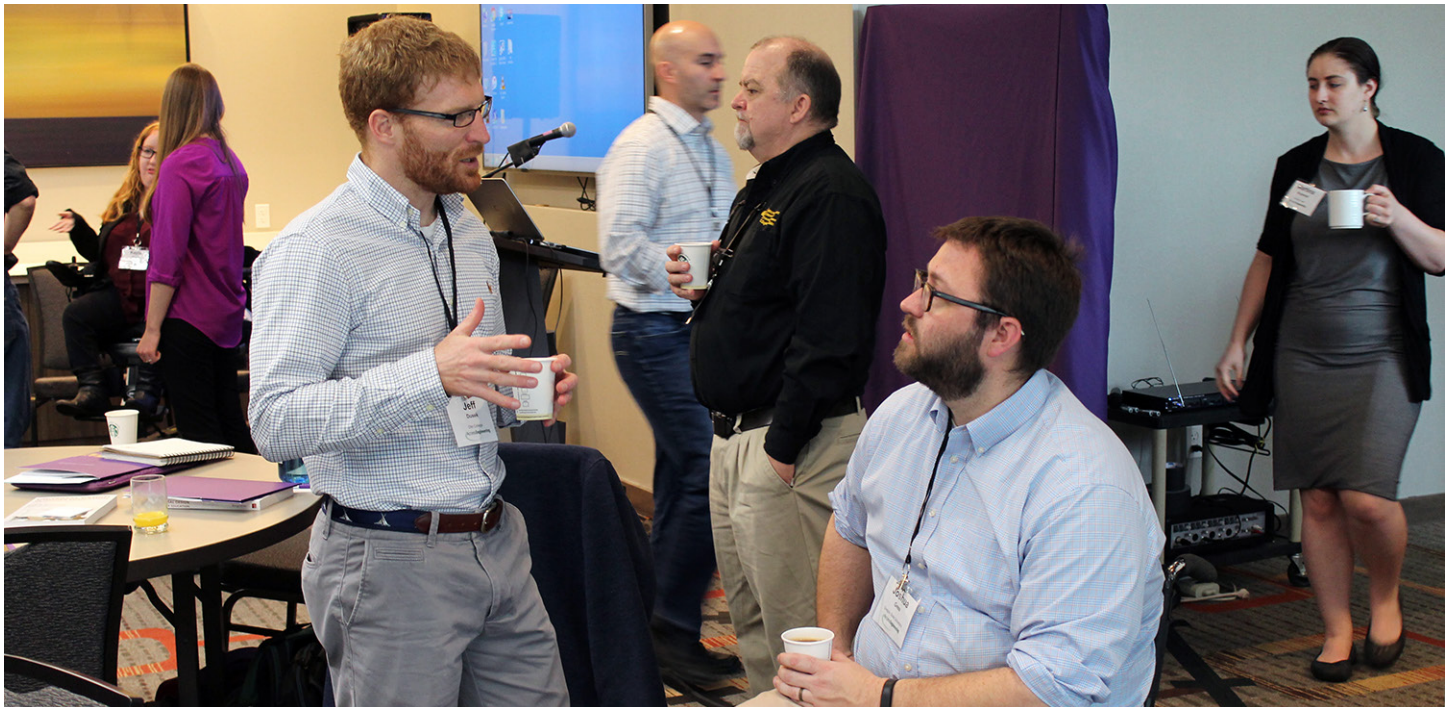
AccessEngineering

Accessibility and Universal Design in Engineering Curriculum

Proceedings of an *AccessEngineering* Capacity Building Institute.

April 19 – 21, 2017
Seattle, Washington



Proceedings of the April 2017 *AccessEngineering* Capacity Building Institute (CBI)

This publication shares the proceedings of the capacity building institute (CBI) entitled Accessibility and Universal Design in Engineering Curriculum that took place in Seattle, Washington in April of 2017. The content may be useful for people who

- participated in the CBI;
- seek to increase their understanding of issues surrounding the participation of students with disabilities in engineering studies and careers;
- are interested in integrating information related to disability, accessibility, and universal design into engineering courses;
- would like to access resources to help make their courses, services, and activities more welcoming and accessible to students with disabilities; and
- have promising practices to share with others.

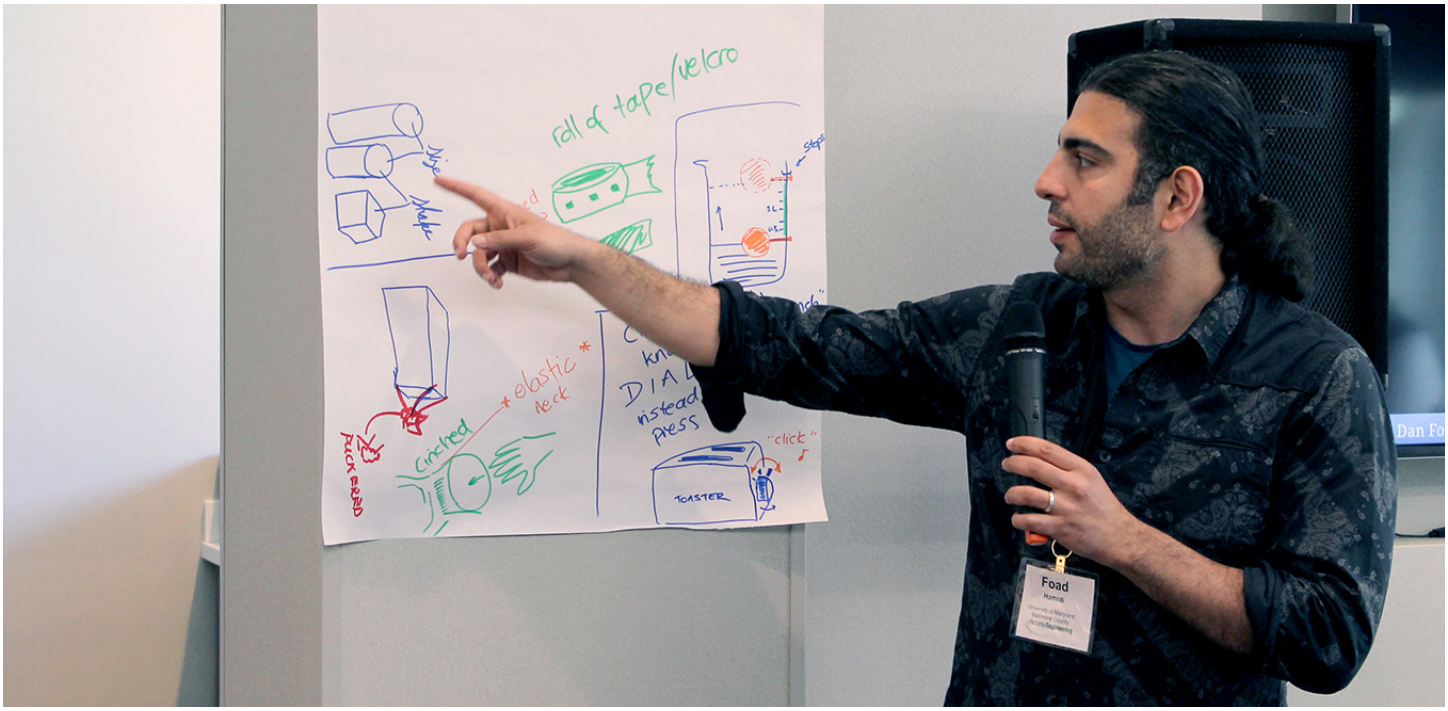
About *AccessEngineering*

AccessEngineering works to increase the participation of people with disabilities in education and careers in engineering and improve engineering fields with their perspectives and expertise. Central to this work is a leadership team of faculty members from colleges and universities across the country. *AccessEngineering* is led by the College of Engineering and the DO-IT (Disabilities, Opportunities, Internetworking, and Technology) Center at the University of Washington (UW) and is funded by the National Science Foundation (Grant #EEC-1444961).

AccessEngineering builds on theory, research, and practice to address immediate challenges facing engineering education today, including increasing the size of the engineering workforce, diversifying engineering fields, and meeting institutional obligations under the Americans with Disabilities Act of 1990 and its 2008 amendments. The project focuses on two objectives:

1. Better serving a diverse student body that includes students with disabilities in engineering courses and programs
2. Integrating relevant disability-related and universal design content into engineering courses

This second objective is an opportunity to improve engineering education as a whole and could lead to the development of more accessible technology by the next generation of professional engineers, while including information in the engineering curriculum that may be of particular interest to potential engineering students, including students with disabilities.



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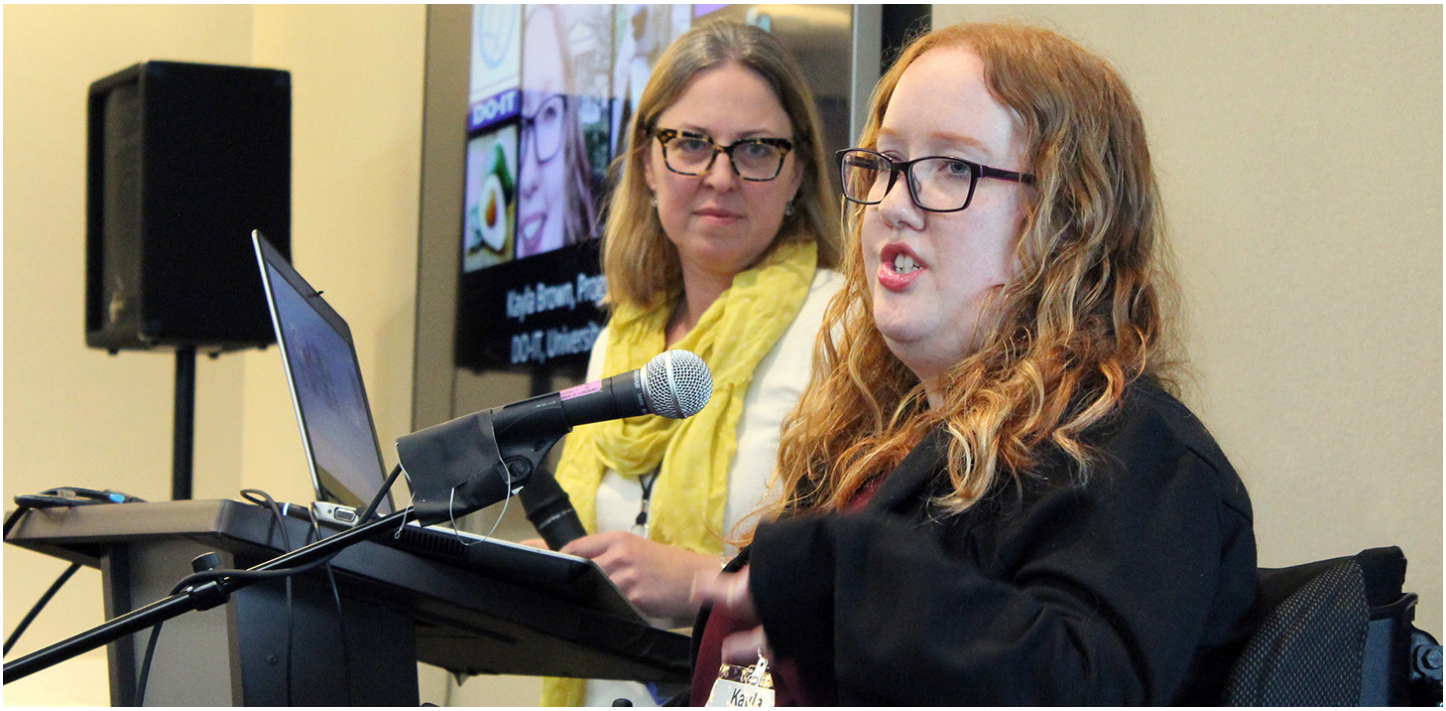


About the CBI

Accessibility and Universal Design in Engineering Curriculum, sponsored by *AccessEngineering*, was held in Seattle, WA on April 19–21, 2017. Its purpose was to encourage efforts to make engineering more welcoming and accessible to students with disabilities and enhance engineering curricula with disability-related and universal design topics. Attendees included engineering students and professionals with disabilities, postsecondary faculty and administrators, disability experts, and professional organization representatives.

This CBI featured the following:

- All participants contributed to its success.
- Speakers participated in group discussions.
- Experts in all topic areas were in the audience.
- Participants gave presentations and participated in small and large group discussions.
- Some predetermined professional development was presented, new content was delivered as the meeting unfolded, participant interests were expressed, and expertise was made known.

The CBI provided a forum for discussing recruitment and access challenges, sharing expertise and successful practices, developing collaborations, creating resources, and identifying systemic change initiatives relevant to the meeting goals.

Topics discussed include

- universal design of laboratories, instruction, and academic accommodations;
- the experiences of engineering students and professionals with disabilities;
- outreach activities designed to recruit students with disabilities into engineering;
- best practices for making courses welcoming and accessible to students with disabilities; and
- inclusion of disability, accessibility, and universal design topics in engineering curricula.

The agenda for the CBI and summaries of the presentations, panels, and working group discussions are provided on the following pages.

CBI Agenda

Wednesday, April 19th

7 – 9 pm **Networking Reception**

Thursday, April 20th

8 – 9 **Breakfast and Networking**

9 – 10 **Welcome, Overview, and Introductions**
Sheryl Burgstahler, Katherine Steele, and Maya Cakmak, University of Washington

- Why are disability and accessibility important for engineering?
- What are frameworks to train engineers in these topics?

10 – 11 **Unpacking What We Know About Disability and Accessibility**
Heather Feldner, Ability & Innovation Lab, and Kayla Brown, *AccessEngineering*

11 – 11:15 **Break**

11:15 – 12:15	**Panel of Engineering Students and Professionals with Disabilities** Panelists: Cindy Bennett, University of Washington Matthew Mack, Microsoft Michael Villanueva, Boeing Moderator: Kayla Brown, University of Washington
12:15 – 1:15	**Working Lunch (Formation of Action Groups)**
1:15 – 2:15	**Keynote — Designing for People: Nine Random Topics** Dan Formosa, Dan Formosa, Inc.
2:15 – 2:30	**Break**
2:30 – 3:30	**CBI Participant Presentations** • Design thinking: Kristen Shinohara, University of Washington • Universal design in digital media: Howard Kramer & Elianna James, University of Colorado - Boulder • Universal design in capstone design: Jered Dean, Colorado School of Mines • Introducing universal design in a bioengineering capstone: Alyssa Taylor, University of Washington
3:30 – 4:30	**Action Group Work Time** What do you want to take back to your classes or institution? Groups will define their goals and deliverables for tomorrow.
4:30 – 5:00	**Preview of Tomorrow's Topics** Complete Daily Feedback Form Pose for Group Picture

Friday, April 21st

8 – 9 am	**Breakfast and Networking**
9 – 9:15	**Daily Overview**
9:15 – 11:15	**Workshop - Design Physics: Relationships** Dan Formosa, Dan Formosa, Inc.
11:15-11:30	**Break**
11:30-12:00	**Report Out**

12:00 – 1:00	**Lunch, Networking and Discussion** Discussion: What are excellent examples of UD for engineers? What should every engineer know about UD? What types of materials are needed to integrate UD into engineering curriculum?
1:00-1:15	**Report Out from Lunch Discussion**
1:15 -2:30	**Action Group Work Time** Individually or in groups, discuss and create actionable tools for implementing the interventions we have discussed. Examples: Checklists, assignments, guidelines, activities.
2:30 – 2:45	**Break**
2:45 – 3:15	**Report Out from Working Groups**
3:15 – 4:15	**Participant Presentations: Participatory Design and Engagement** • Diversity and inclusion in the classroom: Kelly Cross, University of Illinois Urbana-Champaign • Opportunities and pitfalls in project-based at courses: Jeff Dusek, Olin College • iDesignLabs for co-design with community: Anat Caspi, University of Washington • Universal design and geopolitics: Zaza Kabayadondo, Smith College
4:15 – 4:30	***AccessEngineering* Resources and Continuing Activities** Evaluation

Pre- and Post-Survey Results

Before and after the CBI, surveys were distributed to participants to learn more about their experiences with disability and universal design. Some responses to select questions are included below.

In the pre-CBI survey, most participants indicated that they had not been exposed to accessibility or disability in their engineering education. Responses to other pre-CBI survey questions are below.

How would you define universal design?

- Universal design guides the design of products and environments to be as accessible and inclusive of all people, to the greatest extent possible.
- Universal designs serve not only one population but the entire population.
- Universal design considers the actual users of what is being designed, instead of a hypothetical user who tends to look much like the stereotypical design engineer (white, male, and nondisabled). It questions how space/materials/items could be used to understand user experiences beyond a single case scenario
- Universal design solutions consider all users
- In my mind, universal design is an approach that recognizes the diversity of human experience and the importance of being aware of it and benefitting from it in the design process.

What is an excellent example of universal design?

- OXO Kitchen Tools are very universally designed.
- Curb cuts are usually my go-to example of a great universal design feature. Yes they provide increased accessibility for wheelchair users, but they also are great for individuals with strollers or carts, wheeled luggage, bikes, etc.
- Captioning online lectures is not only useful for Deaf students, but for those who might have difficult understanding accents, are taking a course in their non-native language, for someone who needs to access the material in a quiet location without disturbing others, or for someone whose audio isn't working for whatever reason.
- Crosswalks are much more accessible when they have the rumble strip and voice prompts.
- Amazon's Alexa reaches a wider audience by using voice commands to perform interactive and flexible tasks.
- Motion activated paper towel dispensers
- iPhone has built in customization for the range of input and output preferences from blindness to low vision to poor dexterity.
- Keyless door locks could offer a great universal design option.
- I was at a newer hotel recently that had their room numbers posted on a small plaque about halfway down next to the door. There were numbers, a different but common image for each room on the floor, like an apple or a bicycle, and it had braille numbers. It struck me as very inclusive in both physical and sensory ways.
- International airports must be prepared to efficiently serve people of all different backgrounds and abilities.
- Automatic sliding doors are accessible because when people approach, they opens automatically

What should all engineers be taught about universal design?

- A framework for small design tweaks that improve inclusivity
- Why universal design is important and how it can help more than "just" marginalized groups of people
- How to frame the scope of the problem. This is where most engineers miss the opportunity to create something while being critically conscious about their designs. It is important to know the client and the needs of the client
- Instead of thinking in terms of taking an existing design/product/app and modifying it to be more accessible, think of accessibility as an inherent part of the initial design process
- That their duty is to society and that doesn't just mean "the average user"
- Designing for disability can lead to innovations that become better for everyone
- Universal design is not something you tack on at the end of a project—it's a way of thinking and approaching a problem
- That UD is an extension of usability, which every engineer should be concerned with—UD just considers a wider population than usually addressed under usability

What should all engineers be taught about disability?

- Awareness and exposure to diversity of human experiences
- Disability isn't innately a bad thing
- People have varying abilities, and that many people with disabilities don't want to be "fixed"
- The physical or mental limitations should not disqualify people from the field of engineering
- The diversity of abilities and perspectives help us design more complete, robust and holistic solutions or designs
- Engineers should be exposed to varying models of disability, including that disability is a part of diversity

How have you taught students about disability or universal design?

- I teach them that design is for the inclusion of all customers.
- I teach my students about social justice in the context of engineering. It doesn't address universal design specifically, but the intent of the course is to help students develop a critical consciousness.
- I present UD as an ethical issue related to design, and also an issue of potential design failures.
- We ask students to critique their designs' social impact.
- I hope that I teach them everyday just by showing up in my wheelchair ready to work hard for them and for my school.

After the CBI, responses to the post-survey included the following:

How did your definition of universal design change as a result of attending the CBI?

- I realized that we need to be doing more to consider what universal design means when considering invisible disabilities. It's easy to recognize changes that promote accessibility in physical and digital spaces that correlate to specific needs (e.g., ramps or color contrast) that reflect "understood" disabilities. It's a lot less obvious what "universal design" means when discussing things related to processing information, memory, and organizational needs.
- I think I started to see the benefits of designing systems on a much broader spectrum rather than trying to "eat at" the overall problem of universal design through solving one underrepresented group's needs at a time.
- It skewed towards inclusivity. That was part of my thought pattern before but the conference solidified it. Also I realized that, in our rush to id solutions we frequently don't take enough time to think it through completely.
- I recognized that it's not only about helping people with disabilities—universal design ends up helping most people.

What are additional examples of universal design?

- Name tag that considers various peoples' need
- flexible work schedules, including flexible tenure schedules
- I would say spectacles, and no-hassle packaging (now an option when you shop on amazon)
- Touch faucets
- Table with adjustable heights

What should all engineers be taught about universal design?

- Engineers should design products that considered different individuals' needs.
- Using simulation exercises does not stimulate empathy, but rather sympathy or pity.
- Do not think of average users; a wider range of users creates better more realistic.
- Design should be to the margins rather than the average.
- That it is a key part of good design.
- The input of individuals with disabilities must be integrated into the development of universally designed products and environments.

What should all faculty be taught about these topics?

- What can faculty do to accommodate
- Disability is part of diversity
- Limitations exist on a spectrum. Disability is not just reflective of these limitations, but is an identity as well
- How to include UD into project design
- Making your course more accessible doesn't make it easy, just includes better practices.

Presentation Summaries

Introduction to Universal Design

By Sheryl Burgstahler and Kat Steele, University of Washington

Educators come to universal design and accessibility from different perspectives—some people see their departments as inclusive, while others don't; some people have more students with disabilities in their classes than others; and some people know more about universal design, and include it in their classroom curriculum, compared to others.

Ability is on a continuum, with individuals more or less able to see, walk, read, or do other tasks. When engineers are designing a product or environment, a better product can be created not necessarily by focusing explicitly on disability, but rather by considering what is usable by individuals with the widest range of abilities. There are two approaches to access: universal design and accommodations. Accommodations can include creating accessible documents, captioning videos, more time on tests, or a variety of other options. Universal design makes a class accessible, inclusive, and usable to the greatest population possible, including those with disabilities—specifically, "the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design" (Center for Universal Design). Both of these approaches are important.

Universal design was first applied to physical spaces, having a start in architecture. It has since been applied to technology, learning activities, and services. Examples of universal design include curb cuts, automatic doors, and built-in accessibility features such as those on the iPhone. Universal design principles include

1. equitable use,
2. flexibility in use,
3. simple and intuitive,
4. perceptible information,
5. tolerance for error,
6. low physical effort, and
7. size and space for approach and use.

Universal design can also be applied to classroom instruction, such as a welcoming class climate; effective communication; the physical environment, products, and IT; delivery methods; and feedback and assessment.

What if all engineers were trained in the basics of universal design and accessibility? There could be

- more inclusive products and environments,
- more innovative solutions,
- less need for custom accommodations, and
- a shift in burden from individual to society.

What should all engineers be taught about universal design? While there are a variety of answers to this question, the basic value of a universal design approach in any design process is the consideration of a broad range of users.

Unpacking What We Know About Disability and Accessibility

By Heather Feldner, Ability & Innovation Lab, and Kayla Brown, *AccessEngineering*

When you hear the term disability, what comes to mind? It might invoke ideas about inspiration, charity-cases, problems, challenges, fighting, limited access, physical, fixing, "nothing about us without us," or accessibility. Why is it important to acknowledge this? When we are thinking about and discussing disability, we often don't consider our biases and the long history of oppression of people with disabilities. This is part of being a good ally to people with disabilities, and part of making sure what we do in the context of our work is meaningful.

The traditional paradigm to think about disability is the medical model, which sees disability as a problem that needs to be fixed. Barriers in society focus on the individual's issues instead of the institutional problem. In reaction, the social model focuses on attitudinal and environmental barriers that impede people with disabilities rather than focusing on disability as the problem. The social model recognizes that disability and impairment are two separate things. Disability is a social construct created by barriers within institutions, attitudes, and inequality. The complex embodiment model, meanwhile, focuses on bodily experiences of impairment as well as the social and physical barriers, viewing both of these as equally important in defining a person's disability experience.

One framework for thinking about disability and design is Design for User Empowerment, which recognizes disability as a form of diversity and promotes empowerment rather than accommodation (Ladner, R. E. (2015). Design for user empowerment. interactions, 22(2), 24-29.). Universal design, meanwhile, acknowledges and critiques discriminatory processes of design about the able-bodied ideal and informs new and different design processes by and for disabled people as equally valued bodies (Hamraie, A. (2012). Universal design research as a new materialist practice. Disability Studies Quarterly, 32(4).). Both Richard Ladner and Aimie Hamraie suggest that both the material products of design, and the tangible and intangible processes that give way to these products, matter, and contribute to how society acknowledges and makes sense of disability. In other words, design is a social signifier.

The biases and stereotypes we have today have been influenced by events and attitudes from the past. Historically, eugenics and institutionalization, ideas often promoted by scientists, promoted the idea that some lives were less worth living than others. Eugenics made a case for valuing some lives over others by arguing for things like allowing infants with disabilities to die. Institutions rather than being safe havens for people with disabilities were often places of neglect, abuse, and filth. This has led to bias against and increased pitying of people with disabilities. Feeling that their rights were not regarded seriously, members of the disability community have undertaken acts of civil disobedience in recent decades. Actions such as boycotts, the blocking of traffic, and protest marches, have aimed to force change and raise public awareness. Section 504 of the Rehabilitation Act (1973) and the Americans with Disabilities Act (1990) grew out of this activism. A highlight of disability rights activism was the Capitol Crawl, which promoted passage of the ADA (see *www.historybyzim.com/2013/09/capitol-crawl-americans-with-disabilities-act-of-1990/*).

Despite some of the historical and current contexts of social perceptions of disability, there are some pretty neat design and technology advances for people, that were happening in small pockets before any type of ADA regulation. The oldest existing prosthesis, found in Egypt on the mummy of a priest's daughter dated from 970 BC. The artistry and detail of the toe have been attributed not only to function, but also to pride and identity, much like an avant garde prosthesis today. Historically we can look at innovations like ear trumpets for amplifying sound and the development of braille.

Today, universal design has entered the mainstream with innovations like Oxo kitchen tools. User led and centered design includes people with disabilities in the creation of new technology. Examples include the UW's Ability & Innovation Lab's work to include a user in the creation of a custom, 3D printed, elbow driven orthosis that allows her to grip, lift, carry, and manipulate objects with her or the Taskar Center's Access Map that works to enable safe, accessible trip planning on pedestrian ways for people with limited mobility.

What does being an ally look like in engineering and design? Uplifting the voices and experiences of people with disabilities throughout every aspect of the design process. Challenging the notion that disability is a deficit to be fixed or a problem to be solved; rather, envisioning technology and design as a personal choice and as a tool to navigate social and physical barriers. Shifting your thinking to see disability as a positive thing and just another form of the human experience. How do we simultaneously explore technologies and user-centered design for disabled people while affirming disability as diversity and promoting positive disability identity? What commitments can we make as a group going forward in our research with partners who have disabilities?

Designing for People: Nine Random Topics

By Dan Formosa, Dan Formosa, Inc

1. Things I can't explain
2. A quick history of design
3. Why is everyone always coming up with answers?
4. Why are we so bad at math?
5. Why are we designing for average people?
6. Six real people
7. Why are we making thing simple?
8. Why are we fantasizing about women?
9. Think about people, not things

For my talk at AccessEngineering I covered a selection of design-related topics – in no particular order. Here is a quick summary:

Things I can't explain

Virtually everything we see and touch in our daily lives is the result of a design decision made by someone somewhere. Keeping this in mind, be on the lookout, our world is filled with unexplainable decisions.

A quick history of design

If you open Google Images and search "industrial design," you won't see images of people. Design has traditionally been about things, and it's focus on things persists. However, this is the wrong approach if you want to design something well.

In the 1960's, we were suddenly able to advertise products on television. With a desire to sell, there was a new emphasis on aesthetics and visuals. Designers were asked to make products look "new and improved" – whether they were or not. Designers became stylists, making products look better than they actually were in reality.

In the 1980's and 90's some designers decided to re-think their role, and focus on people. The thought was that design could be used to improve quality of life, rather than simply focusing on aesthetics. A design process emerged, typically divided into five phases: research, concepts, development, refinement, and finalization. There are variations on this process —but they basically follow this sequence.

Today design is changing. In the last few years, there has been a focus on innovation, with an emphasis on knowledge and how design affects behavior. However, many design groups are stagnating, failing to move beyond the design process. Designers often base their fees on an hourly rate, which sets a mindset on where they place their value – emphasizing what they do as opposed to what they know.

The "hourly" model can result in designers not spending their time productively – some may simply fill out their allocated hours. In comparison, a start-up will be achievement-based, and can move forward more quickly.

The field of design currently has an opportunity to shift from the "process of designing" to "knowledge about design." One solution is to move from an agency model (where the people in the agency who are most available will be assigned to a project), to a collective model (where team members are assembled from a wide network, placing the most appropriate people on the project).

Why is everyone always coming up with answers?

Teaching a class on branding, I assigned my students a two-part project: 1) envision a brand opportunity and 2) identify the questions you would need to answer to make it happen. All students worked hard on the first part. However, no one did the second part, as if they didn't hear that part of the assignment. The problem repeated itself with the following year's class. This turned into a revelation – it clearly demonstrated that we have been trained to "show how smart we are" by giving answers. We rarely ask questions, students or professionals. Yet great questions can lead to great, innovative design solutions.

Why are we so bad at math?

I spend a lot of time with data visualizations, statistics, mechanics and quantitative methods in design research. To create products that are easy to use you need to understand the physics behind products. For instance, if you don't know the basic principles of a lever, how can you design a tool that provides leverage or some sort of mechanical advantage? Similarly, if you don't understand basic biomechanics of how a hand works, how can you design something to be used by the hand? This understanding is not complex, it involves basic anatomy and some 5th-grade math. Yet think back to your grade-school math class - why would we be interested in math if it isn't made interesting?

Why are we designing for average people?

While there is often a tendency to average things – the height of the average person, for example – the average can be useless. We need to understand extremes, such as the tallest and the shortest, to design for the widest range of people possible. If we just design for the average user, 50% of the population will have difficulty.

Six real people

I often come across products that can be described as well engineered,¬ but not well designed. To create a well designed product you must consider real people. It's not difficult. Testing design concepts early in a project, with just a handful of people, can help immensely. I sometimes even suggest just six people as a target. While that number sounds small, it can be more difficult to design for six real people than for thousands of imagined people who you don't know and who can't give you feedback.

Why are we making thing simple?

The world is complex. Our presentations don't need to be simple – they need to be interesting. Simplicity is overrated. Take as an example a tabloid newspaper like the National Enquirer. Few designers would call it graphically excellent, it's visually complex. But it's extremely interesting. If you don't believe that, try leaving a copy on your office desk and see how many people you work with will start flipping through it. Yet in our PowerPoint and Keynote presentations we feel a need to oversimplify, striving for simplicity and communicating on a sometimes childish level. A worthier goal – don't make things simple, make them interesting. Hopefully more interesting than the National Enquirer.

Why are we fantasizing about women?
Women spend or influence 80% of purchases in the United States. Overall, females represent the world's largest economy. However, females account for less than 20% of product designers and engineers. Understanding females, and designing appropriately, is a tremendous opportunity.

Think about people, not things
Final thought about design: consider real people — it's on the critical path to better design.

Short Presentations

Design Thinking
By Kristin Shinohara, University of Washington

I teach a class called Design Thinking, which is an undergraduate class that requires students to work with people with disabilities to create a product. They must fit their product to the needs of the person they were working with while making it usable by the greater public. These projects resulted in high fidelity prototypes. Each team synthesized an idea, sketched designs, and created paper mock-ups they could use to test with the user.

This course was aimed to teach students user design and the ability to follow a process. How feasible was it to incorporate accessibility into the design? To do this, I chose users that had disabilities.

In the design thinking process, there is an assumption that we will empathize with our user—however, what does this mean and how does it manifest? Awareness does not necessarily mean knowledge for how to design for a specific view—designers didn't usually plan for a user with a disability when prototyping. Furthermore, some of the prototyping tools themselves were not accessible, so students with disabilities may not necessarily be able to design and prototype. How can we create accessible designs if we can't test them accessibly or design them with accessible tools?

These courses were great at bringing awareness and showcasing how accessibility can be proactive instead of reactive. However, awareness is just the first step—where does it go from there? And how can we use this process to build on the idea of empathy and do better user design?

Universal Design for Digital Media
By Howard Kramer and Elianna James, University of Colorado Boulder

We first taught Universal Design for Digital Media in 2010 as a class in the Alliance for Technology, Learning, and Society, and again annually since 2014. As instructors, we have backgrounds in assistive technology and accessibility. Although the class starts out talking about individuals with disabilities, we also discuss aging demographics and other populations that should be considered when designing with UD principles. Topics covered include the following:

- Introduction to universal design: who are we designing for and why?
- The language of design
- General design principles and an introduction to web design
- Interaction design and information architecture

- The case for web standards
- Structure and semantics: document object model
- Accessibility
- The mobile web and accessibility
- Rich internet applications
- HTML 5

Is there a difference between usability and accessibility? Ultimately, there shouldn't be a difference. When people think about accessibility, they specifically think about people with disabilities, whereas usability is perceived to be the average user—but why can't we focus on both?

Particular aspects of the course are particularly effective at promoting universal design:

- Emphasizing the multi-faceted benefits, e.g. mobile phones, search engine optimization;
- assistive technology (AT) user interviews;
- use of screen reader and other evaluation tools; and
- the opportunity for students to redesign a site of their choice.

I also have a few book recommendations:

- *A Web for Everyone* by Sarah Horton and Whitney Quesenbery
- *The Design of Everyday Things* by David A. Norman
- *InterACT with Web Standards: A Holistic Approach to Web Design* by Erin Anderson, et al.

Universal Design in Capstone Design

By Jered Dean, Colorado School of Mines

By the numbers, The Colorado School of Mines Capstone Design Program is one of the larger client-driven programs in the country:

- Every semester we have over 300 students, 50-60 teams, engaged with projects provided by clients
- The teams are composed of anywhere from 5 – 14 students, combined in multidisciplinary teams to fit the needs of the challenge.

In addition to our scale, the multidisciplinary nature of our program is unique and powerful:

- We currently combine students from the civil, electrical, environmental, and mechanical engineering degree programs in the College of Engineering and Computational Sciences.
- This is a great mix of students – especially if you want to address real-world engineering challenges.

At last year's *AccessEngineering* CBI, I developed a UD score card that we could use in our capstone course. The goal of this project was to be a simple, quick activity to inject universal design into any design class. The scorecard is meant to spur students to ask questions about their solutions and encourage positive improvements to their designs. Designs are rated on how well they conform to tenets of UD.

Through a concept critique assignment, teams chose a tool to apply to their design and wrote a memo about what they changed in their design based on the tool. Twenty four of fifty one teams chose a UD checklist. Of those, four used it as a criteria to choose a concept to move forward with.

Some teams just didn't get it and didn't see how accessibility calculated into their design; however, many students realized the issues they were facing when they actually discussed their products with users and thought in a more broad spectrum way. Most made small tweaks—many of these were around safety, failure, tolerance, labeling, and user interfaces.

Email me at *jdean@mines.edu* for a digital copy of the UD scorecard.

Introducing Universal Design in a Bioengineering Capstone

By Alyssa Taylor, University of Washington

I attended the *AccessEngineering* CBI last year, and I learned so much that I decided to join the Universal Design Learning Community that formed at UW last fall. As a result, I brought universal design into my bioengineering capstone course. I teach the second quarter of a two-quarter long design class where teams address current health challenges. I've asked each student to consider universal design during his or her design process. My goals were for students to understand UD as a valuable approach and to prepare students to consider UD during the design process.

I started the class by bringing in an expert to teach about accessibility and universal design. Each student then answered reflection questions on these topics and how UD was or could be addressed in his or her project. Students reflected that they needed to empathize with a broad range of others and not just consider their own abilities.

In the next activity, teams brainstormed about how universal design could be used to create better products such as artery visualization tools or infant breathing monitors. Teams presented on their products and how they would make them more universally designed. Students noted multiple benefits:

- "UD matters so that your product can have a larger user market, user error is minimized, no group of people is excluded from using the product."
- "It leads to innovations we can all benefit from."
- "Benefits of UD include inventing useful solutions and addressing the humanistic perspective of inclusivity and our moral and social obligation to design for a diverse group of users."

Survey results indicated these activities were a valuable addition to the course. In the future, I'd like to have more time for discussion on the topic and incorporate more case studies, including explicitly bioengineering examples. The topic was new to most students and they found it engaging and many shared their personal experiences. Providing supplemental instructional materials and scaffolding team-based analysis through guiding questions worked well. Overall, it was an exciting new addition to the curriculum.

Diversity and Inclusion in the Classroom

By Kelly Cross, University of Illinois Urbana-Champaign

Inclusive Illinois is a community committed to cultivating a more diverse community at the University of Illinois Urbana-Champaign. We define diversity as a noun describing a state with many dimensions—diversity should never be just for the sake of diversity, but for the sake of diversity of thought and difference. Inclusion is a verb—the practice of including and building a

welcoming environment in which everyone has the opportunity to reach their full potential. Creating an inclusive environment will help us achieve diversity. Using universal design to build teaching environments will encourage students with disabilities to come to class.

The Pedagogical and Research-Based Integration of Diversity into Engineering (PRIDE) Model is one way to think about diversity and inclusion. We have two key assumptions: Learning is a social event and Engineering is culture; students have to identify with engineering and be identified by engineers. Those within the field already can gatekeep and make judgments on who gets to fit into this culture, and faculty and students have to understand their own identity and culture being brought into the classroom, as well as the power dynamics involved. Furthermore, assessment and grading showcases what an instructor values—if these values do not line up with how a student works, then the instructor is deeming that student as not being worthy of the field.

The Bioengineering Redesigning Engineering Departments (RED) project brings to the table interdisciplinary and integrated work, which requires the ability to hear different perspectives and listen to others within the discipline. It works to integrate the technical and societal aspects of engineering to address the societal needs of healthcare and medicine.

Inclusion can be promoted in the classroom via

- a diversity statement in your syllabus,
- regular feedback and communication,
- visual markers and language, and
- examining assumptions and stereotypes.

Students benefit from diversity by gaining a variety of insights, advanced critical thinking and leadership skills, conflict management, creativity and innovation, and being prepared to work in a diverse workforce. Diversity, overall, is an outcome of inclusion. Ask yourself, "Am I creating a classroom environment where ALL my students can thrive?"

Opportunities and Pitfalls in Project-Based AT Courses

By Jeff Dusek, Olin College

Project-based assistive technology design experiences often show up in capstone classes, like the MIT Principles and Practice of Assistive Technology (PPAT) class I took and then taught. However, I think universal design should be included in all design classes.

PPAT had small student teams work collaboratively with a person with a disability from the community to develop customized assistive devices. The client is a vital member of the design team, and the course fostered social engagement and connected students with the broader assistive technology community. The class has two sessions a week, an hour lecture and a three hour lab. A very wide range of projects have come out of the course—examples include a dog cart for transporting goods, a touch screen reader with a stylus, and a powerchair backpack track that could allow the user to access the bag on his chair.

This approach values the client's experiential knowledge related to his or her disability and needs. Students then bring their expertise in engineering and a fresh perspective. Students could also reach out to organizations from the community (who were brought in for lectures) for more options and expertise.

There is value in hard, socially relevant problems. A client-based assistive technology course fosters relationships with clients and community providers. Raising awareness of the needs and opportunities in assistive technology is as valuable as the engineering itself. One of the pitfalls in this project is to avoid the temptation to over-engineer; the simplest solution is often the best. Sometimes simplicity could be much easier for a client rather than a huge project. Low-fidelity prototypes can pay huge dividends at a very low cost. Aesthetics can also be important in a client embracing the design and avoiding stigmatization. Furthermore, sometimes even when planning for accessibility, students wouldn't create a product that was accessible – e.g., an app used to find an accessible route that can't be used with a screen reader, voice commands, or other accessibility features.

Where do we go from here? Find ways to incorporate UD and accessibility into all project-based design experiences. Introduce UD throughout the curriculum and make design courses accessible.

iDesignLabs for Co-Design with Community

By Anat Caspi, University of Washington

The Taskar Center for Accessible Technology (TCAT), part of UW's Paul G. Allen School for Computer Science & Engineering, promotes user-focused design of accessible technologies. By integrating the end-user into the design cycle, we hope to allow both end users and caregivers to inform the design process, to encourage students' use of accessible best practices, and to promote the rapid creation of real, usable working prototypes.

Our school has a long history of researching accessibility and accessible technology. TCAT has taken on user-centered design and focuses on a very heterogeneous population. We focus on how technology can change how we engage and focus on our situational and other needs.

The UW's quarter system doesn't lend itself to engaging with the community on design processes, since classes only run for 10 weeks at a time. We've had to build the structures of practice to work with the community, as well as methods to work with our students to engage differently. TCAT engagement opportunities include vertically integrated projects, where all students can focus on their own research projects under an umbrella of a larger project; accessibility capstones where needs experts, as well as other experts from the community, come to class and co-design with the students; and iDesignLabs and Design for America, which are student-led organizations where students can design for people in the community outside of a classroom setting.

Universal Design and Geopolitics

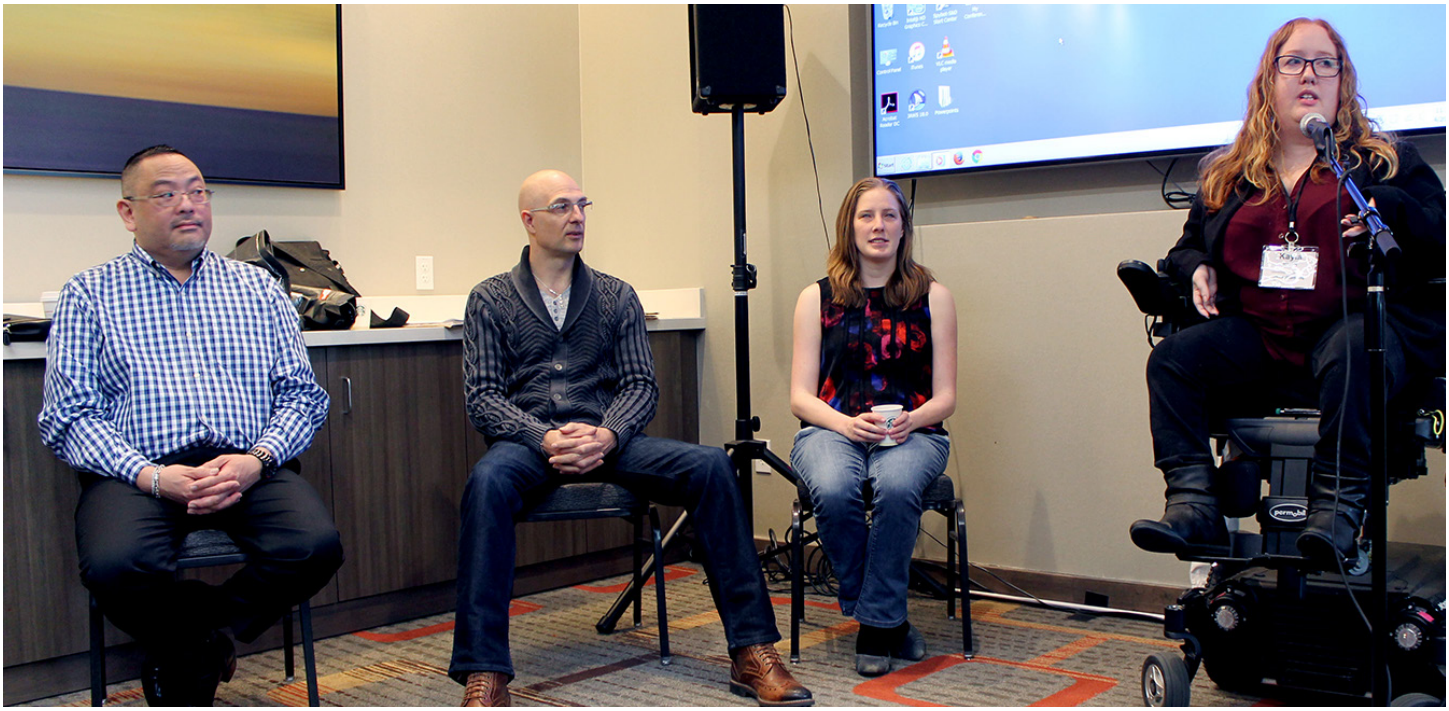
By Zaza Kabayadondo, Smith College

There are people in the margins of design—people with disabilities can be in this group, as well as people from other countries or in a variety of other social margins. We can think of situational ability as a corollary for global marginalization.

Human centered design can be applied to systems, experiences, and narratives. All products, services, spaces, and narratives can be prototyped. Design thinking is the metacognitive and lateral process to gain insight on human interactions to explore or expand novel approaches. Design is broader than just engineering, but can be used by all to expand their "product." There are a variety of mindsets that people use to approach designs.

Cultural heritage structures the way we think and how we communicate; within this, newcomers to a culture are often relegated to the periphery and must learn how to be accepted within a community.

An example of a culturally important design is that of the kombi, a minivan that can hold 16-20 people with any vehicle body on a sedan's turning radius. They are used to desegregate and help transfer people from different parts of South Africa. They are common but not usually legal and can often be dangerous with fast drivers and narrow roads. Commuters and pedestrians both can feel unsafe. Where is the space to represent all involved to be enabled, but not endangered?



Panel Summaries

Panel of Engineering Students and Professionals with Disabilities
Panelists included Cindy Bennett, University of Washington; Matthew Mack, Microsoft; and Michael Villanueva, Boeing.

In your education or career, how have you seen disability been integrated into engineering? Or where did you notice it missing?

- Emphasizing the importance of accessibility. My company has been strong in accessibility, though we have had challenges. How do we ensure our teams address accessibility in every product? It can sometimes be a complete blind spot. Accessibility isn't mainstream – most people don't have experience with accessibility. Assistive technology needs to be taught at the educational level.
- When designing new products, unless there is a person with a disability or who has been trained in accessibility, accessibility is often not considered. Can we all be trained in empathy for a variety of users?
- Even in an environment focused on diversity, disability is still often forgotten and ignored. There needs to be more visibility of disability, including more students and more faculty with disabilities. Empathy requires establishing a rapport with people with disabilities—a one off meeting won't necessarily make a student remember to include disability, but making a relationship with someone with a disability might.
- Accessibility should be taught in all classes. Accessibility should be required to be included in projects and all classes.

Do you use accommodations? What are those accommodations?

- I use a few different screen readers, and I also read braille in print and on a braille display. I also sometimes use a human assistant, for example, to make sure I format my PowerPoint slides correctly.
- I don't want an interpreter—I just wanted to be included. I usually Skype into meetings, so I can turn the volume up.

What is a faculty member's role in accommodations?

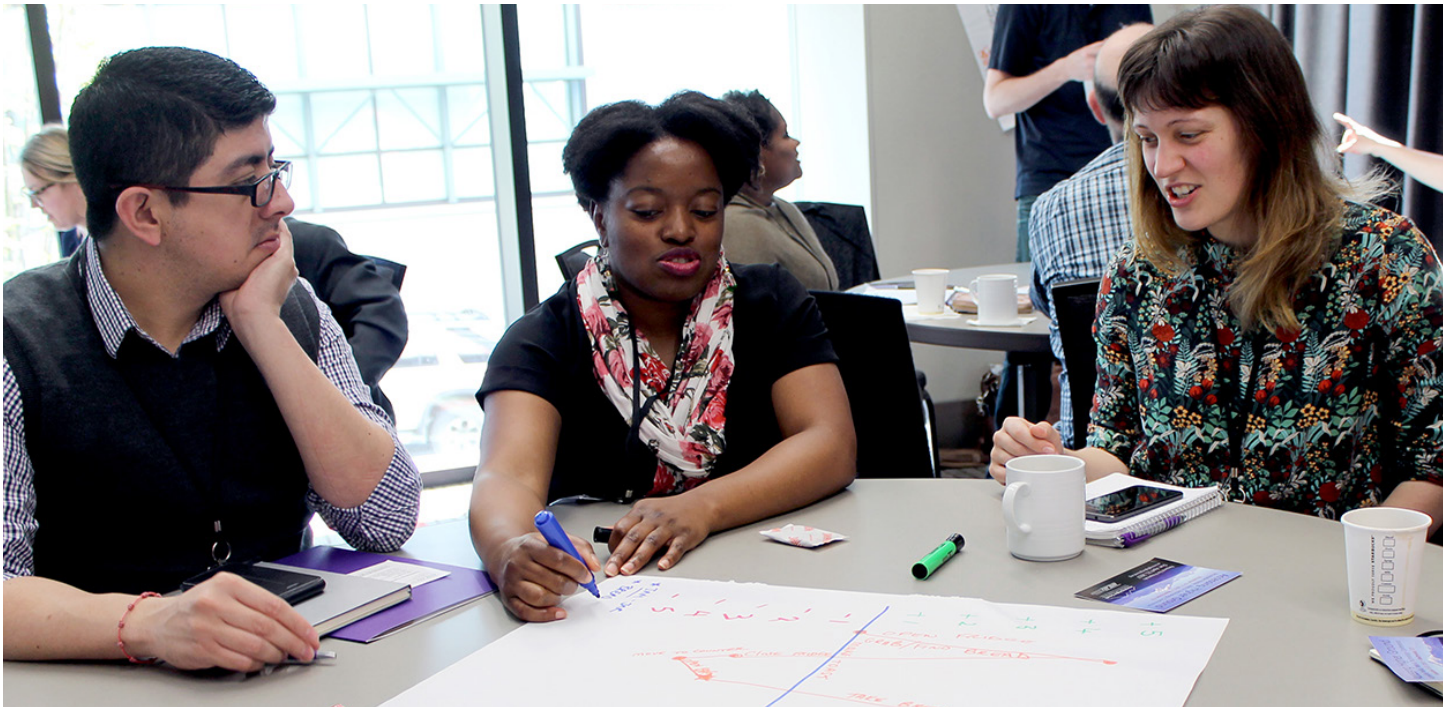
- I sometimes go without if I don't want to jump through the hoops to get my accommodations. Some students may not know what they need. As a faculty member, when you get a letter about a student's accommodations, start a conversation with the student. Working together to find solutions will help the student be successful.
- Students don't want to stand out or feel different. Make a statement about disability as a part of diversity. Teach in as accessible manner. If you can make it easier for a person with a disability, it's only going to make it better for everyone else in the class as well.
- Faculty should act as mentors and advocates. Familiarize yourself with existing resources and advocate for additional resources as needed.
- Accessibility shouldn't be seen as a burden. Students should be able to work towards their full potential rather than spending their time solving accessibility problems. Faculty should work to make sure students aren't confronting roadblocks.
- Some faculty think industry won't provide disability-related accommodations to employees. In reality, this isn't true and many companies value employees with disabilities. Faculty need to know this.
- I worked hard and yet I wasn't encouraged to pursue engineering. If I had listened, I wouldn't be where I am today and my company would be worse off. Faculty should be encouraging their students and thinking globally about how to include diversity.

How do you quickly give someone the skills to solve a problem, especially concerning accessibility?

- Disability is still a niche—students are not thinking about accessibility. Faculty can give students the tools to address accessibility issues. Normalize the practice of accessibility.
- We need to stop telling people that accessibility is hard, because the mindset should be that accessibility is easy.

Accommodations can often be seen as giving someone with a disability an unfair advantage. How can we promote the idea that accommodations merely level the playing field?

- Provide training in unconscious bias. Explain how accommodations create access. People with disabilities just want equal access.
- Accommodations can then be seen as a handout, when they aren't—they are just creating an environment where everyone can engage.
- I don't have the ability to work at a physically-demanding job; my most valuable asset is my mind. STEM education allows me to use my mind to be a productive member of society.



Working Group Summaries

During the CBI participants worked in groups to address issues related to increasing the participation of people with disabilities in engineering and including information related to UD in the curriculum. Ideas that were generated include the following:

Strategies for teaching faculty or students about UD or disability

There are a variety of ways to give students or faculty a taste of UD or disability. Similar strategies can be used for both groups. These activities could be integrated into a course or done at a faculty meeting:

- Create and distribute a slide deck used throughout the department
- Develop an assessment tool for teaching UD
- Invite guest lecturers
- Host a panel of students
- Consider how UD addresses ABET requirements
- Utilize case studies to demonstrate the benefits of UD
- Use practical experiences instead of simulation exercises, which can have negative effects
- Use a screen reader and showcase accessible verse inaccessible websites
- Plan a faculty inquiry group to learn about UD. Over a series of meetings, self-selected participants would form a community and learn about disability and accessibility together. Potential meeting topics could include
    - "Disability 101," including history, rhetoric, and social issues,
    - A panel of students with disabilities,
    - Universal design practice, including technology and other issues, and
    - Campus resources and more discussion of changes that could be made.

- Consider UD in a context other than accessibility. Use a 90-minute class period to discuss space travel. You're going to Mars, and there is a leak in your spacecraft. The person on the inside of the spacecraft is going to start dealing with hypoxia, and the person on the outside has a spacesuit. What would you do to help the astronauts solve this conundrum, and then what best practices would you include in designing a spacecraft for someone with hypoxia (loss of good vision, motor control, etc.) Then, after that, step back and talk about universal design more broadly.
- A 2-, 4-, or 6- week program to teach freshman about universal design and accessibility
    - Week 1-2) Using Time Magazine's Top Innovations (like from this activity: *teachengineering.org/activities/view/usu_ethics_activity1*), have each team pick an innovation, and then assign each team a disability. Ask the team to propose changes and amplifications based on the disability to the innovation. Discuss results and why and how changes could be included.
    - Week 3–4) Bring in people with disabilities to discuss changes and amplifications, either one-on-one with each team or as a panel. Redesign as necessary. Reflect on how universal design can create a product that reaches a wider audience.
    - Week 5–6) Have students act as a consumer reports organization, evaluating an every day product, and think about universal design for this product.
- Create a repository of resources on UD, with three tiers (basic, intermediate, advanced):
    1. Basic: Suggested readings, short 15-30 minute lessons, and a pre- and post survey on the attitudes about disability and UD
    2. Intermediate: full classroom sessions, experts about engineering and disability as guest lecturers, relationships and projects with outside organizations that include people with disabilities
    3. Advanced: Curriculum that builds on concepts of UD, subject matter experts with disabilities who co-design with students

  This repository would have recommendations for curriculum, methods to reach out to organizations and individuals in the community, suggestions for stakeholder motivations, methods to include departmental support and buy-in, and suggested readings and videos. The repository would also have the weaknesses of UD and show its depths.
- Improve a current product using UD. Start a class with defining assumptions about a product. Get classroom or team rebuttal on these assumptions, and then revise them accordingly. Reflect on why these assumptions were made and why they were changed. Use universal design to redesign a product, thinking about all users instead of the average user. Create a means to test the redesigned product to see how accessible it actually is.

Resources that could be developed

- Create a digital catalog of methods for making a lab accessible. This can include a variety of "hacks" that a variety of individuals have used for specific tools and methods. This could be similar to Sara Hendren's Engineering at Home (*engineeringathome.org/*), and could possibly be crowd sourced. Consult *Equal Access: Universal Design of Engineering Labs* at *www.uw.edu/doit/equal-access-universal-design-engineering-labs*.
- Highlight successful researchers and scientists with disabilities. For example, look at Perkin's "Blind New World" or *AccessEngineering*'s case studies (*www.uw.edu/doit/programs/case-studies/2013*).

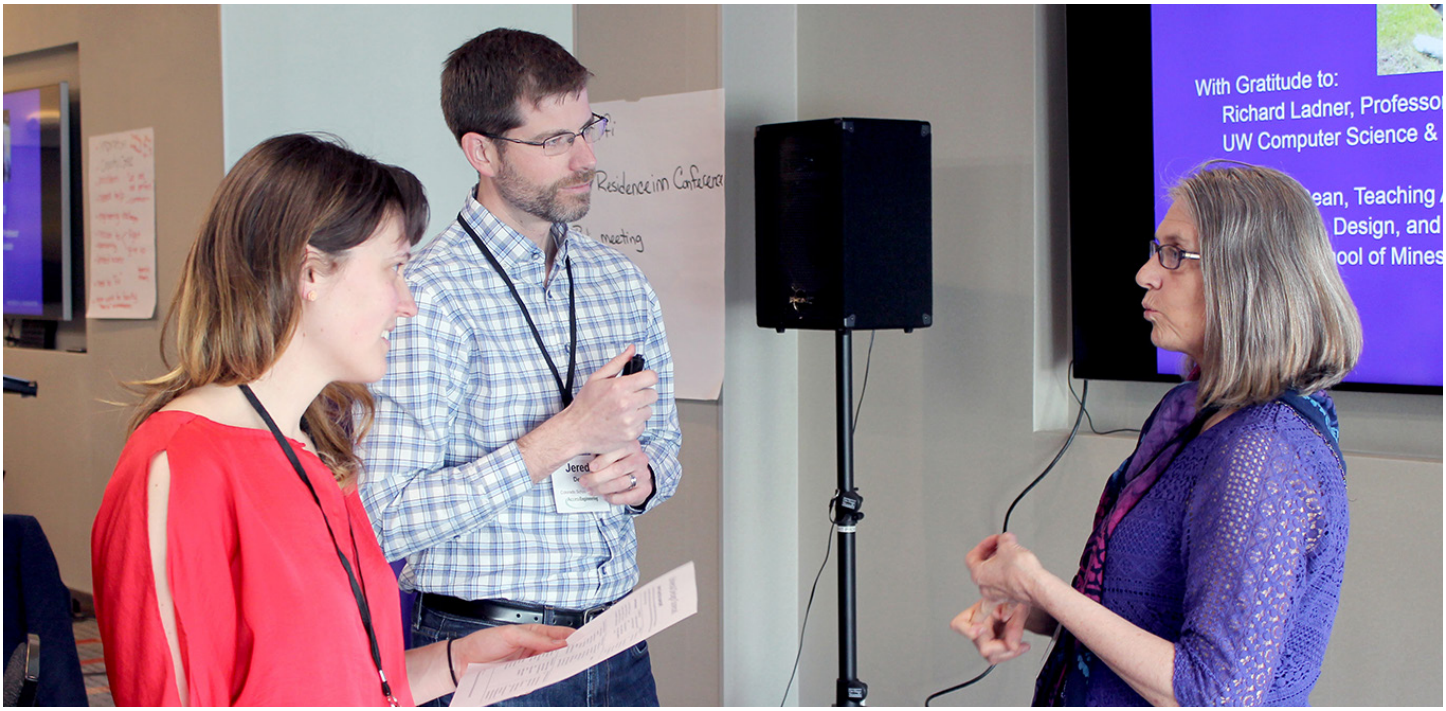
Hiring individuals with disabilities

What would be the perceived risk from a faculty member or lab instructor of hiring a person with a disability? What are the top reasons someone wouldn't hire a person with a disability?

1. Concerns about lab or equipment accessibility
2. Concerns about task requirements and project scoping
3. Concerns about productivity
4. Concerns about the cost of accommodations
5. Concerns about legal issues

How could we work to alleviate these concerns?

- Crowdsource questions that faculty have and develop resources addressing those questions
- Gather success stories of faculty who have hired people with disabilities
- Gathering feedback from people who have hired people with disabilities
- Find faculty and researchers who have made their labs more accessible and develop best practices



Discussion Summaries

Workshop: Design Physics: Relationships

Led by Dan Formosa, Dan Formosa, Inc.

Almost every thing you touch throughout the day has been designed by someone, meaning a decision was made that influenced how it was made. Recently I went on a road trip, and I needed to find a place to eat. Yelp recommended this fantastic place called Daily Planet, with a great menu, which led me to wonder why I don't make a tremendous breakfast at home regularly. What would it take me to make a great breakfast (Western omelette, bacon, home fries, toast, fresh orange juice, and coffee), and specifically, how would I make that if I had a specific disability?

I asked workshop participants to pick a specific disability and design a kitchen and tools to complete this task. Participants reacted to this experience in a variety of ways:

- If I cared about specifics, it was a lot harder—and it was more or less difficult based on my choice.
- It's hard to design for someone when you don't know their exact difficulties.
- When you solve for one problem, you can think of other people it could benefit and finding more solutions.
- Cultural differences can come up—for example, toast can be very different in different countries and may require different tools.
- There is a challenge that this can bring up even more universal design, and it can be hard to implement universal design because you realize you aren't thinking about everyone when solving for one.
- If you solve for one problem, does that create another problem for another population?
- Sometimes a solution wouldn't be used by everyone, and something may be inconvenient for one but a good solution for another.

CBI Participants

Stakeholder groups represented in the CBI included

- student service leaders and administrators,
- faculty members,
- students, and
- professional organizations.

The following individuals participated in the CBI.

Aceros, Juan
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Cakmak, Maya
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Caspi, Anat
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Dusek, Jeff
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Gess, Joshua
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Wang, Chao
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Communities of Practice

AccessEngineering staff and faculty leaders engage in an online community of practice (CoP) that includes key stakeholder groups that impact the success of students with disabilities in engineering programs (e.g., faculty, disability service units, online learning programs, veterans associations, career services, teaching and learning centers, diversity programs, professional organizations, employers) to share ideas and assist in the creation and dissemination of resources to encourage others to help a broader range of students pursue engineering fields and support them in their careers.

CoP members engage together:

- Share strategies for recruiting engineering faculty and administrators to participate in project activities.
- Share successful practices for recruiting students with a broad range of disabilities into engineering programs.
- Discuss how to engage, accommodate, and retain students with a wide range of disabilities in postsecondary engineering studies.
- Share disability-related and universal/accessible design content to be incorporated into senior design and other specific engineering courses.
- Learn about training videos, resources, and publications.
- Identify unmet needs and useful products for the project to develop.
- Provide input for a project video and related online resources.
- Respond to formative results of the project and suggest future activities.
- Share accessibility issues in their engineering courses and departments and brainstorm strategies for improvement.

- Explore strategies for adapting lab-based courses for universal/accessible design.
- Share forums for connecting students to engineers with disabilities in the local community and online.
- Discuss how robotic simulations and other technology can be used to improve access to hands-on educational activities for individuals with disabilities.
- Collaborate in the development of universal/accessible design topics in conference presentations and seminar series.

Join *AccessEngineering* CoP by sending the following information to *doit@uw.edu*:

- Name
- Position/ Job Title
- Institution
- Postal Address
- Email Address

Resources

The *AccessEngineering* website at *www.uw.edu/doit/programs/accessengineering/* contains

- information about project goals, objectives, activities, and project partners;
- evidence-based practices that support project goals and objectives;
- resources for students with disabilities; and
- educational materials for teachers and administration.

AccessEngineering maintains a searchable database of frequently asked questions, case studies, and promising practices related to how educators can fully include students with disabilities in computing activities. The Knowledge Base can be accessed by following the "Search Knowledge Base" link on the *AccessEngineering* website.

The Knowledge Base is an excellent resource for ideas that can be implemented in engineering programs in order to better serve students with disabilities. In particular, the promising practices articles serve to spread the word about practices that show evidence of increasing the participation and success of people with disabilities in engineering.

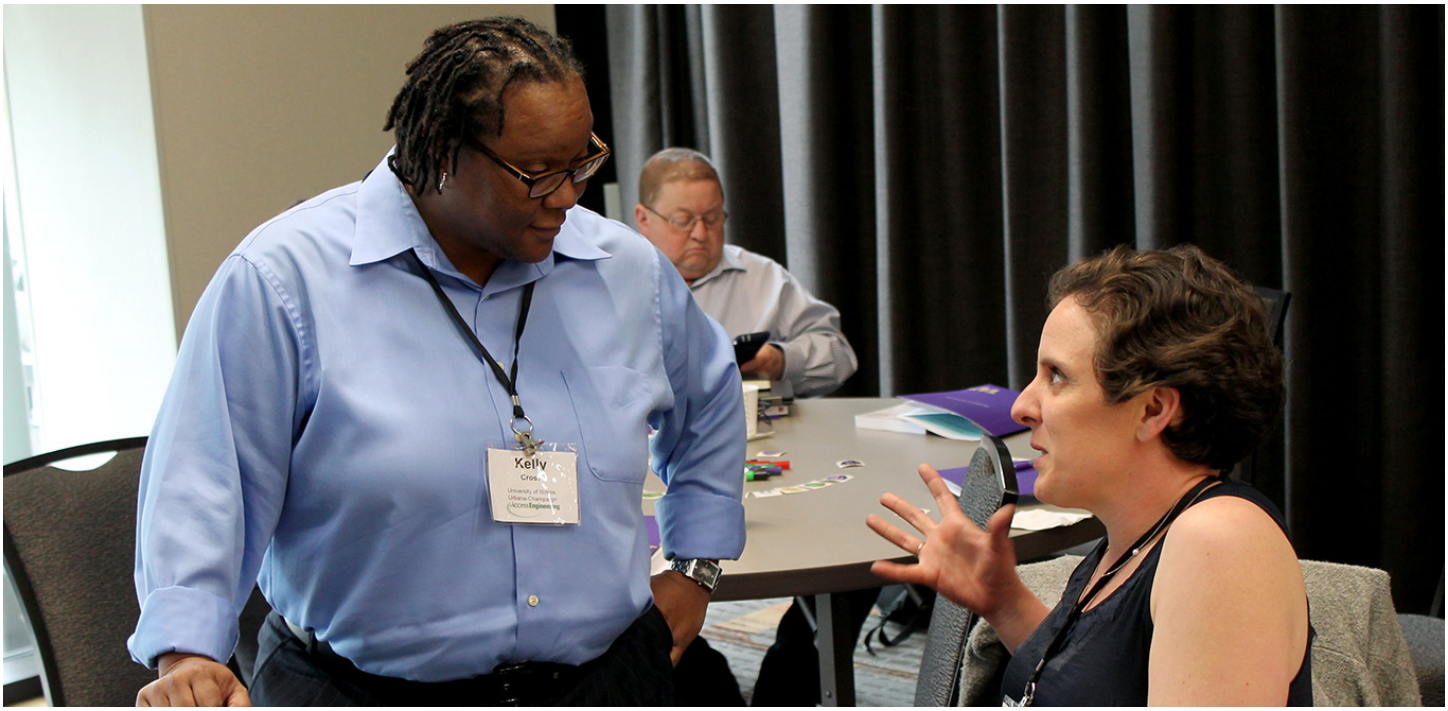
Below are examples of Knowledge Base case studies, promising practices, and questions:

- Conference Engagement via Robot: A Case Study in an Option for a Student Unable to Travel
- Collaboration Struggles in an Engineering Lab: A Case Study About a Student with Autism
- An Assistive Technology Course: A Promising Practice in Including Disability-Related Topics in the Engineering Curriculum
- ATHack: A Promising Practice in Promoting Accessibility Among Engineering Students
- Can people who have visual impairments work in a machine shop?
- How can engineering departments be welcoming and accessible to students with disabilities?
- How can I include people with disabilities in the broader impacts statement of my NSF grant proposal?

Individuals and organizations are encouraged to propose questions and answers, case studies, and promising practices. Contributions and suggestions can be sent to *doit@uw.edu*.

For more information on *AccessEngineering*, universal design, and accessible STEM education, review the following websites and brochures:

- To learn more about and get involved with *AccessEngineering*, visit *www.uw.edu/doit/programs/accessengineering*.
- To find more information on universal design, visit the Center for Universal Design website at *www.uw.edu/doit/programs/center-universal-design-education/overview*.
- For resources specifically designed for faculty, consult The Faculty Room at *www.uw.edu/doit/programs/accesscollege/faculty-room/overview*.
- To learn how to create accessible engineering labs, departments, and makerspaces, review the following publications found at *www.uw.edu/doit/resources/brochures*:
    - *Checklist for Making Engineering Labs Accessible to Students with Disabilities*
    - *Equal Access: Universal Design of Engineering Departments*
    - *Equal Access: Universal Design of Engineering Labs*
    - *Making a Makerspace? Guidelines for Accessibility and Universal Design*
- For proceedings from engineering-related capacity building institutes, visit *www.uw.edu/doit/programs/accessengineering/resources.*



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