Broadening Participation

Ted Conway, Program Director
CBET Division
Engineering Directorate
National Science Foundation

NSF Works with all 3 Branches of the U.S. Government

Executive

Legislative

Judicial

Staff Offices

- Office of Management and Budget
- Science Advisor, Office of Science and Technology Policy
- Other Boards and Councils

Major Departments

- Homeland Security
- Agriculture
- Commerce
- Defense
- Energy
- Health and Human Services
- Interior
- Transportation

Independent Agencies

- National Science Foundation (NSF)
- National Aeronautic and Space Administration
- Environmental Protection Agency
- Nuclear Regulatory Commission
- Smithsonian Institution
- Other Agencies

NSF VISION

NSF envisions a nation that capitalizes on new concepts in science and engineering and provides global leadership in advancing research and education.

DISCOVERY **LEARNING**

RESEARCH **INFRASTRUCTURE**

STEWARDSHIP

Broadening Participation

Why does NSF support Broadening Participation in its basic structure?

Workforce in the Early 1960s

Workforce in 2012

Who Is Still Missing?

Persons with Disabilities?
Native Americans?
Other Groups?

***Persons* with Disabilities** (PWDs) represent:

* 19.6 percent of the U.S. population

* Nearly 60 Million Americans

* 65% of PWD are unemployed (Since 1986)

McNeil 1993; NSF 1996, 2000
Louis Harris Poll, 2004

National Goals and NSF

- **Americans with Disabilities Act - 1990**
- **New Freedom Initiative**
- **No Child Left Behind Act**
- **Individuals with Disabilities Education Improvement Act**
- **NSF Strategic Plan**
- **Surgeon General – Calls to Action**

What traits are necessary for success in Engineering fields?

Problem Solving Skills

Creativity

Persistence

Answer:

Underrepresented groups inherently possess fundamental traits necessary to be successful in STEM fields.

Problem Solving Skills

Creativity

Persistence

and

We bring our own **unique life experiences** *to the problem solving table which* **promotes innovation**.

Broadening Participation

"When I was young, … providing equal (educational) opportunities for everyone was a matter of social justice – part of the social contract in the United States. Now, … it is a matter of national survival. Any country that fails to encourage and develop the talent in each individual through its public school system will suffer greatly…."

Bruce Alberts, Editor-in-Chief of *Science*

Editorial, *Science* Vol. 323, 2 January 2009

Broadening Participation

"We take different approaches to problems, and the best solutions are achieved by the greatest diversity."

Doug Wilde, Professor Emeritus

Mechanical Engineering, Stanford University

Mechanical Engineering Vol. 132, February 2010

Why should we include

Underrepresented Groups

and

Broadening Participation?

TALENT

Question:

What has been one of the strongest “Best Practices” for Entering and Thriving in Engineering Fields for Underrepresented Groups ?

Answer:

MENTORING

TIERED MENTORING

Benefits of Tiered Mentoring

* Provide Role Models
* Recognize Opportunities/Raise Aspirations
* Effective Intervention - Counseling
* Electronic vs. Face-to-Face (Technology)

PEER MENTORING

Student ⟷ Student

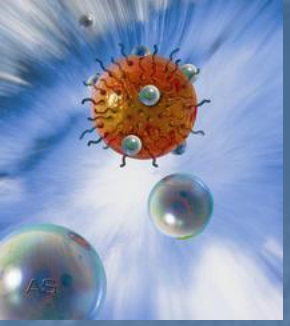
Professional ⟷ Professional

Benefits of Peer Mentoring

* Shared Experiences (Travel)

* Shared Problem Solving (Resources)

* Life Experiences (Cultural)



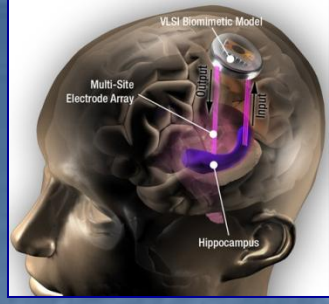
Support Transformative Research in Technologies, Devices, or Software

as

Tool for Greater Inclusion of ALL PwDs (Gen. & Age Related)

in all aspects of daily living

Including the Engineering Workforce



Support Engineering Career Pathways Development

for PwDs

General & **A**ge **R**elated **D**isabilities **E**ngineering

GARDE

Program Director: Ted Conway

Engineering Directorate

National Science Foundation

Support Technology Transfer

for PwDs by PwDs

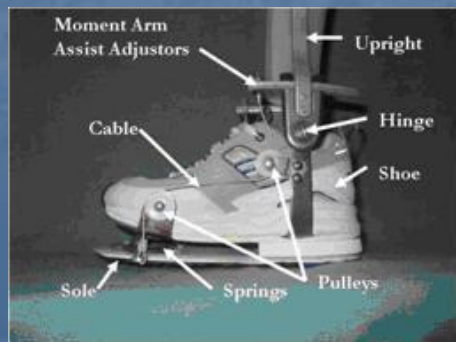
Continuous Evaluation of

Global State-of-the-Art in Assistive Technology

Research and Development

for

General & Ageing PwDs



Bit of a Paradigm Shift

Mechanical Systems Failure Modes

Damage (Mechanical)	Fault (Electrical)	Disability (Biomedical)
Impact	Soft Errors	Trauma
Corrosion	Failure in Time	Degenerative Disease
Fatigue/Wear	Electromigration	Ageing

We will all have the opportunity to experience one or more of these Disability Causing Events

Emerging Priority Areas

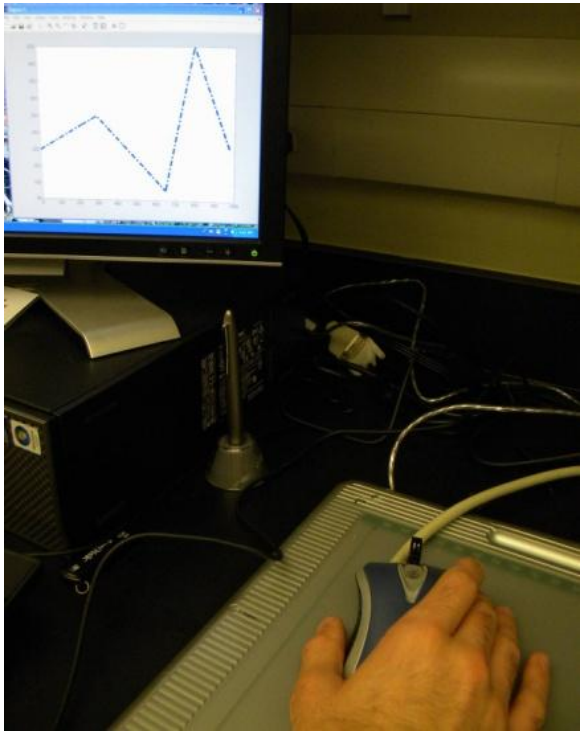
- **Brain-Computer Interface Research and Development for Persons with Severe Disabilities (Locked-In Syndrome)**
- **Exoskeletal Robotics for Assistance and Rehabilitation**
- **Sensory Organ Augmentation and Replacement**
- **Internal Systems Monitoring and Drug Delivery**

Examples of Funded Projects

Dynamic Display of Texture Enhanced Graphics for Individuals who are Visually Impaired

Dianne Pawluk - Virginia Commonwealth University

CBET 0754629



A user shown using the system for a simple graph, shown on the screen. When the user moves the device on the graphics tablet where the line is present, a vibration is felt to convey the information of the line's presence.

Background: **Graphical visual representations have always been important for conveying unfamiliar information, whether at school, in the workplace or for everyday living. For individuals who are blind or visually impaired, although word descriptions may sometimes substitute for graphics, there are many situations for which words are simply inadequate. The most commonly used methods to relay graphical information to individuals who are visually impaired is by raised line drawings and hand-made collages.**

The goal of this research **is to develop an *effective* dynamic haptic display, for individuals who are visually impaired, that can directly interact with virtual graphics on a computer in real-time for such tasks as surfing the web or analyzing data. To ensure practical acceptance by the user population, any display needs to also be affordable, portable and easy to maintain.**

Results: **The device created consists of:**

(1) a tactile display component which utilizes a Braille cell,

(2) a commercially purchased mouse case in which the Braille cell is mounted (see **Figure**),

(3) interface electronics for driving the Braille pins in parallel, and

(4) an absolute position sensing component which utilizes a graphics tablet and a laboratory developed RF transmitter tuned to the tablet. The latter components have been essential to ensure the accuracy of the position of the device, which have been shown to be a critical component for interpreting tactile graphics.

Wireless tracking of tongue movements for wheelchair control and computer access

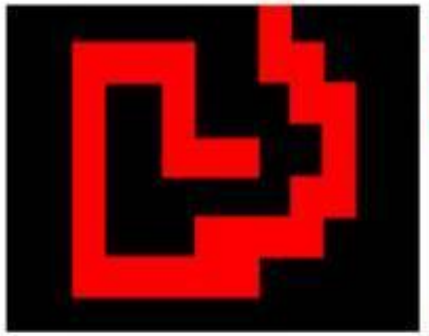
Maysam Ghovanloo - **Georgia Tech** **CBET 0828882**

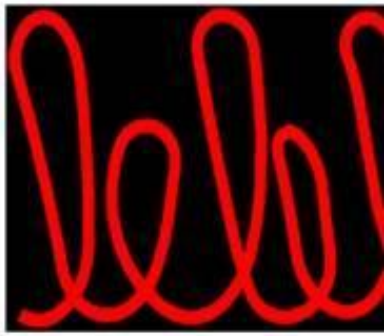
A team of engineers at the Georgia Institute of Technology, have developed a wireless and wearable assistive technology that can convert a user's tongue motions to specific commands, such as moving a mouse cursor or a powered wheelchair. The team was able to detect the position of a small magnetic tracer on an individual's tongue using an array of magnetic field sensors mounted on a headset near the person's cheeks. A novel signal processing algorithm running on a laptop wirelessly received the measured magnetic fields to associate the subject's tongue position to a set of 6 user-defined command positions within their mouth in real time. The average speed of information transfer between participants and the computer was twice the bandwidth of the fastest brain-computer interfaces that have been tested on human subjects. The subjects also had immediate and full control over the powered wheelchair to the extent that they were able to perform complex wheelchair navigation tasks, such as driving through an obstacle course.

Eye-Hand Coordination Assessment/Therapy using a Robotic Haptic System

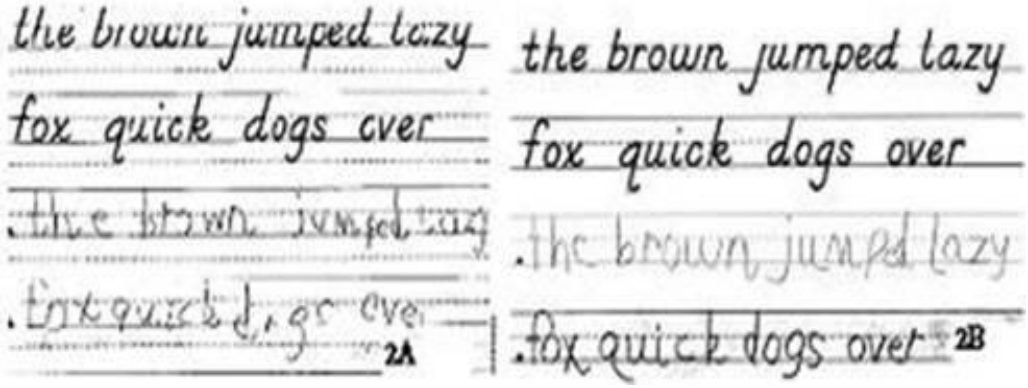
Norali Pernalete- Cal Poly Pomona CBET 0828492

The goal of this project is to develop, implement, and refine a system that will assess and improve the eye-hand coordination and grip strength in children diagnosed with poor motor skills. The system uses a robotic mapping from a hand operated robotic device to a virtual environment along with an intelligent decision support system which will help decide the sequence of tasks to be performed. Haptics refers to the sense of touch, which means that when users manipulate the robotic device, they feel as if they were 'touching' the virtual environment shown in the computer screen. In the case of the eye-hand coordination, the sense of touch is used because the individual does not possess a well-developed visual feedback to control his/her movements.





(a) (b)



CAREER: Engineering nervous tissue *in vitro:* Discovering the mechanisms of rapid axon stretch growth

Bryan Pfister - New Jersey Institute of Technology **CBET-0747615**

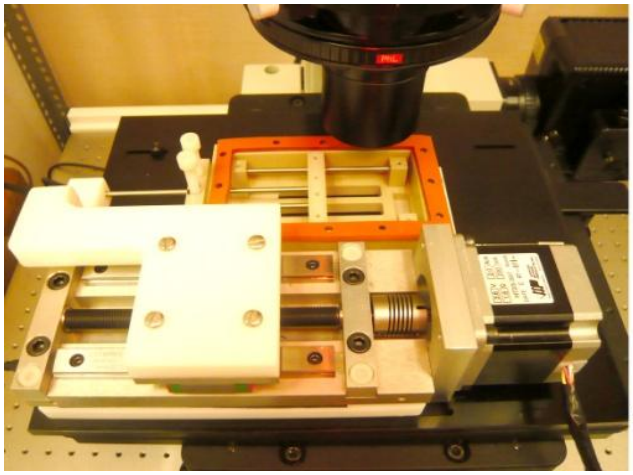
Background: **This NSF-funded laboratory research is defining and analyzing how stretching forces, associated with the growth of an organism, initiate unique neurobiological mechanisms to accommodate stretch growth of axons, driving the natural and rapid formation of long nerves and white matter tracts.**

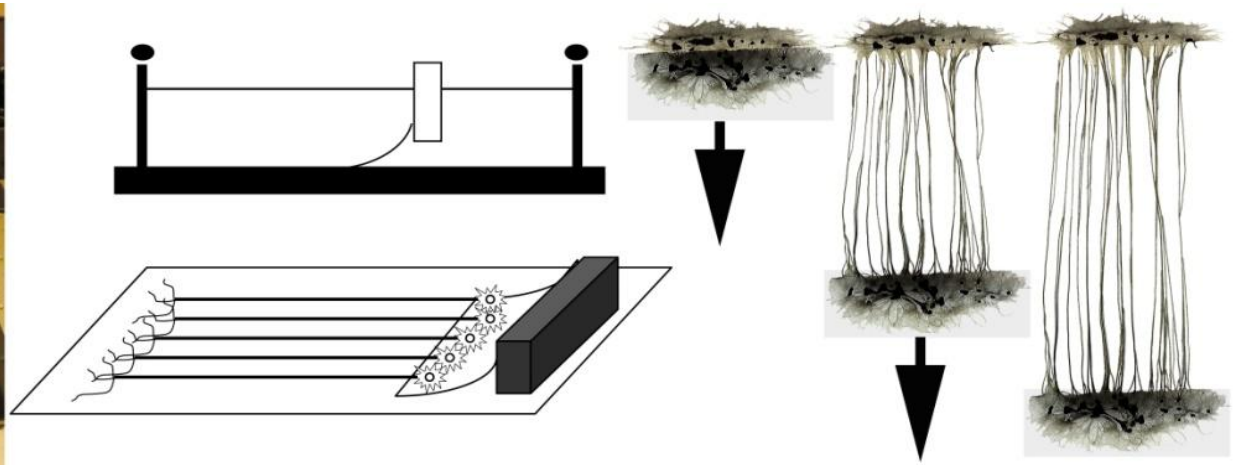
Results:

(1) **Real-time imaging and quantification of axon stretch growth.**

(2) **Investigating the biomechanical limitations and long-term effects of axon stretch growth.**

(3) **Identifying and analyzing the unknown mechanisms of axon stretch growth.** The research team has identified a set of genes involved in the mechano-transduced growth associated with increasingly applied tension. Based on these analysis, the PI is investigating the unique differences between embryonic and adult neurons to further differentiate the set of genes that may reveal natural limits in the growth of adult neurons.





(**Left**) ***Axon stretch growth bioreactor for real time imaging.*** (**Middle**) ***Axons are stretched by displacing an overlapping substrate, towing neuronal cell bodies away from the axon terminals.***
(**Right**) ***An illustration of stretch-growing axons. Here, neuronal cell bodies can be seen at each end.***

Assessing and Optimizing Retinal Prosthetic Stimulation

Nicolas Cottaris - Wayne State University

CBET-0756098

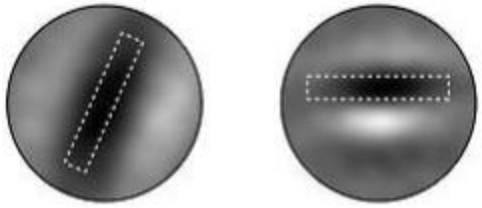
Background: This work provides a novel paradigm for assessing and optimizing **the efficacy of retinal prosthetic stimulation based on neural feedback from the brain**. Presently, the perceptual efficacy of retinal prostheses is assessed in behavioral experiments with blind volunteers that are qualitative and prone to patient fatigue and frustration. The proposed approach allows for a more systematic exploration of the multi-dimensional space of electric stimulation of the retina and may lead to the development of improved stimulation methods.

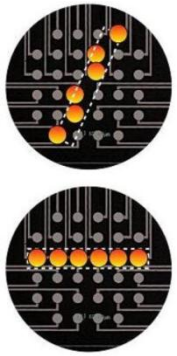
Results:

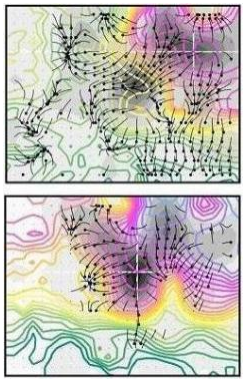
(**1**) **Developed analysis methods that decode the sampled cortical activity to identify the inducing retinal stimuli.**

(**2**) **Demonstrated that key spatial components of visual objects, including retinal location, orientation and spatial frequency content can be estimated accurately by decoding neural activity.**

(**3**) **Discovered that asynchronously delivered retinal prosthetic stimuli may have a strong potential for inducing spatially-patterned percepts.**







(**Left**) ***Visual recpetive fields of orientation-processing primary visual cortex neurons*** (**Middle**) ***Retinal multi-focal stimulation patterns*** (**Right**) ***Cortical response to retinal multi-focal stimulation– asynchronous current delivery***

FINAL THOUGHTS

Captain Pike en route to Talos IV

FICTION

State of the Art Assistive Technology in the 23th Century (used to benefit from the talent which still existed in Captain Pike).

(as envisioned in 1968)

Talosians Provide Direct Neural Assistive Technology

Captain Pike is able to live out the rest of his life pursuing his goals and dreams

Jemma, who has cerebral palsy, uses a computer to communicate. (Courtesy of the Leech Family)

REALITY

Person of the Week – ABC News

Winner – Times Educational Supplement Write Away Competition (1600 Contestants)

Age: 10

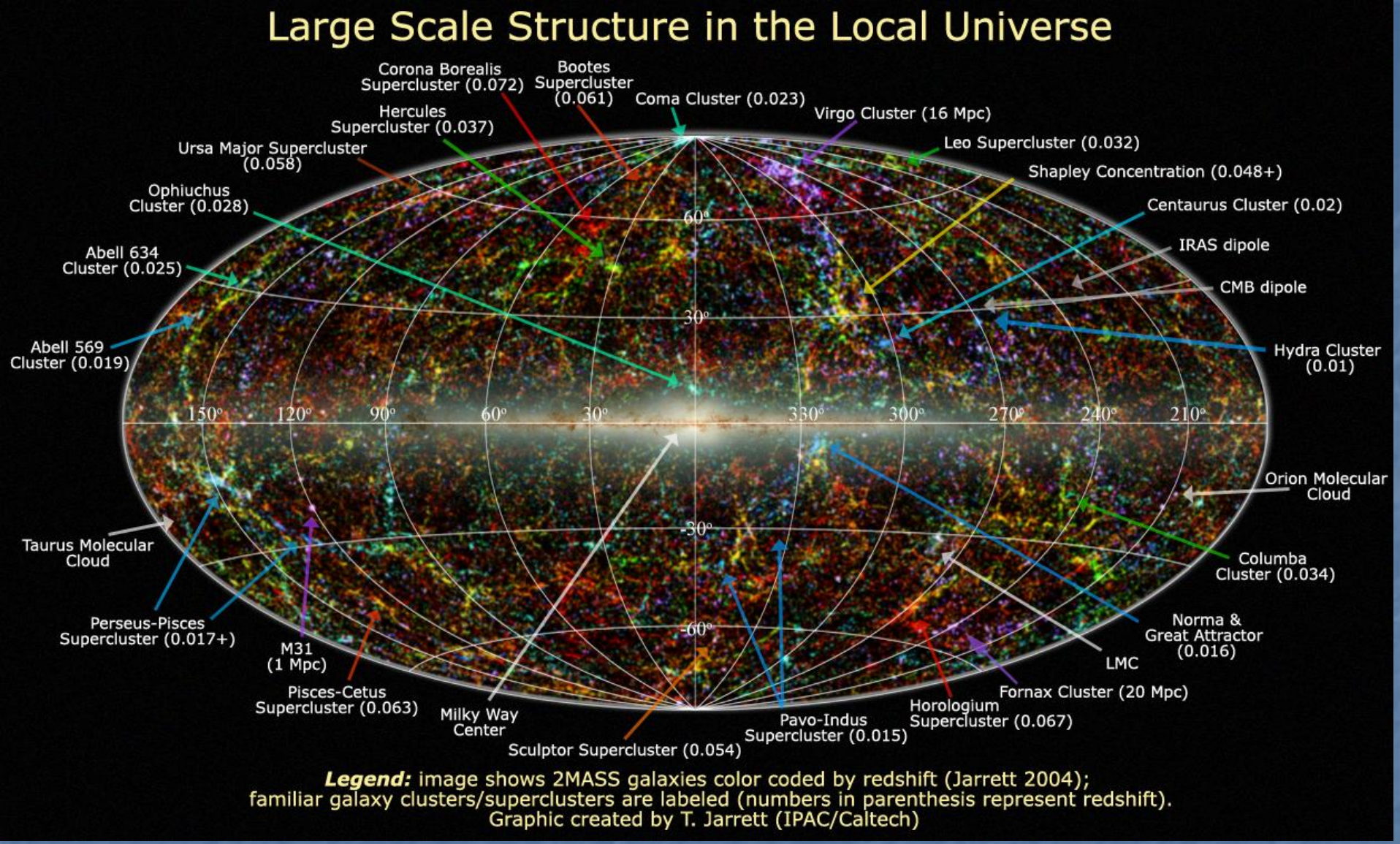
"Many people can't imagine how there could be a brain in this body. *They see a broken child like a broken toy, simpler to dispose of than use for the few things it can still do. …* Few people suspect a city of people lies inside my fractured casing, with artists, musicians, politicians, teachers, priests and spacemen all vying with each other for airtime on Jemma FM." **Jemma Leech**

WHY GARDE EXISTS

Jemma, and those possessing her level of talent, should have every opportunity to pursue their goals and dreams and not be limited by a "fractured casing".

There is much talent to be developed in historically underrepresented human resources.

QUESTIONS???



UNIVERSAL PERSPECTIVE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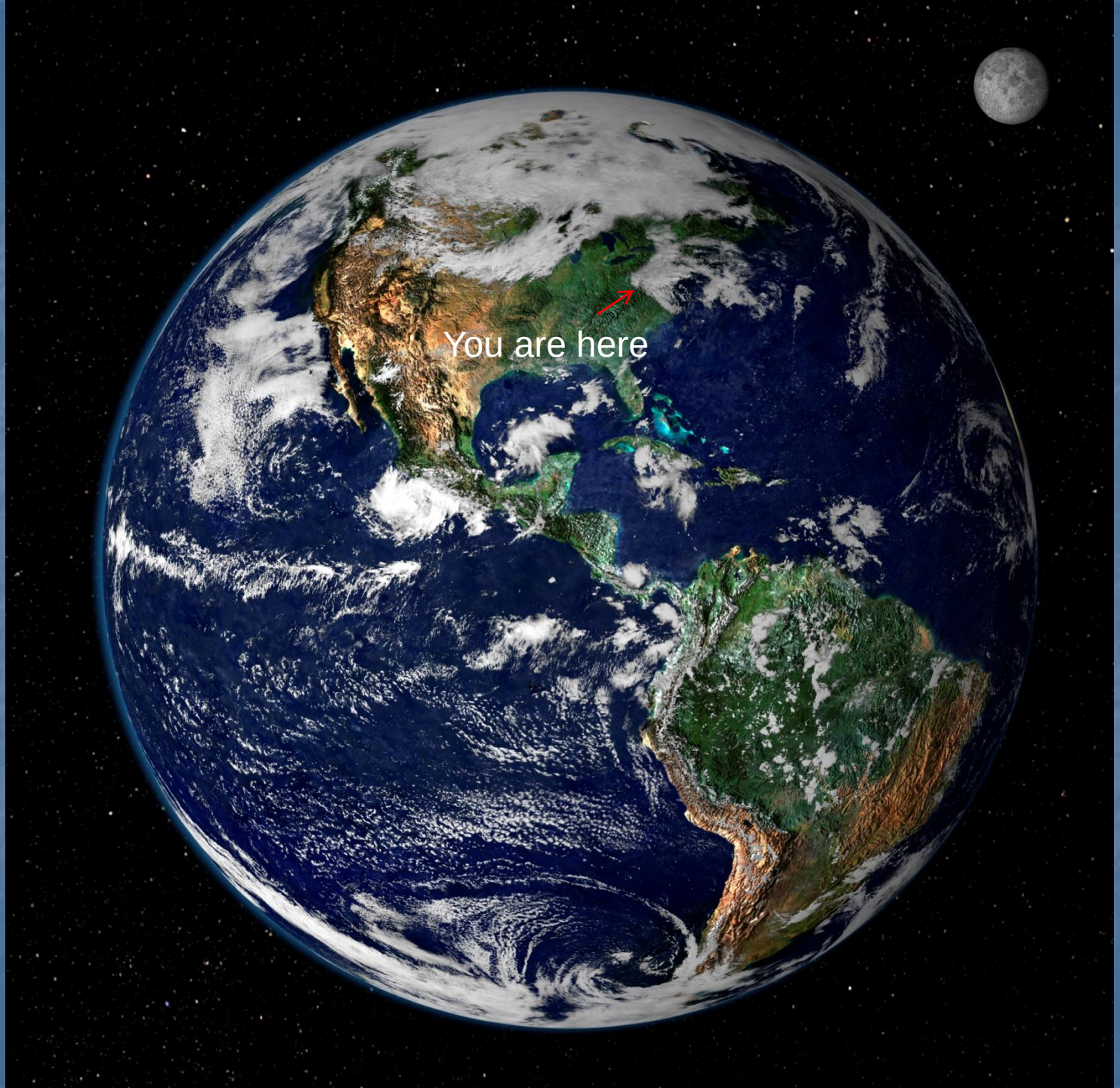
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