**The Human Brain Project**

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Have you ever wanted to know something about the human brain, but could not figure it out because experiments would be impossible? Have you ever wanted to find the cure to diseases of the brain? Have to ever wanted to use a computer that could think as well as a human being? While those things may seem impossible now, with the data and technology developed by the Human Brain Project it could be right around the corner. “The Human Brain Project (HBP) is a ten-year, large-scale European research initiative whose goal is to understand the human brain and its diseases and ultimately to emulate its computational capabilities”1. The HBP is a revolutionary project that aims to develop a complete understanding of the human brain and how it functions. They plan to do this by integrating past, present and future brain research into a unified source, which has never been done before. The HBP will greatly impact many areas of science including neuroscience, medicine and computing. The information gathered from the project will help fill in gaps in our knowledge of neuroinformatics and brain function. It will also allow for huge leaps in medical technology, including the ability to get earlier diagnoses for brain diseases and to create personalized treatments for people. Furthermore, this information will allow for new types of supercomputers to be developed that have systems with brain-like intelligence. There are promising benefits associated with the HBP, the technology just needs to be completed and made readily available to scientists.

The HBP is a huge undertaking and the work is being done by more than 130 research institutions throughout Europe. The various institutions plan to work together to significantly improve the brain research that is being conducted today. “The major obstacle that hinders our understanding of the brain is the fragmentation of brain research and the data it produces”2, so the HBP plans to solve that problem. The project can be broken down into three main areas, which can be further broken down into smaller aspects:

1. Objectives – design, develop and deploy ICT platforms; demonstrate scientific value of six ICT platforms, research for future versions of platforms; ethical research and responsible innovation; transdisciplinary education; and develop a framework for collaboration.
2. Platforms – neuroinformatics, brain stimulation, high performance computing, medical informatics, neuromorphic computing, and neurobiotics.
3. Research areas – neuroscience, medicine, and computing.

The objectives, or goals, of the HBP mostly revolve around developing platforms that can be utilized by scientists and researchers for years to come. The platforms that are being developed are like the foundations for which future brain research can be built upon. Many of the platforms will be built off existing research, either done by the HBP or its partners. It is imperative that the HBP demonstrate the value of their platforms by doing small experiments to see how they work. The first phase of the project will “test how the platforms work together on specific scientific problems and allow developers to benefit from user feedback”1. This type of testing will allow researchers to determine if the platforms work and will also allow them to see how to make the platforms better for the future. Another goal of the HBP is to study the ethical implications of their research. Many ongoing debates that the HBP will contribute to range from the “neural bases of human selfhood and higher mental functions to the concepts of personhood, free will and consciousness”1. It is important for everyone involved to remember that many of the experiments about the brain are done on living things, and that the outcomes will have a great impact on humans.

The platforms developed by the HBP are all centered on ways that brain research can be used because “without sound theoretical foundations, it will not be possible to overcome the fragmentation of neuroscience data and research”2. The platforms are the foundations of future brain research, and without them much of the data would remain unintegrated. The first platform is the neuroinformatics platform which aims to provide new technology to enable scientists to analyze structural brain data and build multi-level brain atlases. Having complete brain atlases that can be navigated will be fundamental in figuring out parameters that are currently impossible to test in the human brain. The second platform is brain simulation which will hopefully make it possible to build and simulate brain models at different levels of detail depending on the questions scientists are trying to answer. This platform is important for the HBP as a whole because it will allow researchers to answer questions in other areas such as medicine or neurobiotics. The third platform is the high performance computing platform which is basically the backbone of the HBP. This goal of this platform is to provide the HBP with the computing power they need to create these highly technical brain models. It can also provide the HBP with new capabilities to manipulate the brain models and simulations. The fourth platform is medical informatics which aims to organize data from hospital archives and databases. With this information, researchers could identify “biological signatures” of neurological diseases1 – that is, they will be able to identify the disease on a biological level rather than looking at symptoms in a person. Using this information, researchers will be able to better understand disease cause and effect which will allow for the development of better and earlier treatment. The sixth platform is neuromorphic computing which will provide the HBP with the hardware and design tools they need to develop these detailed brain systems. The current version of this platform features a silicon wafer with 200,000 realistic neurons that can evolve by itself2. The new platform would allow researchers to develop even more advanced systems with brain-like intelligence. The last platform is the neurobiotics platform which aims to provide the tools researchers need to work with the multi-level brain models. It will also give researchers the tools they need to develop robots that can achieve human-like capabilities. Overall, all of these platforms are put in place by the HBP to create and utilize new technology that will help in the research and manipulation of the intricate details of the brain.

The aforementioned platforms will greatly enhance technology and data in the field of neurobiology which will allow for the generation of huge amounts of new research. Some areas of research will benefit more than others, and the three research areas that will be most impacted by the HBP are neuroscience, medicine and computing. While neuroscience has ever growing volumes of data on specific aspects of healthy or diseased brains, it does not have the tools to create a fully complete and functional map of the brain. Much of the data is broken up into different categories such as different species, different age groups or different diseases, which makes it hard to find out information not relating to those specific groups1. The computing platforms, fueled by past, present and future research will hopefully allow neuroscientists to utilize new technology to construct a complete brain model so they can fill in the gaps in our knowledge of the brain.

Another area that will be greatly affected is future medicine. Similarly to neuroscience, medical data and technology are always growing and evolving, but it is hard to incorporate all the data together. However, with new databases and technologies developed by the HBP all of the data will be able to be combined in a single place while will allow for researchers to discover things that were impossible before. For example, if all hospital archives are put into a single database, researchers will be able to study every documented case of a disease instead of just a few cases. Studying diseases this way will be beneficial in finding biological signatures for the diseases which will enable scientists to develop better treatments or cures1. Also, probing the complete brain models for details of brain diseases could allow for more personalized treatment for patients with these diseases. Brain diseases are one of the leading medical expenses in the world, so any improvements in diagnosis or treatment would be extremely helpful2.

The third most impacted research area is future computing. Many of the HBP platforms are attempting to develop technology that can mimic human cognition. The brain “performs computations inaccessible to the most powerful of today’s computers – all while consuming no more power than a light bulb”1. Also, the human brain can compute information with unreliable elements, while a computer can only compute exact information. If researchers can figure out how the brain computes so much information with so little power, and how the brain overcomes the issue of unreliability, a computer with the same skills could be made. Having computers with brain-like intelligence would have an enormous impact on society – high demands for the computers would lead to falling costs, falling costs would lead to higher demand, and these supercomputers would become more easily accessible to everyone2.

Although the HBP is a fairly new organization, it has already achieved recognition for its groundbreaking research and revolutionary mission. Most recently the HBP made it onto MIT Technology Review's Top 10 Breakthrough Technologies List for its work on neuromorphic chips and brain mapping. This list recognizes the breakthroughs that will have the greatest impact on the shape of innovation in years to come, and this is only the beginning for the HBP1. The next ten years will certainly experience great advancements in neuroscience, medicine and technology. Having a complete brain model that is able to be navigated will allow those advancements to happen. The researchers of the HBP are great leaders in their field, and the research they do will continue to help for generations to come.

References

1. *Human Brain Project.* European Commission. 2013. Web. 20 April 2014. <www.humanbrainproject.eu>.

2. Walker, Richard (Ed). “Human Brain Project: A Report to the European Commission”. The HBP-PS Consortium, Lausanne, April 2012. Page 8-13. 20 April 2014. <http://ec.europa.eu/>.