a person's position in the world—and in relation to the world around them—are critical skills when developing thoughtful, well-reasoned arguments. Therefore, I was interested in exploring the potential for virtual reality, such as Google Cardboard, to have my University Writing students see and immersively experience someone else's perspective. My students were beginning multimodal research projects, and the goal was to encourage the students to consider how many sense-making processes are involved in perceiving experiences and communicating them to others. Multimodal projects require attunement to how writers and audiences use multiple meaning-making modes to process information. In order to use multimedia intentionally, students ought to thoughtfully consider how their efforts to compose involve acute sensitivity to audience, context, and purpose.

Since this deployment was fundamentally about engaging and shifting perspectives, it was only fitting to engage multiple perspectives in the deployment's design and development. What resulted was a cross-cultural feedback loop that radically transformed the shape the deployment took from conception to execution. As I conceived of this project, I recorded my preliminary plans and rationale and shared them with the WRC via Google docs for feedback, which was provided at our weekly meetings. Active co-creation, therefore, was heavily encouraged and valued, since Jason had been working with Cardboard in his class for a few weeks, and because the undergraduate RAs had been experimenting with Cardboard at LATIS. The undergraduate RAs and I consulted with LATIS before, during, and after drafting in order to anticipate challenges to the project's feasibility as it took form, making the deployment a particularly participatory, iterative process. Key to making the deployment participatory and iterative was cultivating a nonjudgmental approach when eliciting and offering feedback, in which critique and suggestions were not only welcomed, but considered vital to the deployment's growth. This back-and-forth between conception, experimentation, and drafting represented a convergence of

cultures, at which undergraduates, graduate students, professors, and technology consultants traded and co-constructed knowledge.

Meinel and Leifer (2015) emphasize in their introduction to the edited collection, *Design Thinking Research: Building Innovators*, that “Design thinking is mainly about building innovators who can use the design thinking paradigm to transform ideas into reality, to transform organization, and to transform all aspects of life” (p.1). They provide four specific “rules of design thinking” (i.e., design requirements) for such work:

- I. The Human Rule: All innovator activity is ultimately social in nature. Never go hunting alone.
- II. The Ambiguity Rule: Innovators must preserve ambiguity. Never go home with a lone idea.
- III. The Re-Design Rule: All innovation is re-innovation. Who is the innovator that preceded you?
- IV. The Tangible Rule: Make innovation tangible. Make your ‘innovator story’ tangible. (pp. 2-4).

The interplay between these particular cultures fostered three of these rules: the Human Rule, Ambiguity Rule, and Tangible Rule. All innovator activity was social, occurring over conversations at WRC meetings and while learning Cardboard’s ins and outs through hands-on engagement at LATIS and in Jason’s classroom. What one or more of us learned about the device, we would relay in order to build a shared archive. Ambiguity was preserved because few things are certain when working with an emerging technology, and we found that our plans for deployment needed to be flexible in order to accommodate technical difficulties beyond our control, such as a strong enough internet connection or a malfunctioning app. For example, I originally planned to have my students use Cardboard in conjunction with the Body Swap app, which—as the name suggests—allows users to feel as though they have inhabited another user’s body and are experiencing the world through the other person’s eyes. However, one week before deployment, the app stopped working in the LATIS space, where the

deployment would take place. This malfunction prompted a LATIS specialist to suggest using the Vrse app for perspective-shifting by looking at 360-degree videos from *The New York Times*. Although the Body Swap app would have been more interactive, having students watch an immersive video encouraged them to be making more explicit connections between how what they were sensing influenced the narrative being constructed by and for them, better foregrounding the pedagogical goal of this deployment.

What stood out in this deployment and our broader work within the WRC was the vibrant creative energy fostered by design thinking, because nobody assumed one specific or static role. Because we work with emerging technologies, their possibilities and limitations are still relatively uncertain—and must, therefore, emerge through hands-on experimentation with the devices. This experimentation demands patience, open-mindedness, and comfortability with jumping before a net has appeared. These qualities—at the heart of design thinking—invited each member of the WRC to fluctuate between being an instructor, a research assistant, and a technology consultant, with the lines often quite blurry between these roles. As the RAs experimented at LATIS, they had to adopt a pedagogical mindset as they unearthed possibilities and encountered obstacles: how would the available options fit into a lesson on usability, an exploration of culture, or an exercise in perspective-shifting? As each of us made discoveries, we assumed an instructor role when making these developments understandable and actionable to the rest of the WRC. Each of us became research assistants to Ann, Megan, Jason, and Joe as they deployed, since each project required us to help the lead instructor negotiate a desired pedagogical outcome with a particular technology or set of technologies. This role-shifting between instructor and RA enabled each of us to acquire enough first-hand expertise with selected wearables that we could function as technology consultants to both students and the other WRC members as they deployed. The malleability of our roles thus challenged the forces of hierarchy and routine that can consciously or subconsciously structure and stultify collaborations and shortchange their potential for organic, inventive vitality.

In this reflection video, John and Nathan share about their deployment of immersive video in Megan's course, Joe's deployment on the rhetoric of technology, and their use of the 360 Theta camera. They focus most on their work, assistance with deployments, and issues with the technology. Note their excitement as they share about the special event they planned (pop-up event at the student union), their development of a Qualtrics survey, and the user experience research they plan to add to the project website.

Nathan Ernst, Undergraduate research assistant

Our group worked constantly with technology and people. Our group worked specifically with usability of wearable technology. As the four undergraduate research assistants, we decided to host a pop-up event on campus. The idea of the pop-up was to bring an assortment of wearable technologies to a busy area for any students who are passing so they can take part in researching and articulating their thoughts on different wearables we used at LATIS. We brought Google Cardboard, Leap Motion, and Google Glass with us to the pop-up. Quickly we found that there were a lot of students that were wary at first to engage and try the wearables. We had to invite them to come over and try the wearables. As soon as a few came over we had lots of students and older adults coming to investigate what wearables have to offer. Before the pop-up started we created a survey to give to students after they had experienced wearables. One question we asked them was "Would you incorporate wearable technology in your everyday life?"

The results (Table 1, p. 62) were very interesting to us. Two thirds of those responding would use wearables in their everyday life. Keeping in mind that our sample size was only 18, what I found to be very interesting was that there were six people who would not use wearables in their everyday life. It seemed in my mind that most people, especially those who are young, are always interested in new and innovative technology.

Table 1

Survey results from the pop-up event

#	Answer	Response	%
1	Yes	12	67%
2	No	6	33%
	Total	18	100%

This pop-up was valuable for everybody involved. Students were able to learn about wearable technology, and our research team was able to see how these different wearable technologies were used by first users regarding usability. At the time we only had our own team's experiences with this new technology. So it was really valuable to see what types of technology are relatively easy for people to figure out right away or technology that is confusing to figure out. We found that Leap Motion which is an infrared camera that will track your hands and display them in 3D on the PC screen, and Google Cardboard which is a virtual reality device, were relatively easy for people to understand because they did not involve a lot of interaction. However, a technology like Google Glass that requires constant human interaction to work was very hard for people to understand. It is also very hard to help somebody that has Google Glass on because we cannot see what they are seeing. Overall the pop-up event, an approach that we as RAs proposed, developed, and implemented ourselves, was one of the most important projects we did all semester.

Most important, the RAs became more than a team; they valued each other's knowledge and perspective, and became friends. In this video, all four RAs share about the importance of changing and adapting to learn new things; the importance of transparency, communication, and working as a team; the importance of being part of a professional level of research and technical writing team; the importance of working along with others in a field; and the huge opportunities to do almost anything within the constraints of wearables. As John concludes: Teamwork makes the dream work!

Radical collaboration: A model for applying design thinking

In the Wearables Research Collaboratory, we have begun to explore how a design thinking framework can support learning across cultures of age and academic experience. Our extended question-finding process enabled questions first to emerge through engagement with wearables on the basis of each WRC participant’s interest in the devices. In early drafts of this article, we described various interests from professional, graduate, and pre-professional perspectives, which then led us to visualizations in the form of our collaboratively written drafts for this *connexions* special issue. We have identified advantages of working in a team where we crossed cultural boundaries—established by our institution—between participants of different academic experience and rank. Specifically, we sought to sustain a non-hierarchical learning experience for all while working within an institution that arranges cultures by orientations to scholarship by rank, discipline, and years of experience as outlined in Table 2.

With respect to ill-defined and ambiguous problems, our experience has shown us the potential for design thinking to add value to instruction in an important and unexpected way: our prolonged process of question-finding enabled us to explore the complexity of the many problems posed by wearable technologies. That is, while design thinking is a framework for supporting collaborative work on complex problems, it is also a framework for revealing complexity that more hierarchical frameworks for instructional design must of necessity mask.

Table 2

Cultural orientations to scholarship by academic rank and experience among participants in the Wearables Research Collaboratory, 2015-16

Ann Hill Duin Professor	John Orzechowski Senior
Joe Moses Senior Lecturer	Linus Chan Junior
Megan McGrath Ph.D. candidate	Brian Gapp Sophomore
Jason Tham: Ph.D. candidate	Nathan Ernst Freshman

Learning experiences that reveal true complexity of problems have a different kind of value to students than the clearly defined and partial, simpler problems we present to students in order to protect them from complexities that may overwhelm what we consider to be novices' capacities. Our experience suggests that discovering complexity—to “pedagogically overwhelm”—gives learners a clearer understanding of problems and more fully prepares individuals for addressing complexity when they enter their workplaces. In the aggregate, the complexities that unfolded in the Collaboratory addressed the wicked problem of how to use design thinking to create a technical and professional communication experience to enable cross-cultural, innovative insights and solutions.

We have learned that designing learning environments across cultures requires a communication framework for collaborative learning across cultures. We characterize such a framework in Table 3 (p. 65).

Throughout this project, we also generated enormous amounts of shared documents and video resources as a means to communicate constantly and share discoveries. Findings from these many resources, along with the cross-cultural reflections above, have informed our initial development of a radical collaboration model that may be used to inform the work of others planning to deploy design thinking methodology.

A technical and professional communication experience designed to enable cross-cultural, innovative insights and solutions can begin with a focus on participatory design, i.e., one that involves students (graduate and undergraduate) as well as academic technologists in the development (prototyping) phase of projects. Key here is to bring together innovators with varied backgrounds and viewpoints to enable insights to evolve from diversity (i.e., “radical collaboration,” see Fig. 4, p. 66).

However, as Di Russo (2016) has described, participatory design may fail if/when participant or user decisions conflict with those of key stakeholders. Indeed, student input gleaned via a participatory process may or may not be heard or acted upon by those with greater academic authority. In response to such a dilemma, Norman re-defined participatory design into user-centered design

Table 3

Key features of communication design for learning across cultures.

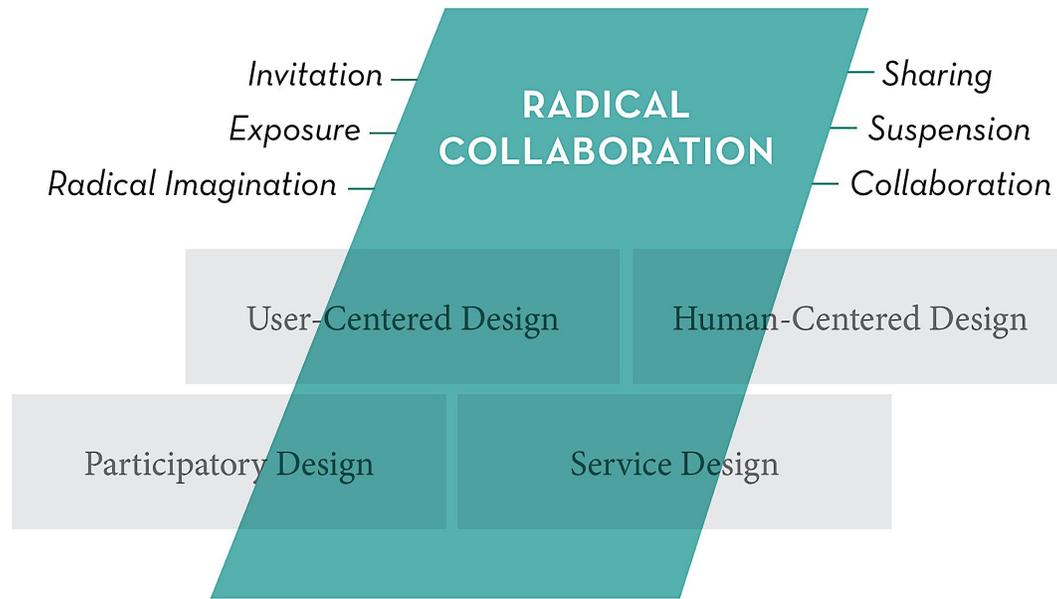
Feature	Communication Design for Learning across Cultures
Exposure	Expose participants to the complexities of problems regardless of experience
Collaboration	Resist hierarchical structures Invite and welcome perspectives across institutional boundaries Value team learning
Invitation	Invite and welcome perspectives that span theoretical, personal, and professional boundaries
Suspension	Suspend beliefs about knowledge boundaries Suspend judgment of people and ideas Suspend closure; sustain openness
Sharing	Explore empathy together as a collaborative learning tool Share leadership, research, teaching roles
Radical imagination	Invite radical change to what learning in academia can mean and be

with the goal of making things visible. The point here in terms of applying design thinking methodology to a technical and professional communication experience is that one must elevate user [student] experience. Understanding user [student] guinea-pigs to co-developers of systems.” It requires making the experience and overall process visible.

But how do we gain understanding of what students actually do with their use of emerging technologies, including their journeys and experiences?

Figure 4

Components of a radical collaboration model



Rather than focusing solely on end-user experience, service design further emphasizes the importance of collaboration, building relationships and communication. The key point here is value creation, i.e., focusing on value throughout the process as well as understanding the value that the project brings to students. As part of this project, we asked RAs to meet together to share both excitement and disappointment, to construct collective insights and create collective value surrounding the project. We also met together weekly as a team to generate knowledge; and we met together with LATIS to expand relationships, expertise, and communication. Furthermore, the RAs were invited to share the relationships they had with other entities involved with the design and deployment of wearable technologies (e.g., connecting with Pristine.io).

Human-centered design continues this shift toward social systems, engaging users, and designing methods to gain direct understanding of people. It

brings design together with emotion. Once human-centered design is embraced, a project team can embrace design thinking methodology and focus work on interpreting wicked problems. Along with Zachry and Spyridakis (2016), editors of the recent *JTWC* special issue on human-centered design, we believe that human-centered design is about “accounting for and reflecting shared human values in the creation of the technologies, artifacts, and systems that humanity shares in the collective pursuit of life. Recognizing that values vary from context to context, and that they are subject to change as people and technologies interact, we remain grounded in the assumption that human values are primary and should guide the world that people collectively create” (p.394). Human-centered design spurs design thinking forward with its emphasis on activity and interactions with people of various groups for the purpose of expanding understanding and developing pedagogy that prepares students to address ambiguous and ill-defined problems.

In conclusion, design thinking by its very nature is cross cultural. A model for design thinking begins with a focus on participatory design, with students and faculty innovating together in radical collaboration. It views all involved as co-developers and fosters visibility, curiosity, empathy, and open mindsets. It emphasizes relationship building and collaboration, makes innovation tangible, and is guided by human values. We can deploy such a model as we redesign courses and curricula as well as research/teaching/outreach experiences; by so doing, we move forward in preparing students to both lead and collaborate amid ambiguity. Applying design thinking to the development and deployment of a technical and professional communication experience indeed enables cross-cultural, innovative insights and solutions. ■

Notes and Acknowledgments

First, some background on our work with wearable technologies: Our initial experience with studying wearable technologies began in 2014 with an invitation message from Google: “You've been selected to join the Glass Explorer Program, a group of bold, creative individuals who want to help shape the future of Glass.” Ann Hill Duin bought a pair and began envisioning pedagogical implications. She and Joe Moses developed a grant proposal and received funding from the College of Liberal Arts (UMN) to investigate how the Glass device “reframes” writing pedagogy and digital literacies across the curriculum. A 2016 article titled “Wearable Computing, Wearable Composing” published in *Computers and Composition Online* details our deployments of the Glass device across undergraduate and graduate courses.

Second, we want to thank the College of Liberal Arts at the University of Minnesota for generously supporting this project through an academic innovation grant, and we thank the members of the Liberal Arts Technologies and Innovation Services (LATIS) team for their insight, direction, and collaboration throughout this project. In particular, we thank Alison Link for helping each of us to stretch our design thinking.

In addition to coauthor Nathan Ernst, we thank the three additional Research Assistants:



Linus Chan graduated in 2016 and recently completed his position at Digital River as a Product Marketing Intern. During the project, he wrote: The first instance that I remember interacting with a wearable technology is when I was completely jealous of my cousin’s Nintendo Super Scope. This Super Scope was a piece of plastic with an IR sensor on it. It didn’t work very well. However, we’re now in the year 2016 and we get Google Cardboard, Fitbits and the Apple Watch. As a Research Assistant in the Wearables Research Collaboratory, I want to get my hands dirty. There’s a host of new hardware directly purposed for pedagogical reasons. I’m eager to bring phones out in classrooms. I want to meld our present reality with the virtual and really bring engagement and enthusiasm back into learning.



Brian Gapp is now a senior in the undergraduate program in Technical Writing and Communication. During this project, he wrote: In the past I only encountered wearables on a sparse basis, firstly when borrowing my high school classmate's Oculus Rift while it was still in its earliest testing form. Seeing the OR when it was still quite new, my curiosity of wearables blossomed; what is their quality, importance, and value? At my family's last phone plan renewal, my dad and sisters had free Fitbits included with their new phone plan purchase, and it was neat for us to investigate those. After testing the movement-recognition Leap Motion device at the U of M, I became more interested in consciousness of wearables' controllability than their design alone.



John Orzechowski graduated in May 2016 and accepted a position as an Interaction Designer (UX) with Cerner Corporation, a leading Health IT company, located in Kansas City, MO. During this project, he served as project manager of the WRCollab website. He wrote: I have had exposure to Google Glass, Google Cardboard, Oculus Rift, etc. and the question I continue to carry with me throughout my research is "how can wearable technologies improve the human condition?"; after all, UX research is the foundation of usable design. I bring my passion of UX to my work as a researcher and have been thrilled with the amount of untapped capabilities wearable technologies offer. With a UX scope and experience with wearable technologies, I have been able to individually focus my research on accessibility, information architecture, and qualitative design analysis of wearable technologies.

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About the authors



Ann Hill Duin, PhD, is a professor of scientific and technical communication at the University of Minnesota where she studies the impact of emerging technologies on the future of teaching/learning and higher education. During the project, she wrote: My experience with “emerging wearables” began in March 2014 with an invitation message from Google: “You've been selected to join the Glass Explorer Program, a group of bold, creative individuals who want to help shape the future of

Glass.” I bought a pair and started using them!

Ultimately, the Glass device was pulled from the market and this opened us to the realm of exploring new dimensions of pedagogy and digital literacy through the deployment of Google cardboard, Oculus Rift, Pebble Watch, Leap Motion, etc. Most importantly, we launched the Wearables Research Collaboratory—a cross-generational, cross-cultural, cross-disciplinary open collaboration—through which we are applying design thinking methodology to individual and collective investigations of wearables.

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Joseph Moses, PhD, is a senior lecturer of writing studies at the University of Minnesota where he is developing an agile writing framework for instructional design in technical communication. During the project, he wrote: As soon as we started using Google Glass during the Spring of 2015, the device imposed itself physically between us and our familiar understandings of audience, author, setting, purpose, message, and presence.

Wearable computing, in the instance of Glass, complicates our experience of audience in ways illustrated by the case of Emotient, a startup recently purchased by Apple. The Emotient app's function is to detect emotion by analyzing facial expressions. Emotient's Glass app scans faces for cues that indicate levels of attention, engagement, and sentiment and produces data streams for analysis. How should we orient students to rhetorical situations in which audiences are both present and transmitted? Do we train our students to captivate audiences or to capture them in data streams? Do we teach audience analysis or audience analytics?

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Megan McGrath is a PhD candidate in the Writing Studies Department at the University of Minnesota—Twin Cities, where she teaches first-year writing and technical and professional writing. Her research examines how emerging technologies, such as wearables, influence agency, identity, and social norms. In the process, Megan's work also focuses on helping students cultivate digital literacies in ways that draw attention to the power structures enabling and constraining—and enabled and constrained by—technology use today. During the project, she wrote:

My experience with wearables began in the fall of 2014, when Dr. Ann Hill Duin, Dr. Joe Moses, and I started exploring Google Glass and its potential to expand and enrich communication. The more I used Glass, the more I became especially interested in how it might extend the concept of the think-aloud protocol and encourage more mindful reading, thinking, writing, and researching. At the same time, I wondered if its hand-free, seemingly-seamless, first-person POV might actually impede metacognitive awareness, which quickly blossomed into an interest in what—and whom—wearables make visible and invisible, familiar and unfamiliar. Specifically, I've been intrigued by how wearable technologies influence, and are influenced by, our

constructions of identity, when wearables are used for communication, community formation, and learning. I'm continually fascinated by and look forward to continuing to explore how wearables affect the ways we see and ascribe meaning to ourselves, others, and our experiences in the world.

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Jason Tham is a PhD candidate in the University of Minnesota's Rhetoric and Scientific and Technical Communication program. He studies how emerging technologies invite different ways of thinking and learning, and the increasingly intense flow of information occurring between people and machines. One of his long-term projects is the study of the scale and intensity of interconnected complex learning networks in the digital communication context. During

the project, he wrote:

My experience with the WRC has been rewarding. With the support from WRC researchers, I am able to investigate the uses and implications of emerging wearables in general and technical communication, as well as integrate innovative approaches to teaching writing using wearables. My current research revolves around two interrelated domains: **culture** and **pedagogy**. With regards to the former, I am studying what international users think of the designs (hardware and software interfaces) of current wearable devices, and argue for the importance of reducing the disparity between the imagined and the real needs of wearers. To do so, I deploy wearable devices in my composition classroom and invite students to experience, analyze and critique, and conceptualize wearable designs. This bleeds into my pedagogical domain of research, where I observe and theorize how to best facilitate learning with wearables. Last year, with the help from WRC members, I devised a way to enrich student peer reviews with Google Glass through first-person point-of-view video and audio recording. This

year, I am reimagining student presentations using Google Cardboard, 360° camera, and virtual reality video editing applications to produce immersive presentational experiences.

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Nathan Ernst is a second-year student in the undergraduate program in Technical Writing and Communication. During the project, he wrote:

So far my experience with wearable technologies has been amazing. I've had the opportunity to research many types of advanced wearable and virtual reality technologies that most people don't get to try at all. I am working hard with the other research assistants to

generate a lot of ideas about the uses of current wearable technologies in our society and culture. Wearables are the future.

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