



CENTER for  
**NEUROTECHNOLOGY**

A National  
Science Foundation  
Engineering Research  
Center  
since 2011

#### Partner Institutions:

- Massachusetts Institute of Technology
- San Diego State University

## Center for Neurotechnology (CNT)

University of Washington (lead institution)

### *Improving health and function by engineering neural devices*

#### Vision and Mission

The Center for Neurotechnology's transformational vision is to revolutionize the treatment of spinal cord injury, stroke, and other debilitating neurological conditions by discovering and applying principles of engineered neuroplasticity.

Engineered neuroplasticity is a new form of rehabilitation that uses engineered devices to restore lost or injured connections in the brain, spinal cord, and other areas of the nervous system.

The Center's mission is to develop innovative neural devices and methods for directing engineered neuroplasticity in the brain and spinal cord. This will assist, improve, and restore sensory and motor function for people with spinal cord injury, stroke, and other neurological disorders.



*An engineered neural device runs mathematical algorithms (top), which control delivery of electrical stimulation to targeted neurons in the brain (middle). This targeted electrical stimulation changes the strength of synaptic connections in the brain, resulting in improved health and function after a brain or spinal cord injury.*

#### Goals

- Promote the development of technologies that assist people with neurological disorders
- Promote global neural engineering research through partnerships with international institutes
- Develop lesson plans, courses and degree programs (K-12, undergraduate, graduate) that support advancements in the interdisciplinary domain of neural engineering
- Promote commercialization and small business startup activities
- Increase diversity in research and industry in the U.S. with a focus on the emerging domain of neural engineering

#### Research

The center's research mission is being accomplished with four core engineering thrusts:

1. The **Experimental Neuroscience** thrust uncovers principles of engineered neuroplasticity in animal models and humans.
2. The **Computational Neuroscience** thrust aims to better understand neural circuit dynamics and develop co-adaptive mathematical algorithms for inducing neuroplasticity in the brain and spinal cord.
3. The **Communication and Interface** thrust designs and develops hardware enhancements for the Center's research platforms, as well as multifunctional electrodes for engineering neuroplasticity in the brain and spinal cord.
4. The **Neuroethics** thrust studies how ethical issues such as identity, privacy, safety, authority, and moral or legal responsibility are intertwined with neurotechnology.



The Center focuses on three testbeds which evaluate the applicability of Center-developed technologies for helping people with neurological conditions, as well as test and validate the Center's vision of engineered neuroplasticity. These technologies are adaptive, closed-loop, and tailored specifically to the individual. Safety, security, autonomy, and ethical considerations are paramount.

1. **Cortical plasticity testbed:** The goal of this testbed is to engineer neuroplasticity in the brain, improving the brain's ability to heal and recover after injury. It is targeted toward people with neurological disorders such as stroke. In this testbed, researchers test the ability of neural stimulation protocols to induce activity-dependent neuroplasticity by remodeling neural connections between cortical regions in the brain.
2. **Spinal plasticity testbed:** In this testbed, researchers test the ability to engineer neuroplasticity within the spinal cord after injury. For example, researchers use electrical spinal stimulation synchronized with residual muscle activity or movement to produce lasting improvements in hand and arm function after spinal cord injury.
3. **Co-adaptation testbed:** This testbed focuses on understanding and developing mathematical algorithms designed to help a brain-computer interface co-adapt with the brain itself in a neural stimulation system. An example of work in this testbed is to quantify large-scale cortical dynamics during learning and neuroplasticity induction, as well as changes in cortical dynamics that occur when users directly control brain stimulation using their thoughts.



## Education

The Center develops courses, lab experiences, cross-disciplinary degree programs, and partnerships to train the next generation of neural engineers to create cutting-edge neurotechnologies. For example, students in the Neural Engineering Tech Studio course work through all stages of the device development process, from idea generation to the possibility of technology transfer and commercialization.

Center students host a neural engineering hackathon involving students from the University of Washington (UW), Massachusetts Institute of Technology (MIT), and San Diego State University (SDSU). The hackathon encourages camaraderie among the partner institutions and also allows students to be innovative and creative in the neural engineering realm.

The Center is expanding and diversifying the pipeline of students prepared for college and advanced degrees in neural engineering by working with programs that

serve students with disabilities and also by actively recruiting participants from historically underrepresented groups—including women, minorities, and individuals with disabilities—for Research Experiences for Undergraduates (REU), Teachers (RET), and Veterans (REV) programs. The Center also runs a post-baccalaureate program to provide support for college graduates who are interested in neural engineering and pursuing graduate studies. The Center helps place post-bac students in a lab, so they can gain more research experience, and provides financial support for them in a transition year.

Education partners include Morehouse College and Spelman College—historically black colleges in Atlanta—and Southwestern College in San Diego—where a high number of Hispanic students are enrolled.

International partners in research and education are the University of British Columbia in Vancouver, B.C., and the BrainLinks-BrainTools program at the University of Freiburg in Germany.

Center staff and faculty develop new lesson plans and education programs to increase awareness about neural engineering from a research perspective and as a career option. Materials developed are shared among partner institutions and are posted on the Center's website. At the UW, undergraduate students can minor in and graduate students can receive a certificate in Neural Computation and Engineering.

The Center has created a seminar series—featuring national and international leaders—to highlight neural engineering research. The Center also leads or is involved in formal and informal science education





events and activities. The Center hosts school visits from precollege students at the Center for Neurotechnology headquarters, and Center staff, faculty and students visit classrooms and schools. The Center also participates in national and local science fairs and museum events.

## Innovation Ecosystem

Center for Neurotechnology researchers work with large and small companies—and start-ups—to develop neural engineering technologies for medical devices and consumer electronics applications. The Center works with industry partners to ensure that technologies developed by center researchers are on-point with what people need. The Center fosters the translation of promising innovations created by Center researchers and students into prototypes and products that will help people.

Through the Industry Affiliate Program, the Center engages member companies to support technology transfer and commercialization efforts. The Center also provides industry-relevant training opportunities for faculty and graduate student researchers.



## Facilities

The Center for Neurotechnology is headquartered on the UW Seattle campus, within reach of all key programs and departments. The Center has dedicated space for administrative staff and areas to host visiting faculty and students from core partner and affiliated institutions, industry members, and for student-faculty interactions.

The headquarters includes a conference space that comfortably seats 60 people for seminars, advisory board meetings, Center research group meetings, and educational outreach. An additional 1,500 sq. ft. has been created at the SDSU campus, which houses shared conference and administrative space. All three CNT core institutions—UW, MIT, and SDSU—have an array of shared laboratories ranging from fabrication and machining facilities to motion-capture systems.



Although the Center draws upon existing infrastructure in laboratories and facilities distributed across all partner institutions, the headquarters has significant open space for hands-on demonstration, exploration, and to accommodate start-ups. This space provides a physical portal between the Center's research activities and its educational and commercial interests. In addition, the open space serves as an exhibit space for visiting K–12 students and teachers. Almost all of the Center's equipment and furniture is on wheels, offering flexibility in the space. For example, the Center can reconfigure its open space to host annual meetings, poster presentations for research conferences, and school events. All central facilities were designed with the assistance of students with disabilities to ensure an open and accessible environment for all.

## Center Configuration, Leadership, Team Structure

Center for Neurotechnology leaders develop and implement the Center's strategic plans and oversee research at all three institutions. This team includes the director, three deputy directors (one at each core institution), thrust leaders, executive director, administrative director, education directors, precollege and university education managers, industry liaison officer, diversity director, diversity manager, and communications director. The Center receives guidance from a Scientific Advisory Board, Practitioner and End Users Board, Industrial Advisory Board, Deans Council, and the Student Leadership Council.

## Center Headquarters

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