Opening up the discussion on dual use in the Human Brain Project (HBP)

The Human Brain Project, as an ambitious research and technology development project, is developing insights and technologies that are of crucial interest to military applications. It therefore raises the question of how dual use is to be addressed.
The present newsletter reports on the outcome of a workshop where HBP researchers came together with experts on dual use to explore and learn about dual use issues related to ICT, robotics and neuroscience research.

" […] If you are a scientist you cannot stop such a thing. If you are a scientist you believe that it is good to find out how the world works; that it is good to find out what the realities are; that it is good to turn over to mankind at large the greatest possible power to control the world and to deal with it according to its lights and values."[1]

"It is only when science asks why, instead of simply describing how, that it becomes more than technology. When it asks why, it discovers Relativity. When it only shows how, it invents the atom bomb, and then puts its hands over its eye and says, 'My God what have I done?"[2]

It is a fact that science and engineering have contributed to the development of very dangerous weapons. Examples include the atomic bomb, precision and long distance weapons, chemical and biological agents, and in recent years, semi-autonomous drones. Many believe, that without international prohibitions, the battlefield of the future will include technologies drawing on a convergence of developments in ICT and robotics with bio and nanotechnology and neuroscience. Examples that are already imagined and talked about, include enhancement of soldiers, human-robot teams, cyber war, autonomous weapons systems and

Key points:

- There is historic precedence for civilian research leading to military applications
- Autonomous weapons, brain-computer interfaces, robots, and intelligent machines are all seen as key components on the battlefield of the future
- Prevention of dual use must come from a combination of legal and voluntary measures, and it will take time
- Responsibility to act falls on reseachers, as well as state and international actors.

The HBP could:

- Develop education on dual use issues to foster a culture of awareness and responsibility;
- Continue its system of 'checks and balances' for access to its ICT platforms, and continuously check that it offers sufficient protections against misuse;
- Recognise that HBP leaders have a special responsibility to create a culture of responsibility and awareness of risks of misuse;
- Initiate international discussion on use and misuse of neuroscience, robotics and ICT research with state actors and relevant international and global players

[1] J. Robert Oppenheimer. From speech at Los Alamos (17 Oct 1945). Quoted in David C. Cassidy, J. Robert Oppenheimer and the American Century (2009), 214

[2] Ursula K. Le Guin. The Stalin in Soul (1973). Quoted in Gary Westfahl, Science Fiction Quotations (2005), 322

surveillance and intelligence gathering systems drawing on AI and advancements in computing. HBP research in supercomputing, robotics and simulations of brain function, map onto areas of science and engineering seen as central to the battlefield of the future[3]. The HBP, as an EU-funded project, aims exclusively at non-military applications. Its outcomes may nevertheless be of military interest.

It is not simple to predict how discoveries will be used, or how a technology will develop, however, history teaches us that scientific discoveries and technological breakthrough, which promise increased combat effectiveness, will be developed and deployed. Most likely new innovations will come from insights and combinations across many fields and applications. The key questions among the participants was therefore: *"What, if any, are the key dual use concerns in relation to the work on robotics and future ICT of the HBP?"*, and *"What could the HBP do to prevent its research from being used for military purposes?"*

SCIENCE, ENGINEERING AND MILITARY USE OF KNOWLEDGE AND TECHNOLOGY

Several times during the workshop, it was emphasised that the HBP, like all EU funded research, is committed *to not* accept funding from military sources, or conduct research for military purposes. However, as external participants pointed out, historically, civilian research has often led to discoveries later used for military purposes. Civilian research in neuroscience has already contributed to chemical weapons.

A well-known example of a lethal chemical weapon is the discovery of the nerve gas Sarin in Germany during an experiment aimed at developing stronger pesticides.
An added complication is that other brain research initiatives, like the U.S. led Brain Initiative, does not have to follow the same guidelines on military funding as the HBP. In fact, the Defence Advanced Research Projects Agency (DARPA) openly participates in the U.S. Brain Initiative[4].

Overall, the research projects funded by DARPA aim to benefit veteran health by e.g. developing new forms of prosthetics, or assisting soldiers with memory loss or traumatic brain injuries. However, as the participants discussed, there is also an explicit interest in developing technologies for e.g. enhancement of soldiers on the battlefield. Research in braincomputer interfaces, or AI and robotics could be interesting for enhancement purposes, as well as for controlling insects or (small) mammals as carriers of intelligence systems or weapons.

One of the presenters at the seminar explained that the U.S strategy for military R&D is an explicitly offensive strategy. Superior technology is positioned as *"a cornerstone of the U.S. military's strategic posture"*[5], the use of which is seen to make sure that the U.S. maintains *"a decisive military superiority to defeat any adversary on any battlefield"*[6].

BACKGROUND FOR THE NEWSLETTER

This newsletter results from the seminar *"Dual use, future computing, neurorobotics and the Human Brain Project".*

The seminar took place on March 10 and 11, 2016, and is part of the work carried out by the Human Brain Project's ''Science and Society" sub-project 12, in collaboration with Alain Destexhe at the European Institute for Theoretical Neuroscience (EITN).

The seminar aimed to develop a dialogue dual use issues and risks. Participants included HBP researchers and experts in issues of dual use of science and technology. Questions discussed included:

Which advances in computational neuroscience and robotics might lead to new advances in military technologies, and with what social and ethical implications?

What influence can the scientific research community, policy makers, and civil society have on the possible military applications of research?

An HBP webinar series on dual use issues can be accessed HERE

[3] The book "Mind Wars" by Jonathan Moreno, gives a systematic overview of brain research and national security (http://www.jonathandmoreno.com/about/mind-wars/)

[4] An overview of DARPA funded projects in the U.S. Brain Initiative: http://www.darpa.mil/program/our-research/darpa-and-the-brain-initiative

[5] As quoted in "Defense Manufacturing Man-agement Guide for Program Managers", 2012 [Online] https://acc.dau.mil/docs/plt/pqm/mfg-guide-book-10-16-12.pdf

[6] Ibid.

The participants in the seminar agreed that U.S. defence policies are a key driver in research and technology development in the U.S. in general, but also in parts of the U.S. Brain Initiative specifically.

They were more uncertain as to what U.S. policies could mean for the research taking place in the HBP.

The participants therefore struggled with the vexing question; If, despite one's best intentions, military use is a possibility, what can one do to prevent it, and on whom does the responsibility to act fall?

LEARNING FROM HISTORY

As the participants at the seminar discussed, the HBP might find some comfort in the fact that the research areas collected under the HBP, are not unique in facing the threat of dual use. There are lessons to learn from previous and on-going efforts of dealing with 'weapons of mass destruction' (nuclear, chemical and biological weapons).

The external participants in the workshop explained that there exist a number of measures for control and oversight with nuclear, chemical and biological weapons. These measures can be divided in three types: state-level arms control agreements, limited-membership consensus, and informal strategies.

Examples of state-level arms control agreement include the Nuclear Non-Proliferation Treaty (NPT), the Chemical Weapons Convention (CWC) and the Biological Weapons Convention (BWC). The CWC was widely discussed during the workshop. Presenters commented on the CWC in being successful in part by mobilising actors, and achieving wide-spread agreement on the destruction of stores of chemical weapons. However, the experts also pointed out challenges that this type of convention faces with e.g. verification and compliance. A gap in the CWC relevant to neuroscience relates to non-lethal chemical weapons. The CWC prohibits riotcontrol agents in war, but allows riot control agents for law enforcement including domestic riot control purposes. The gap opens a way for states to e.g. research systems for rapid delivery of riot control agents over large areas. With a little imagination, non-lethal agents might be substituted with lethal ones.

The Australia Group (AG) is an example of a limited-membership type strategy. The group consists of a group of 38 nations in addition to the European Commission. The group meets annually to discuss licencing measures for making sure that export of chemical and biological agents, as well as of facilities and equipment, do not contribute to the spread and development of chemical or biological weapons.

The International Committee for Robot Arms Control (ICRAC), established in 2009, is also an exam-ple of the limitedmembership strategy. The committee works to raise awareness and it pushes for state-level regulation of, and prohibition of autonomous weapons. It also performs independent studies, publishes, holds conferences and is part of campaigns, like the 2013 campaign to stop killer robots[7].

The third type strategy uses informal control measures like codes of conduct and frameworks. Several of the participants mentioned that the U.S. National Academies published a report on the development of a framework for addressing ethical, legal and societal issues related to already

[7] www.stopkillerrobots.org

The HBP Ethics and Society sub-project 12 (SP12)

SP12 is part of the Human Brain Project's (HBP) research core. Through its research and ethics management, SP12 promotes Responsible Research and Innovation (RRI) practices within the HBP. SP12 helps to shape the direction of the HBP in ethically sound ways that serve the public interest.

SP12 carries out research to identify and address the conceptual, social, ethical, legal and cultural implications and challenges raised by HBP research. SP12 does so by focusing on foresight, neuroethics, philosophy, public engagement, and researcher awareness.

SP12 is also in charge of translating ethics research into practice by implementing ethics management and compliance programs for the HBP. SP12 collaborates with an independent Ethics Advisory Board (EAB), and produces Opinions on the most immediately relevant ethical issues within the HBP.

SP12 director is:
Prof. Kathinka Evers, Uppsala University;
Deputy-director, Prof. Jean-Pierre Changeux, Institute Pasteur

available as well as emerging technologies and national security[8].

Talking about the past, participants suggested that all stakeholders from science to policy and industry could do better. Oftentimes, action to limit proliferation of dangerous weapons has not been undertaken before disastrous effects have been demonstrated in actual warfare and conflict. Stakeholders have neglected the time and effort is takes to come to agreements and develop measures for control and disarmament. The research communities exploring the science and technology for AI, supercomputing, 'big data' research, robotics, braincomputer interfaces, surveillance and intelligence gathering have a chance to do better. Instead of waiting ("naively" as some participants framed it) for the proof to find their results being developed and used for military purposes, stakeholders[9] should take action now.

TECHNOLOGIES FOR THE BATTLEFIELD OF THE FUTURE

The researchers from the HBP presented their work with developing virtual testing environments for understanding brain function, the development of the HBP supercomputing infrastructure and development of neuromorphic computing tools.

All participants found is very hard to point at direct implications of dual use in relation to the work in the HBP. Instead several examples were discussed of developments or areas where the type of research that the HBP does could contribute.

The possibility of autonomous weapons systems was discussed intensively during the workshop.

As one participant put it, autonomous weapons systems might not be the most 'sexy' technology, but it might be one of the more dangerous.

The Samsung SGR-A1 is a robot capable of identifying and firing at a target without human intervention. The robots are developed by South Korea. On the one hand such weapons would potentially eliminate the need for human soldiers on the battlefield. On the other hand, if in the hands of terrorist groups or corrupt regimes, autonomous weapons could be used for e.g. assassinations and ethnic cleansings. In 2015, a group of scientists published an open letter from AI and robotics researchers, calling for a ban on the use of offensive autonomous weapons operating outside of meaningful human control[10].

In addition to the physical battlefield, the internet is emerging as a new battlefield of its own. Increasingly powerful computers with improved capabilities of predicting the behaviour of complex systems could offer new opportunities for e.g. hackers. With the ability to analyse large sets of data one could get a powerful system for developing new types of weapons targeted to specific population groups. Presently, nation states and businesses are experiencing challenges with protecting (big) data stored on e.g. health, finance and identities. Companies only look at hacking of their data as a security risk with financial implications. Furthermore, as one presenter explained, you do not know if data has been stolen unless you look for it.

HBP SP12 FORESIGHT LAB: REPORT ON FUTURE COMPUTING AND ROBOTICS

The HBP Foresight Lab at King's College London, led by Prof. Nikolas Rose, identifies potential ethical and social concerns at an early stage by producing scenarios of potential developments and implications, produces reports and publications, and feeds these back to the HBP researchers to build capacity to adapt to differing uncertain futures.

The HBP Foresight Lab has written a number of foresight reports on the Human Brain Project. Among these reports on o the social, ethical and legal implications of the future computing and robotics research of the HBP.

The foresight reports are available on the web-page of King's College, London.

[8] The report, also referred to as the Lemon-Relman report, is available here: http://www.nap.edu/read/18512/chapter/1

[9] I have used the vague term 'stakeholder' on purpose here to avoid narrowing down responsibility to one group e.g. researchers. The question on who responsibility falls will be discussed a little further on in the newsletter.

[10] The letter can be found here: http://futureoflife.org/open-letter-autonomous-weapons/

Chances are that you have been hacked, and you will never know it.

More powerful tools for data analysis of large datasets have the potential to be very influential in understanding disease and developing cures. However, the flipside is that they also make individuals, groups and governments susceptible to exploitation and extortion. At present no one is performing biosecurity assessments or even considering the implications of new tools for analysis for cyber war.[11]

The neuromorphic and supercomputing researchers at the seminar explained, that the most powerful supercomputers are presently being used for developing predictions about the weather. As one presenter explained, basically it's about pattern recognition and prediction. One challenge the neuromorphic computing field faces is the hardware. Another challenge might be human understanding of the systems that are being developed. Already, as the participants explained, researchers are experiencing that in training deep networks, they cannot understand how the machines reach certain conclusions. Machine intelligence developed for gaming is also interesting. If you have an algorithm developed for winning games, it could possibly also be used to predict your enemy moves, and then to plan military attacks.

THE RESPONSIBILITY TO ACT

The individual responsibility of researchers versus the responsibility of state and global actors to prevent dual use was extensively discussed.

Participants agreed that responsibility do not fall squarely on the one or the other.

At the project level one can e.g. work with user agreements and systems of checks and balances for granting access to e.g. the HBP ICT platforms (which the HBP already does). Education of (younger) researchers on issues of dual use and ethics was also discussed as a key preventive measure. However, as participants mostly agreed, risks from research are wider than technical safety concerns, and cannot be left in the hands of individual scientists.

State and global actors are harder to influence from the project level, but equally crucial to preventive measures. The HBP does not have the capacity to drive technological change, but e.g. commercial companies have greater capacities and influence. Therefore, the actions of global actors, including states, have important repercussions for the dual use implications of neuroscience.

One of the presenters made the point that there is an urgent need to put up systems of oversight, which are transparent, foster a culture of responsibility and with sound accountability practices. Using the debate on gain-of-function (GoF) research as an example, the participant argued for clear 'red lines' in terms of the kind of experiments which are permissible. As was explained, one of the key messages from a December 2014 U.S.

HBP SP12 PHILOSOPHICAL REFLECTIONS ON BRAIN AND MIND

This WP, led by SP12 leader Prof. Kathinka Evers, Uppsala University, performs philosophical, ethical and social analyses of HBP key activities and issues, thereby contributing to the conceptual and epistemological development of neuro- and computational sciences; and the reflective capacity of HBP researchers and others in addressing societal implications.

The WP publishes in neuroethics and philosophy on simulation, cultural imprinting in brain development, consciousness and mind studies, and privacy and data protection. The group collaborates with researchers in the other sub-projects of the HBP on the writing of its articles.

The collected work and research plans of the group can be found on the web-site of Uppsala University.

[11] Interested readers may find further information in the reports from the project "Big Data, Life Sciences, and National Security", a collaboration between the American Association for the Advancement of Science (AAAS), the Biological Countermeasures Unit of the Federal Bureau of Investigation Weapons of Mass Destruction Directorate (FBI/WMDD/BCU), and the United Nations Interregional Crime and Justice Research Institute (UNICRI): http://www.aaas.org/oisa/aaas-fbi/bigdata

National Academies meeting[12] in Washington D.C., was that the benefits of doing certain experiments, simply do not match the potential harms. Again, decisions on what (not) to do cannot be left to individual scientists, but must be governed politically and internationally.

What scientists and research projects can do is learn from history, recognise the dangers that are present here and now, and take an active stance to prevent dual use of (their) research.

NEXT STEP FOR THE HBP

The participants in the seminar recommended that the HBP develops mechanism for reflection on dual use, and develops education, and management systems. The project could explore issues further in additional workshop, explore public opinion, and liaise with other brain research programs and institutions to develop international collegiality and shared morals and attitudes. There is a unique opportunity to act before the science and weapons for the battlefield of the future are already developed.

The HBP already has a number of ethics guards in place, like an independent Ethics Advisory Board, a Point of Registration (PORE) for concerns, ethics rapporteurs in all its sub-projects, an ethics manager and a research program on societal and ethical issues.
Educational and outreach activities could build on these programs. However, building an infrastructure is not enough, as many participants emphasised, ethics and building a culture and community of responsibility is also a leadership issue.

This newsletter is written by DBT senior project manager Lise Bitsch.

Special thanks to the chairs and speakers of the seminar. Thank you to the participants at our seminar, for their efforts and dedication to the discussions in the seminar, and for the comments and contributions to the present newsletter.

The discussions were tape recorded, transcribed and analysed before writing the present newsletter. While every caution has been taken to represent the views of the participants in this newsletter accurately, the final representation remains the responsibility of the Danish Board of Technology Foundation. The seminar was held under the Chatham house rules.

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The DBT leads the HBP SP12 engagement activities with stakeholders and the general public.

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HBP SP12 ETHICS MANAGER AND INFRASTRUCCTURE FOR ETHICAL AWARNESS

Ethics Management, led by HBP ethics manager, Prof. Bernd Stahl, De Montfort University, develops ethics governance measures to ensure compliance, reflection, and engagement with ethics among the entire HBP. It works with all ethics stakeholders to ensure that the ethics-related activities of the scientific and technical SPs are collected and communicated, and ensures open interaction between SP12's wider research and other SPs. This ensures that ethical issues are managed to the highest standards within the HBP and develops international good practice.

For more on ethics management in the HBP, on the web-site of the HBP.

[12] The summary of the meeting can be found here: https://www.nap.edu/catalog/21666/potential-risks-and-benefits-of-gain-of-function-research-summary

SPEAKERS AND CHAIRS AT THE SEMINAR WERE:

Jürgen Altman (Technische Universität Dortmund);
Valentina Bartolucci (University of Pisa);
Berit Bringedal (Research Institute of the Norwegian Medical Association);
Malcolm Dando (University of Bradford);
Alain Destexhe (The National Center for Scientific Research, CNRS);
Vitali Karasenko (Heidelberg University);
Filippa Lentzos (King's College London);
Jonathan Moreno (University of Pennsylva-nia);
Vincent Müller (American College of Thessa-loniki);
Florian Röhrbein (TU Munich);
Thomas Schulthess (Swiss National Supercomputing Center);
Guglielmo Tamburrini (Universita' di Napoli Federico II);
Edward You (FBI Biological Countermeasures Unit)

Participants at the seminar were:

Christine Aicardi, Martí Bayo Alemany, Jean-Pierre Changeux, Hester van den Elzen, Elis-abeth Dienel, Richard Frackowiak, Adriana Galvani, Dennis Kenji Kipker, Vicente Medel, Timon Prata, Sudeep Rangi, Benjamin Sim-menauer, Bernd Stahl, Delphine Stoffel, Ine Alvarez van Tussenbroek, Fabio Valone, Emma Vos