Annotation: This is a proposed syllabus for a senior-level or masters-level product design course that I have developed as part of the Columbia Teaching Development Program. Here, I was inspired by conversations with clinical collaborators in my research, who wished for some way to take a small fraction of the prototyping time and resources spent by engineers towards novel research questions and leverage this towards producing "useful things that people could take home". I was thinking also of the longstanding and unfortunate reputation that engineers have for producing unnecessary solutions for imaginary problems—known as "disability dongles" in my subfield—because engineers too often consult end-users and stakeholders only at the beginnings and endings of a design project, and not in the middle when high-level ideas become concrete. A course like this does not yet exist in Columbia; however, MIT 6.811 "Principles and Practice of Assistive Technology" is a beloved and successful course that has student teams work closely with and produce a practical solution for a person with a disability in the Cambridge area; Olin ENGR3299 "Investigating Normal" also focuses on person-specific solutions and client interactions while also reinforcing the idea that "all technology is assistive technology"; finally UMD ENME472 "Integrated Product and Process Development" and MIT 2.75 "Medical Device Design" both maintain client relationships (including with clinicians) and offer student teams each semester a menu of project requests, so that learners can go through the process of realizing "a physical artifact to satisfy a particular need". My syllabus is modeled after these courses, and the learning goals and course component structure borrow especially heavily from MIT 6.811.

This course requires the "buy-in" from NYC-area disabled communities, which would have to be established from scratch at Columbia. NYU's Ability Project can be considered a model research initiative for creating such partnerships. This course also relies on numerous guest lectures from subject-matter experts that speak to the realities, challenges, and promise of assistive technology and its role within the overlapping fields of disability justice and advocacy, human-centered design and engineering, and medical devices. For this sample syllabus, I have chosen existing non-profits, laboratories, and groups local to NYC who could speak to the desired topics. However, implementing this course in practice would likely require a semester or summer's worth of lead time in order to contact and schedule guest lectures from all of these groups.

I have written this syllabus for a 1-semester course, expecting a class size of 15-20 students. It is an intensive design course, which could fulfill a capstone engineering design requirement as an alternate to more typical design courses (UMD ENME472 and MIT 2.75 are examples of alternate capstones). It could instead be an advanced design-studio elective for senior undergraduates (like Olin ENGR3299). The most likely format to run this class at Columbia would be as a primarily graduate course that is open to undergraduates with instructor approval (like MIT 6.811 or Columbia MECE4611 "Robotics Studio"; also MIT 2.750 is the graduate version of MIT 2.75 that shares projects and lectures with the undergraduate version but has extended assessments).

Personalizing Assistive Technology

Course Information

Modeling after MIT 6.811, Olin ENGR3299, UMD ENME472, and MIT 2.75. This course would likely be housed in Mechanical Engineering, Electrical Engineering, Industrial Engineering, and/or Computer Science.
4 credit hours
Meeting times, Classroom location
Website URL or link to Courseworks.

Instructor Information

Ava Chen
Office location, Office hours
Phone number
Email address

Personalizing Assistive Technology is a project-based course that is centered around a design project in which small teams of students work closely with a person living with a disability in the NYC area, or a local rehabilitation clinician, special-needs educator, or caregiver for a person with a disability, to design a personalized device, piece of equipment, app, or other solution to improve access and inclusion in an everyday activity. Over the course of the term, students will iterate through multiple prototypes and learn about the complexities of designing technologies with, and for, people with disabilities.

The course features guest lectures from disabled makers and inventors, special-needs educators, clinicians in rehabilitation, and product designers, with topics such as principles of human-centered design; perspectives on technology, society, and ethics from people with disabilities and from makers and users of assistive technology; design for self-maintenence, adaptation, and adoption; and development of human-machine interfaces.

Laboratory experiences serve as skill-builders for fundamentals of mechanical and electrical hardware, as well as hands-on opportunities to introduce students to various assistive technologies.

Course Goals / Intended Learning Outcomes

- Understand and apply principles, process, and complexities of engineering assistive technology.
- Learn about the lived experiences, challenges, and everyday problem-solving from people with disabilities.
- Gain practical experience in working on a team-based engineering project and in designing solutions for a real client.

Prerequisites:

- There are no formal prerequisites for the course. Students tend to be upper-level (junior/senior) undergraduate or 1st-year graduate students. Many of the students will be in Mechanical Engineering, Electrical Engineering, and Computer Science, but students from all majors are welcome and we will seek students from a wide range of backgrounds and disciplines to provide complementary skillsets when forming teams.

Co-requisites:

- None. It is advisable to avoid co-registering with other intensive team projects during the term, as much of the course work towards the later half of the semester will take place according to team and client schedules.

What to expect in this course

We aim to have lively discussions, debates, and hands-on activities about disability and assistive technology in lecture and lab sessions. We expect your presence and active participation attendance at all sessions (unless you have an

excused absence), as we are truly interested in your perspectives and reflections throughout the semester. Most importantly, we require your commitment to listening and thoughtfully responding to the client's expressed needs.

This class focuses on continuous learning through **process** and **reflection** over evaluating end products. Our approach is reflected in the assessment structure—we grade your presentation, documentation, and reflections; however, we do not grade the performance of your interim or final prototypes—and we have tried to structure the course activities themselves to highlight how figuring out how to evaluate what you've developed is itself a part of the design and reflection process. Therefore, our assessments focus on communication, self-improvement, working together on a team for problem-solving, and so on.

Course Components

- Lectures and Labs: These involve hands-on activities, discussions, and many guest speakers with experience in disability and assistive technology. Attendance and active participation in all in-class activities are required. Some of the lab periods (Open Lab Hours) will provide attendance-optional scheduled time during which technical mentors will be available to discuss and work with teams on projects.
- Client Project: This is a central part of the course. Descriptions of potential projects and clients will be presented in the second week of class, and matches will be announced by the end of the second week. Teams will meet regularly with their client to understand their needs, define a problem that can be solved with assistive technology, develop evaluation metrics, and test multiple iterations of prototypes. The client meetings, design work, and documentation represent the majority of work required outside of class. Deliverables for the project include written documentation on the client's challenge and design process, midterm and final presentations, and blog reflections.
- Reflections: Each student will write multiple individual blog-style reflections (1-3 paragraphs) in Courseworks. We expect that you will think critically about the material and activities during the course, reflect on the experiences and perspectives presented by the guest lecturers, and iterate upon feedback from your client. Posts on Courseworks will be private (read only by instructional staff) by default, but we encourage you to make the majority of posts public so that your fellow students and the world at large can learn about your work in the course.

Assessments

Grades in this course will be based off the following types of evaluations:

ACTIVITIES	PERCENTAGES
Weekly lab reflections and course blog posts	20%
Team project documentation on client challenge and design process & press release (+ high quality photos)	20%
Mid-semester presentations	10%
Final-semester presentations	10%
Attendance, discussion participation, lab check-ins (i.e. mentor feedback)	20%
Client and peer feedback	20%

Course Calendar

Date	**Lectures** Two 1-hour sessions	**Labs** Two 2-hour sessions	**Weekly Deliverables**
Unit 1: Building Blocks			
Week 1	**Welcome to the course!**		
Monday	Registration Day		
Tuesday		No Lab	
Wednesday	Welcome to the class • Syllabus overview • Landscape of assistive technology • Narratives of disability		Read this syllabus Have a digital design notebook Fill out a background sheet
Thursday		Introduction to labs • Intro to digital lab notebook • Intro to iterative design process • How to work in groups Pair-and-share challenge “I wish I had a simple ‘?’ in my home” (with iteration)	
Friday	Project Presentations by Project Proposers 1 Students meet with Project Proposers		Add reflection on Pair-and-share challenge to course blog
Week 2	**Iterative Design**		
Monday			
Tuesday		Project Presentations by Project Proposers 2 Students meet with Project Proposers	
Wednesday	Iterative Design • Development Process		Project preferences due midday Thursday. When

	• Functional Requirements • Identifying minimal testable concept • Hardware and Software Debugging		teams are announced: Schedule weekly team & mentor meetings Meet clients (meet first as a team) Start prior art search

Thursday		Visual Access lab: Screen Readers
		• Learning objectives:
		  ○ Experience using screen readers on web pages and mobile devices
		  ○ Learn how to add metadata to improve screen reader performance
		• Mobile: use the VoiceOver screen reader built into iPhone/iPad devices, or TalkBack for Android devices
		• Web: use a free web screen reader on web pages
		• Design: look at visualizations of a web page's accessibility and edit the page to improve its accessibility	

Friday	Guest lecture from Adaptive Design Association		Make a copy of your Pair-and-share blog post, update it to improve web accessibility, and post the new version along with your reflection on this process.
Week 3	**Prototyping Basics**		
Monday			Team webpage, email, slack populated. Initial background research conducted. Write a draft mission statement. Identify functional requirements.

Tuesday		Mechanical Design Lab: Micrometer Screw Gauge
		• Learning objectives:
		  ○ Experience fabricating and evaluating a self-designed piece of equipment.
		  ○ Practice mechanical design,	

		assembly, and debugging skills • Lab safety and machine shop safety • Guided design walkthrough of part and material selection • Guided fabrication (3D printer, Laser Cutter, and CNC Mill)	Identify minimal testable concept. Upload reflection on previous week's lab to course blog.
Wednesday	Basics of Machine Design • Accuracy and Precision • Estimating Errors and Tolerances • Principles and Practice • Structures • Interfaces		
Thursday		Micrometer Lab, cont'd. • Continue guided fabrication • Assembly Instrumentation Lab • Guided walkthrough of height gauge • Measure Micrometer Errors • Analyse statistical distribution	
Friday	Basics of Practical Electronics • Common Circuit Components • Resistance, Capacitance, Inductance • Analog and Digital Signals • Noise and Filters • Modular Electronics		
Unit 2: Design Iteration			
Week 4	**Human-Centered Design**		
Monday			Submit team plan for evaluating minimal testable concept and protocol for collecting user feedback. Schedule design review of initial prototypes with
Tuesday		Electronics Design Lab: EMG Sensor • Learning objectives: ○ Experience designing and implementing a differential amplifier	

		circuit for sensing muscle activity ○ Practice electrical design, assembly, and debugging skills ● Lab safety and wearable prototyping safety ● Guided design walkthrough of part and layout selection ● Compare electrode sensitivities and muscle activation patterns across students.	instructional staff. Upload reflections on user feedback lecture activity and on previous week's labs to course blog.
Wednesday	Basics of Human-Centered Design ● Design philosophy ● User Experience ● Guidelines for collecting user feedback ● Iterating on user feedback		
Thursday		Mobility Access Lab: Wheelchair ● Learning objectives: ○ Experience navigating campus with a wheelchair and evaluate accessibility infrastructure ○ Explore common techniques and accessories that "hack" the default wheelchair to improve mobility independence ● Teams are assigned a series of locations on campus that require navigation using accessible elevators, ramps, alternate entrances. ● Teams choose from a list of prepared wheelchair improvements and reflect on whether tasks are easier or more cumbersome with them.	
Friday	Guest lecture from an disabled AT Maker/Inventor		
Week 5	**Perspectives on Assistive Technology**		

Monday			Upload team documentation and personal reflections on minimal testable concept evaluation and action plan for next prototype Upload reflection of previous week's labs to course blog.
Tuesday		Open Lab Hours Teams present minimal testable concept to instructional staff	
Wednesday	Assistive Technology ● History of accessible technologies ○ Mobility aides ○ Typewriter ○ Audible Crosswalks ○ Exogeneic Bladder tools ● ADA, WCAG ● Discussion on ableism, independence, advocacy		
Thursday		Open Lab Hours Teams present minimal testable concept to instructional staff	
Friday	Guest lecture from NYU Ability Project		
Week 6	**Intersection of Disability, and Technology, Society, and Ethics**		
Monday			Teams schedule video call with clients this/next week to present prototype updates and collect feedback.
Tuesday		Cognitive Access Lab: Memory Aids ● Learning Objectives: ○ Experience using various memory aids that are designed to assist memory retrieval ○ Explore personalization tools that are designed to reduce digital distractions ● Testing accommodations: Experience using various memory aids (cue cards, mnemonic devices, reminder apps) to assist with playing memory-based card games ● Web accessibility: Explore browser and app solutions for streamlining content (reducing	

		extra buttons, adding feedback to actions) for improving cognitive accessibility	
Wednesday	Guest lecture from Columbia Action Lab for Social Justice		
Thursday		Dexterity Access Lab: Reaching Aids, Button Hooks, Adaptive Kitchen Utensils, and Adaptive Clothing ● Learning Objecives: ○ Experience using various dexterity aids that are designed to assist limited grip strength, finger dexterity, and/or trunk mobility ○ Experience using clothing adaptations that are designed to facilitate dressing from a seated position ● Adaptive Tools: Compare torque and range of motion requirements to complete manipulation tasks with and without the use of assistive devices ● Adaptive Clothing: Explore various solutions in commercially-available adaptive clothing, such as alternate seams and openings, magnetic and velcro closures, passive braces, etc.	
Friday	Guest lecture from Disability Rights New York		
Week 7	**Mid-Semester Check-Ins**		
Monday			Teams upload documentation of client meeting and feedback from this/last week. Upload reflection on previous week's labs to
Tuesday		Open Lab Hours	
Wednesday	Mid-semester presentations 1		
Thursday		Open Lab Hours	

Friday	Mid-semester presentations 2		course blog.
Unit 3: System Integration			
Week 8			
Monday			Teams meet with instructional staff to debrief on mid-semester presentations and prototyping progress. During upcoming studio weeks, teams will schedule meetings with clients and instructional staff as-needed.
Tuesday		Open Lab Hours	
Wednesday	Guest lecture from CUIMC clinician on rehabilitation		
Thursday		Open Lab Hours	
Friday	Guest lecture from PhD student researching an assistive technology		
Week 9	**Studio Week**		
Week 10	(Buffer for a week of no classes, e.g. Thanksgiving holiday)		
Week 11	**Studio Week**		
Week 12	**Final Studio Week**		
Monday		Open Lab Hours	During studio weeks, teams will schedule meetings with clients and instructional staff as-needed.
Tuesday		Open Lab Hours	
Wednesday	Studio (class will be held in lab)	Open Lab Hours	
Thursday		Open Lab Hours	
Friday	Studio (class will be held in lab)	Open Lab Hours	
Week 13	**Course Reflection**		
Monday			
Tuesday		Open Lab Hours	

Wednesday	Recuperation		
Thursday		Open Lab Hours	
Friday	Q&A on Final Presentation logistics. Students provide feedback / discuss course.		**Peer Evaluations, Team Project Documentation and Final Self-Reflection due**
Week 14	**Final Presentations!**		
Monday			
Tuesday			
Wednesday		Schedule TBD so everyone can attend	
Thursday			
Friday			