WHAT TO KNOW
- This event explores the technical, clinical, and ethical implications of emerging brain technologies.
- Speakers include neuroethics scholar Judy Illes, neurologist Eran Klein, and Dong Song, a USC professor of biomedical engineering and co-director of the Center for Neural Engineering.

THE SPEAKERS

JUDY ILLES is a past president of the International Neuroethics Society and director of Neuroethics Canada at the University of British Columbia. A pioneer and eminent scholar in the field of neuroethics, she has made groundbreaking contributions to ethical, social, and policy challenges at the intersection of biomedical ethics and neuroscience, emerging neurotechnologies for neurologic and psychiatric conditions affecting people across the life span, decision-making, cross-cultural values, and the commercialization of healthcare.

ERAN KLEIN is a neurologist specializing in dementia at Oregon Health and Science University (OHSU) and the Portland VA Medical Center. He is part of the neuroethics thrust at the NSF Center for Neurotechnology (CNT) at the University of Washington. He works at the intersection of neurology, neuroscience, and philosophy.

DONG SONG is a research associate professor of biomedical engineering and co-director of the Center for Neural Engineering at USC. His research interests include nonlinear dynamical modeling of the nervous system, hippocampal memory prosthesis, neural interface technologies, and development of novel modeling strategies incorporating both statistical and mechanistic methods. He invented the multiple-input, multiple-output (MIMO) nonlinear dynamical model of spike transformation that serves as the computational basis of hippocampal memory prostheses.
VOCABULARY CORNER

**brain-computer interface (BCI)** – a direct pathway between the brain and an external device; also known as a mind-machine interface (MMI), neural control interface (NCI), or brain-machine interface (BMI)

**deep brain stimulation** – the implanting of electrodes in certain areas of the brain to treat conditions such as dystonia, epilepsy, essential tremors, obsessive-compulsive disorder, or Parkinson’s disease (other potential uses are being studied)

**neuroethics** – a subfield of bioethics that focuses on the ethical issues raised by an increasing understanding of, and ability to monitor and influence, the brain

**neuroprosthetics** – devices that can replace an impaired motor, sensory, or cognitive function

KEY MOMENTS IN THE HISTORY OF BCIS

1924 – Neuroscientist Hans Berger discovers how to record brain activity through electroencephalography (EEG)

1965 – Composer Alvin Lucier creates *Music for Solo Performer*, known as “the brain wave piece” because the performer’s brain waves stimulate various instruments

1973 – UCLA professor Jacques Vidal coins the term **brain-computer interface**

1990s – Neurologist Phillip Kennedy invents the neurotrophic electrode, an invasive wireless device that can read the brain’s electrical signals

Early 2000s – First humans implanted with BCIs

2010s–present – The Defense Advanced Research Projects Agency (DARPA), a longtime funder of BCI research for military purposes, launches the Neural Engineering System Design program “to develop high-resolution neurotechnology capable of mitigating the effects of injury and disease on the visual and auditory systems of military personnel”

Big tech companies like CTRL-Labs (owned by Facebook) and Elon Musk’s Neuralink work on developing commercial neurotechnology devices

FOR FURTHER REFLECTION

- What do you think are the most promising uses of the technology you learned about in this event?
- What concerns you about this technology?
- Why do you think BCI research has historically focused on medical or military applications? What do you think will change as commercial applications are increasingly explored?
- Who is the technology that is being developed by Neuralink and other tech companies for? Why would people want to use it? Why would they not want to?
- Does the production of multi-brain systems bring us closer together—or divide us further?
IF YOU LIKED THIS EVENT, YOU MIGHT WANT TO CHECK OUT:

- The International Neuroethics Society 
  [neuroethicssociety.org](http://neuroethicssociety.org)
- IEEE Brain's Neuroethics Framework 
- The Future of Privacy Forum 
  [fpf.org](http://fpf.org)
- Rafael Yuste's TEDMed talk on mapping brain activity 
  [tedmed.com/talks/show?id=75798](http://tedmed.com/talks/show?id=75798)
- BrainGate 
  [braingate.org](http://braingate.org)
- Suzanne Dikker’s Mutual Wave Machine 
  [suzannedikker.net/mutualwavemachine](http://suzannedikker.net/mutualwavemachine)

DISCOVER MORE AT THE USC LIBRARIES

LISA CROW of the USC Libraries selected the following resources to help you learn more about this evening’s event. Electronic resources are accessible through the search bar on the USC Libraries homepage at [libraries.usc.edu](http://libraries.usc.edu) but may require the user to log in using their USC credentials.

BOOKS


ARTICLES


JOURNAL

*Journal of Cognition and Neuroethics*

DATABASES

*Colloquium Digital Library of Life Sciences*
*Neuroscience-related Databases*

WEBSITES

*Brains@Play*  
*BrainMaps.org*  
*TheHumanBrain.info*

PRESENTERS

*Dong Song*  
*Judy Illes*  
*Eran Klein*