The NeuroMaker Creative Challenge

The NeuroMaker Background

"There's technology to help these people in the U.S. but why can only 4% of the people who need these things afford them?" A group of 4 engineers sitting in the Harvard Innovation Labs mulled over this question while finishing their first AI algorithm.

Every year hundreds of thousands of people around the USA learn to live their lives with different forms of amputations that require serious rehabilitation and sacrifice. While some are fortunate to afford often very expensive high tech solutions, the vast majority struggle with different forms of mechanical devices that are no more complicated than a metallic hook. Comfortably shaking another's hand, performing household tasks and regaining essential pieces of the human experience require giving technology in a way these people can receive it.

After years of research and development facing this issue, BrainRobotics engineers created the BrainRobotics AI Dexus Prosthetic, which gives an accessible way for amputees to use cutting edge artificial intelligence and neuroscience to naturally control a prosthetic with muscle and brain signals. Since then, amputees using this technology have played the piano for the first time, regained their ability to write calligraphy, and finally given a firm handshake. For these results and more, the BrainRobotics Prosthetic Hand was awarded the Time Magazine Top Inventions of 2019, multiple Consumer Electronics Show awards and has been featured on CNBC, the Today Show and more.

This first innovation was because a group of committed engineers asked themselves how an issue they discovered could be solved. Now, we wish to ask our next question: "How do we inspire and educate the next generation of students to take on more problems in our society?"

And thus, the NeuroMaker and its Creative Challenge were born! Using the NeuroMaker Hand and NeuroMaker BCI as a baseline, students around the world are likewise challenged to research real world issues they can solve with their own creations. Join us and work with our engineers to design your own solution to a real world problem that YOU want to solve!

What is the NeuroMaker Creative Challenge?

The NeuroMaker Creative Challenge is an annual, open design competition in which middle school and high school students choose a socially conscious engineering problem they would like to solve and present a prototype on how they would solve it. Students research their problem, design a solution, create a physical prototype incorporating NeuroMaker materials and then submit their solution virtually for real world engineers to review based on a judging rubric.

The engineering review board selects six finalists, three from middle school submissions and three from high school submissions. The first, second and third place finalists respectively receive $1,200, $800 and $500 and award certificates with recognition from MIT research scientists and our engineers. Additional awards will be presented at the judge's discretion to teams that recognize important engineering and personal growth traits such as empathy, creativity and perseverance.

The NeuroMaker Creative Challenge is free for any student team that has purchased NeuroMaker educational equipment including the NeuroMaker Hand, NeuroMaker BioSensor Kit and NeuroMaker BCI.

In this guide you will find all of the specific competition rules, description of awards, educational methodology, resources to get started and contacts for additional information.

NeuroMaker's parent organization BrainRobotics itself was created through awards from start-up accelerators and open design competitions such as the Harvard iLab and Mass Challenge. In this way, we hope to invigorate the next generation of learners to find their passion in solving real world problems with STEM just like we did!

How Does the NeuroMaker Creative Challenge Work?

1	Competition Challenge Dates	Groups of students working together in a team may create a project using NeuroMaker technology and submit it by December 1st of each year.
2	Form a Team	Participants will form a team of at least 1 mentor 18 years or older and 2-4 participants in either middle school or high school.
3	Teams Research	Working as a team, students will research a topic in Assistive Technology and identify one problem they would like to solve.
4	Build a Prototype	Students build a creative prototype to solve their identified problem. Students are encouraged to follow and document their progress using the engineering design process and to test their solution. Students use NeuroMaker materials to guide their development and are free to use other materials.
5	Create a Video and Report	Students write a written report of their solution and create a short video which they submit virtually prior to the Challenge deadline.
6	NeuroMaker Engineers Review	The NeuroMaker Judging Committee reviews each project according to our competition rubric and selects finalists and award winners.
7	Results Announced	Competition results are announced approximately one month after the submission deadlines. All are invited to view the projects and awards which take place online at the end of January and end July for each respective submission date.

The NeuroMaker Creative Challenge Theme

Unlimited Assistive Technology

From comfort blankets all the way to brain embedded microchips, there are countless examples of how technology improves the lives of those living with disabilities. If you can identify an item like this in your community, congratulations! You now understand the growing field of assistive technology!

The Assistive Technology Industry Association (ATIA) defines Assistive technology (AT) as

"Assistive technology (AT) is any item, piece of equipment, software program, or product system that is used to increase, maintain, or improve the functional capabilities of persons with disabilities."

These can range from robots that dispense medicine to people in hospitals to brain controlled wheelchairs. In fact the ATIA provides these wonderful examples:

AT can be low-tech: communication boards made of cardboard or fuzzy felt.
AT can be high-tech: special-purpose computers.
AT can be hardware: prosthetics, mounting systems, and positioning devices.
AT can be computer hardware: special switches, keyboards, and pointing devices.
AT can be computer software: screen readers and communication programs.
AT can be inclusive or specialized learning materials and curriculum aids.
AT can be specialized curricular software.
AT can be much more—electronic devices, wheelchairs, walkers, braces, educational software, power lifts, pencil holders, eye-gaze and head trackers, and much more.

What could the future of assistive technology look like with advanced prosthetics and brain computer interfaces? That is the question the NeuroMaker judging committee would like to pose to you as you research, define, ideate, prototype, refine and present!

Your NeuroMaker Challenge:

Research: Discover issues facing people with disabilities around the world and imagine what methods we can take to improve their life with technology. Use different learning resources to empathize with the issues facing people in this community.

Define: Out of these discovered issues, choose one to focus your efforts. Identify the user, their needs and any insights that can provide design opportunities.

Ideate and Prototype: Brainstorm different solutions to the issue you have identified. Using the NeuroMaker Hand, NeuroMaker BioSensor Kit, NeuroMaker BCI and other resources at your disposal, create material prototypes that demonstrate the effectiveness of your solution.

Refine and Present: Test your prototypes and document your learning and design process. When ready, create a video and written summary of your solution and submit these to NeuroMaker engineers for review.

Recognition and Development: Attend our virtual awards ceremony and learn how others have solved the issues they have defined. Win cash prizes to further refine your solution and gain recognition from real assistive technology engineers!

Resources to Get Started

There are numerous ways you can research ideas for your prototype! We recommend using online resources, consulting members of your community and interviewing real life experts in the field. To get you started we have compiled a list of resources below:

Resources for Projects Involving Prosthetics and Amputees

1. Common Problems that Amputees Experience from London Prosthetics
   https://www.thelondonprosthetics.com/prosthetic-solutions/patient-information/after-care/common-problems/

2. Amputation: Prosthetic Hand and Fingers--Hand Care
   https://www.assh.org/handcare/condition/amputation-prosthetic-hand-and-fingers

3. People with Amputation Speak Out--Amputee Coalition of America
   https://www.amputee-coalition.org/wp-content/uploads/2014/11/lsp_people-speak-out_120115-113243.pdf

4. Living with Amputation--The War Amps
   https://www.waramps.ca/ways-we-help/living-with-amputation/

5. Helping People Transition to Life after Amputation--Edge
   https://opedge.com/Articles/ViewArticle/2016-06_01

6. What to expect after an Amputation--UPMC Life Changing Medicine
   https://www.upmc.com/services/rehab/rehab-institute/conditions/trauma/after-amputation

7. The Prevalence and Impact of Pain associated with Upper-Limb Amputation--Edge
   https://opedge.com/Articles/ViewArticle/2016-09-22/2016-10_02

8. What to Know Before Getting a Prosthetic Leg: Hopkins Medicine
   https://www.hopkinsmedicine.org/health/wellness-and-prevention/what-to-know-before-getting-prosthetic-leg

Resources for Projects Involving BCI

1. MIT Media Lab Biofeedback Concept Using Focus 1 Headband for better learning outcomes in the classroom: https://www.media.mit.edu/publications/attentivu-a-biofeedback-system-for-real-time-monitoring-and-improvement-of-engagement/

2. Using Brainwaves and Neurofeeback in the classroom: https://kids.frontiersin.org/article/10.3389/frym.2020.00096

3. Introduction to Neuroplasticity: https://kids.frontiersin.org/article/10.3389/frym.2020.522413

4. NASA Technology Transfer Program: Engagement https://spinoff.nasa.gov/Spinoff2019/cg_6.html

5. Brainwaves Reflect Different Kinds of Learning: https://news.mit.edu/2017/brain-waves-reflect-different-types-learning-1011

Need Some More Inspiration?

There is a large active community of students and educators seeking to improve life for human beings facing a myriad of different issues. Here is a list of projects that students have designed for multiple different kinds of challenges around concepts you can find in this theme:

MIT Assistive Tech Hackathon: An annual, MIT sponsored hackathon in which college students from around the country design solutions for assistive living technology.
http://assistivetech.mit.edu/

Principles and Practice of Assistive Technology: An MIT course in which students must create an assistive technology for a user group they have identified.
http://ppat.mit.edu/fall2019/index.html

California Polytechnic State University Quality of Life Plus Club: A university level student club which challenges students to develop technologies to improve the quality of life for people around the world.
https://cpqlplus.com/

NeuroMaker Challenge Previous Results: Don't forget about students who submitted projects last semester! To see what students did last visit our NeuroMaker Challenge Website at https://www.neuromakerstem.com/neuromaker-challenge/.

Cybathlon: The "Olympics" of assistive technology. Disabled competitors and technology partners develop new techniques and products to complete competitive events in BCI technology, powered prosthetic arms, exoskeletons and more. https://cybathlon.ethz.ch/en

Awards and Judging Description

The NeuroMaker Creative Challenge is designed to engage students with the design thinking process within a defined problem space. In order to recognize the many kinds of talent that our participants have, the NeuroMaker Creative Challenge Awards are separated into two categories: Finalist and Judged Awards.

Finalist Awards are scored according to the rubric below based on the submitted video and report. Judges review both of these items together and create one score for the entire team submission.

Judged Awards are intended to recognize achievement in areas that deserve special recognition from our judging team. Judges will select submissions that best display the award description. In case other special characteristics are displayed during the judging process, the NeuroMaker judging committee has the right to add additional awards to recognize the work of the entrants.

NeuroMaker Grading Rubric and Award Description

Category	Criteria	Description	Points
Engineering Design Process	**Introduction & Background Research**	Clearly introduces the chosen challenge to the reader with adequate background knowledge.	10
	Analysis	Provides a comprehensive technical analysis of the chosen challenge, including the key issues, potential solutions, solution constraints, etc.	10
	Design Methodology	Describes why the team decided on the design and how the team implements the design.	15
	Test & Result	Tests the prototype for its identified use. Evaluates the performance and effectiveness of the solution.	5
	Reflection & Discussion	Reflects on the problems the team encountered. Discusses the potential solutions and improvements.	5
Presentation	**Practical Value**	The practical value of the solution in the real world. The societal needs and wants surrounding this challenge are identified and described	15
	Supporting Materials / Appendices	The supporting materials(eg. tables, figures) are related and easy to understand.	5
	Video Quality	The provided video meets time limits, presents the challenge, solution and students. Transitions are smooth. All sound and visual elements are balanced and clear. Professional video editing is not required.	5
	Communication	Team members can clearly express their ideas and use appropriate scientific and technical information to convey key points in video and writing.	10
General	**Overall Design**	The overall design of the solution is elegant. The prototype works towards accomplishing the mission goals.	10
	Creativity	The solution is original and unique. The prototype shows the creative thinking and innovative ideas of the team.	5
	Reliability	The mechanical and control programs are reliable. The prototype is solidly made and the motion of the prototype is stable and consistent.	5
Total Maximum Score			100

Select From	Creative Challenge Awards	
3 Finalists from Middle School Submissions + 3 Finalists from High School Submissions	1st Place	Presented to the team with the highest points
	2nd Place	Presented to the team with the second highest points
	3rd Place	Presented to the team with the third highest points

Other Judged Awards	
Creativity Award	Presents to a team with the most creative solution to their chosen challenge. Judges will look for the creative idea in the team's design process and final prototype.
Design Award	Presents to a team with the best technical design. Judges will determine the effectiveness and efficiency of the team's design and prototype.
Inspiration Award	Presents to a team with the most inspiring idea. Judges will look for a team which develops an unique and unusual solution to an existing problem.
Empathy Award	Presents to a team with the most thoughtful design. Judges will look for the team's consideration of practical use and feasibility in the design process and final prototype.
Judges Award	Presents to a team that deserves a special recognition. The winning team shows great efforts and impresses the judges for more than one aspect.

NeuroMaker Creative Challenge Rules

These rules have been selected by the NeuroMaker Judging Committee as of March 1st, 2021. By submitting a project to the NeuroMaker Creative Challenge judging committee, you agree to follow the following rules and guidelines. In case any rules are found to be violated, the NeuroMaker judging committee holds the right to reject any submission received.

Team Makeup

1. A NeuroMaker team must be classified as either a middle school team or high school team. Middle School teams are defined by those that have started sixth grade and have not yet begun ninth grade. High School teams are defined as those having started ninth grade but have not yet reached September 1st of their high school graduation year.

2. A team must be made of a minimum of two students and one adult mentor that is at least 18 years old at the time of project submission. No team may have more than 4 student members. Only one adult mentor may be formally registered to one individual team. An adult mentor may be registered to multiple teams however student members may only be registered to one team.

3. In case your team is located outside of the United States, please contact your local partner for specific instructions.

4. Each mentor and student must sign and submit a photo release form in order to process and post project information.

Prototype Materials

1. Teams must use at least one NeuroMaker Hand or NeuroMaker BCI Unit in the creation of their final prototype. Teams are allowed and encouraged to modify kit materials as they see fit.

2. There is no limitation to outside materials used in the creation of their prototypes so long as at least one NeuroMaker Hand or NeuroMaker BCI Unit is utilized.

3. There is no limitation to the programming software or controllers used in the creation of the team's final prototype.

Submissions

1. All submitted materials must be received by the BrainCo NeuroMaker judging committee by 11:59 PM of the determined submission late. Any late submissions will not be accepted. A submission folder will be posted on the https://www.neuromakerstem.com/neuromaker-challenge/ website approximately one month before submissions are due.

2. Each team is required to submit one written report and one video which conveys the required information in the NeuroMaker Grading Rubric.
    a. The written report must be presented in PDF format and may be no longer than 2,000 characters. Illustrations, graphs and other supplemental materials are encouraged.
    b. Sources must be cited appropriately. Educators are encouraged to follow grade appropriate Common Core Science and Technical Writing Standards available here: http://www.corestandards.org/ELA-Literacy/RST/introduction/.
    c. If programming is a key portion of your submission, please provide your program file or a description of it in your report.
    d. The video report may not exceed 2 minutes and 30 seconds of time. Acceptable formats are avi, mpeg, wmv and mp4.
    e. All submitted videos and reports must be provided in English

3. Each team must also provide a separate video casually describing what the students learned, their experience during the competition and encouragement for other students to pursue designing solutions in this problem space.

4. Although it is recommended that mentors play a key role in guiding student learning and

Updates and Sign Ups

1. The NeuroMaker judging committee reserves the right to make any adjustments or changes to competition rules. Updates will be posted on https://www.neuromakerstem.com/neuromaker-challenge/

2. Please use team sign up forms prior to the submission deadline. Team sign up forms will be posted on https://www.neuromakerstem.com/neuromaker-challenge.