ETICA Project
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Deliverable D.3.2.2

Ethical evaluation

Part of D.3.2 (Evaluation Report)

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Executive Summary

This document deals with the evaluation of the "ethical analysis" carried out in WP 2 "with the aid of the overview of computer and information ethics and bibliometrical analysis" (D.2.2. p. 5). Our approach is based on official documents on the European level as suggested in the "Description of Work" allowing a comparison between the ethical issues addressed in academic research and the issues likely to be addressed at the level of the European Union.

During the course of the ETICA project, our subject of enquiry was named "Official (European) Ethics" (cf. D.5.6). We prefer to call it "Ethics of European Institutions" based on the fact that the European Union is often referred as a "community of values." One of our main indicators for the likelihood of ethical issues is therefore a potential conflict with the values and principles of the EU Charter, the Opinions of the European Group on Ethics in Science and New Technologies (EGE) as well as of other National (Bio-)Ethics Committees (NEC) and other official EU documents. Among these core values of European institutions we highlight for instance: human dignity, freedom (which includes autonomy, responsibility, persuasion and coercion, informed consent), freedom of research, privacy, justice (which includes: autonomy, consumer protection, cultural diversity, environmental protection, safety, ownership, social inclusion). We also take into consideration the principle of proportionality, the precautionary principle and the principle of transparency as key principles of an "Ethics of European Institutions."

According to this framework we consider the following technologies as having a "very high" degree of likelihood for becoming an ethical issue as far as they concern or might concern human dignity, namely: Ambient Intelligence, Human-machine symbiosis, neuroelectronics, and robotics. Other technologies such as Affective Computing, Artificial Intelligence, Bioelectronics and Virtual/Augmented Reality can be seen, according to our analysis, as having a "high" degree of likelihood. Cloud Computing and Future Internet were qualified with "medium" and Quantum Computing (for the time being) with a "low" degree.

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1 Introduction

D.3.2.2 is part of the overall Evaluation report (D.3.2) presenting the findings of Work Package 3 (WP 3) of the ETICA project.

A major outcome of WP 3 is a ranking of technologies based on the need to address the normative issues raised by these technologies. The "Ethical evaluation" presented in this deliverable will contribute to this task by identifying those technologies that will most likely become an ethical issue at the level of the European Union.

As stated in the "Reporting Guidelines for Ranking of Normative Issues connected to Information and Communication Technologies" (D.3.1) the evaluation and ranking will be based on official documents on the European level, the outcome of European funded (sub-)projects on the ethical implications of ICTs, etc. (D.3.1, p. 12-13)[1] – A full list and a justification of the indicators used will be given in Chapter 2 of this deliverable.

It's important to note that it is *not* the objective of this report to provide answers to the ethical questions raised. The objective of this deliverable is to determine the level of expected level of controversy from the view point of ethics.

To carry out this task we started by analysing the way a technology becomes an ethical issue at the European level (Annex I). The most important findings will be summarized in the following section. Here we will also address methodological issues, which in part already have been discussed in D.3.1.

In section 3 we will discuss ethical issues that are likely to be raised with regard to more than one technology in our list and that may be regarded as common or even central ethical issues of emerging ICTs.

In section 4 we will present the findings of our ethical evaluations,[2] which are informed by our understanding of how ethical issues are constructed at the EU level. The ethical analyses are based on the outcome of WP 2 as documented in D.2.2 (Identifying Ethical Issues of Emerging Information and Communication Technologies)[3] and the descriptions of technologies (called "meta-vignettes" in D.3.1).

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[1] All deliverables of the ETICA project quoted or referred to in this document are available at the project's web site (http://www.etica-project.eu/). All deliverable will be referred to in the text by their numbers (e. g., "D.3.1.").

[2] While the „ethical evaluations" are not only to be understood as „evaluations" of the "ethical analyses" presented in D.2.2, since they do also include original research carried out in our subproject, we have decided to refer to them as "ethical evaluations" to avoid confusing them with the "ethical analyses" carried out in WP 2.

[3] We would like to point out that most of our ethical analyses had been finished at the time of the WP 3 workshop (September 2010). Therefore, we build our analyses on the latest available version of D.2.2 at that time. Since D.2.2 had not been reviewed and finalised at this point in time, there might be differences between the version we had worked with and the final version available to the public at the time this deliverable is been released.

We kindly remind our readers that our aim was to give a reasonable estimation of the likelihood of ethical issues within given budgetary constraints. Every technology addressed in this deliverable may become the subject of a much more detailed study. This deliverable does not aim to provide such an extensive review on each technology. We do not claim that our very schematic approach should replace such studies either. However, the chosen methodology did prove to be effective in providing a quick evaluation on different technologies to build a ranked list of technologies with regard to the likelihood of becoming an ethical issue at the EU level.

In section 4 you will find the ranking of the technologies based on the ethical evaluations. We will also make some remarks of the methodology used in the evaluation process.

2 How does a technology become an ethical issue at the European level?

2.1 'Official' European Ethics vs. Computer Ethics

Originally, the term "Ethical Evaluation" to be carried out in WP 3 was understood in a very broad sense. In the "Description of Work" it is said:

> *The heart of the evaluation of the issues identified during the ETICA project will be done from the viewpoint of ethics. Such ethical evaluation will need to be based on well-supported knowledge of the technologies and their applications. It will simultaneously need to take into consideration current ethical debates concerning technology, in particular their European angle.*[4]

Obviously, such an evaluation would have to take into account the academic discussion of such ethical issues as represented in publications on computer and information ethics. But since there is an "ethical analyses" carried out in WP 2 "with the aid of the overview of computer and information ethics and bibliometrical analysis" (D.2.2, p. 5), we decided to take a different approach for the "ethical evaluations" presented in this deliverable.

As we explained in D.3.1 (p. 12) we decided to base our evaluation on official documents at the European level (e.g. EGE opinions) to minimize redundancy with regard to D.2.2, to view the issues from a "European angle" (as suggested in the "Description of Work"), and to allow a comparison between the issues addressed in academic research and the issues likely to be addressed at the level of the European Union.

[4] Ethical Issues of Emerging ICT Applications (ETICA), Grant agreement, Annex I – "Description of Work", p. 7-8.

2.2 Reconstructing the „Ethics of European Institutions“

2.2.1 Summary of our analysis

In order to determine the likelihood of a specific technology becoming an ethical issue at the European level, we started by analysing the way something is turned into an "ethical issue" in the arena of European politics. In the following we will summarize the outcome of this analysis carried out by Lisa Stengel and Michael Nagenborg.[5]

While our subject of enquiry was named "Official (European) Ethics" (c.f. D.5.6) during the course of the ETICA project, we suggest calling it the "Ethics of European Institutions."

Our notion of "Ethics of European Institutions" is based on the fact that the European Union is often referred to as a "community of values." For example, in his "Foreword" to the "General Report on the Activities of the European Group on Ethics in Science and New Technologies to the European Commission 2005-2010"[6] the President of the European Commission, José Manuel Barroso, states:

> *The European Union is founded on values: respect for human dignity, freedom, democracy, solidarity, equality, the rule of law and respect for human rights. Promoting these, as well as peace and the well-being of the Union's peoples, are the main objectives of the Union. … In the science and new technologies sector the Commission is promoting a responsible use of science and technology, both within the EU and worldwide. The goal of the Commission is to strike a balance between ethical and socio-cultural diversity, both at EU level and globally in other regions of the world, while also respecting internationally recognised fundamental values.*[7]

Since the 5th Framework Programme (1998-2002), e.g., the European Union incorporated as a precondition in its funding process the adherence to and observation of „fundamental ethical principles".[8]

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[5] See also Capurro (2010). – The complete analysis is presented in the Annex I. As it is mentioned in the "Annex", most of the analysis had been finished in April 2010. Since the time of finishing the study, for example the "General Report 2005-2010" of the European Group on Ethics in Science and New Technologies to the European Commission has been published. Also, certain decisions made within the ETICA project could not have been foreseen at the time of writing. We decided not to fully update and reedited the study for publications for reasons of consistency as well as to provide a document of our original starting point. We will note relevant adjustments and changes made during the time of the evaluation process in this deliverable.

[6] European Commission (2010): *General report on the Activities of the European Group on Ethics in Science and New Technologies to the European Commission 2005-2010.* Luxembourg: Publications Office of the European Union.

[7] Barroso, José Manuel (2010): Foreword. In: European Commission (2010), p. 5.

[8] Decision No 182/1999/EC of the European Parliament and of the Council of 22 December 1998 concerning the fifth framework programme of the European Community for research, technological development and demonstration activities (1998 to 2002), Article 7: „All research activities conducted pursuant to the fifth framework programme shall be carried out in compliance with fundamental ethical principles, including animal welfare requirements, in conformity with Community law."

The „fundamental ethical principles of the European Union“ – as the name already suggests – are valid throughout the European Union. The *Charter of the Fundamental Rights of the European Union* (EU Charter)[9] has become the key document in this regards. The EU Charter assembles for the first time the basic rights of the citizens of the European Union's member states. In the first few paragraphs, the EU-Charter sets out what can be viewed as the core values of the EU: Human dignity, freedom, democracy, equality, the rule of law and the respect for human rights. Already the "General Report 1998-2000" of the EGE stated that the EU Charter „...is (...) unique, since it is the first international instrument of a general nature dealing with Human Rights which makes specific reference to bioethics and infoethics."[10]

While the EU Charter can be regarded as the key document for understanding the „fundamental ethical principles of the European Union", it is also important to point out that its scope is limited by Article 51:

> *The provisions of this Charter are addressed to the institutions and bodies of the Union with due regard for the principle of subsidiarity and to the Member States only when they are implementing Union law. They shall therefore respect the rights, observe the principles and promote the application thereof in accordance with their respective powers.*

Hence, the EU Charter may be regarded as a strong commitment of the European Union itself to the values and principles expressed in the Charter. However, the „fundamental ethical principles of the European Union" are to be regarded as the foundation of an "Ethics of the European Institutions" and may not be confused with a "European Ethics", in the sense of common moral principles and/or values shared by all citizens of the European Member States.

Of course, the EU Charter also shapes the way research is funded by the EU. For example, the in "Decision No 1982/2006/EC of the European Parliament and of the Council of 18 December 2006 concerning the Seventh Framework Programme of the European Community for research, technological development and demonstration activities (2007-2013)" it is stated that

> *Research activities supported by the Seventh Framework Programme should respect fundamental ethical principles, including those reflected in the Charter of Fundamental Rights of the European Union. The opinions of the European Group on Ethics in Science and New Technologies are and will be taken into account.*[11]

In Article 6 of the Decision, this ethical imperative is further specified towards the research process: „All the research activities carried out under the Seventh Framework Programme shall be carried out in compliance with fundamental ethical

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[9] Charter of the Fundamental Rights of the European Union. In: Official Journal of the European Communities, C 364, Volume 43 (18 December 2000).

[10] European Group on Ethics in Science and New Technologies 2000: General Report on the Activities of the European Group on Ethics in Science and New Technologies to the European Commission 1998-2000, Introduction by Noelle Lenoir, President of the EGE, p. iii.

[11] Decision No 1982/2006/EC. In: Official Journal of the European Communities, L 412, Volume 49 (30 December 2006).

principles.“ In an additional *Regulation*[12] laying down the rules for the participation, Article 15 specifies that „a proposal which contravenes fundamental ethical principles (…) shall not be selected. Such a proposal may be excluded from the evaluation, selection and award procedures at any time.“

One of our main indicators for the likelihood of ethical issues is therefore a potential conflict with the values and principles of the EU Charter. Since the focus of the ETICA project is on research founded within the FP7 programme, one may assume that no such conflicts could be identified. However, conflicts may only arise in certain areas of applications, or while issues may arise they may not be regarded as serious enough to exclude the respective research. Also, it has to be noted that Ethics in FP7 concentrates on the research process. Control mechanisms are not in force when it comes to the products of research or possible ethical implications of their use, misuse or unintended consequences of mass use (Stahl et al 2009, p. 7).

2.2.2 List of values, and principles

Based on our analysis we produced a list of values and principles based on the EU Charter, EGE Opinions, and other documents:[13]

Human Dignity

Freedom

- Autonomy
    - Control
    - Responsibility
    - Persuasion and coercion
    - Informed consent
- Freedom of Arts
- Freedom of Research
    - Dual use
- Privacy
    - Data protection
    - Surveillance

Justice (Equality and Solidarity)

- Autonomy
    - Dependency
- Consumer Protection
- Cultural Diversity
- Environmental Protection

[12] Regulation (EC) No 1982/2006 of the European Parliament and of the Council of 18 December 2006.

[13] See: Annex I to this document, p.14, for the original list. The list presented here does already take into account the actual issues identified in the evaluation process.

    - Animal Welfare
- Health
    - Safety
    - Equal access to Health Care
- Respect for human rights
- Ownership
- Social Inclusion
    - Equal Access to Education
    - (Non-)Discrimination
    - Participation
    - Access to the labour market
    - Surveillance and Security

Principle of Proportionality

Precautionary Principle

Principle of Transparency

The list of values and principles has been used to identify issues relevant to estimating the likelihood of a technology becoming an ethical issue based on the analysis of the respective technology within WP 2. In the first step of the evaluation we asked if any of the values and principles has been addressed within the current academic literature. In the second step asked if any of the above listed values, and principles had not been addressed in the academic literature but may reasonable to be addressed with regard to the technology in question.

2.2.3 Some remarks on the list of values and principles

Since it will become apparent in which way we made use of the list in chapter 4, where the analyses are presented, and additional information is provided in the chapter 3 (Common ethical issues) we will provide some basic information on the list in the following section.

The structure of the list is based on the first four chapters of the EU Charter of fundamental rights entitled “Dignity”, “Freedoms”, “Equality”, and “Solidarity”. The two later topics have been merged to “Justice (Equality and Solidarity)” because it became obvious during the process of evaluation that the items addressed under this topic had much in common from the perspective of ethics. However, the choice was made more due to stylistic consideration than for philosophical reasons.

Each evaluation of each technology includes sections on “Human Dignity,” “Freedom”, and “Justice (Equality and Solidarity).” While we treated “Human Dignity” as a single subject, within the sections on “Freedom” and “Justice (Equality and Solidarity)” we address the individual items from the list.

As we will explain in chapter 3.1 we have decided to single out “human dignity,” because serious threats to human dignity within the field of emerging ICT are most likely to arise with “ICT implants in the human body.” Hence, we decided to reserve the topic “human dignity” mostly to issues of bodily integrity. Because of this, issues

of autonomy have been dealt with mostly in the section on "Freedom." An exception has been made in cases, where there might be a danger of people becoming dependent on a technology, where we choose the topic of "Justice". We are fully aware that this decision might look odd from the perspective of Western ethics, but by making this choice it proved much easier to make a distinction between the challenges presented by such different technologies as ICT implants and, e.g., assistive robots.

With regard to the three principles mentioned at the end of the list, we raised the question concerning each technology if there is a need to invoke one or more of these principles in addressing the specific technology. Because of the major political implications of the "precautionary principle," we decided to be very careful about invoking this principle which has been often referred to in the Computer Ethics literature.[14]

2.3 Further Indicators

Besides providing an overview on values and principles underlying the Ethics of European Institutions, our analysis on how a technology becomes an ethical issue at the European level also provided us with some insights for further indicators.

All of our evaluations presented in chapter 4 will start with a list of EGE opinions, NEC reviews, and FP (sub-)projects that address (similar) technologies.

2.3.1 (Similar) technology addressed by EGE

Given the fact that the EGE deals with ethical issues on science and new technologies we assume that ethical issues of ICT will be further dealt with by this European body either by proposal of the EC or on its own initiative.[15] Therefore, we assume that a technology that has already been addressed by the EGE or that is similar to a technology being subject of an EGE opinion is more likely to become the subject of ethical concerns.

2.3.2 (Similar) technology addressed by National Ethics Committees (NEC)

While the analysis on how ethical issues are constructed within the EU clearly shows that NECs might influence the process,[16] there are very few opinions and reports published by NECs on ICT issues. There might be an easy explanation for this: most NECs in Europe clearly focus on issues of bioethics, particularly of medical ethics.[17]

We would like to stress that at present there is no centralized data bank where all opinions produced by NECs are stored and searchable in an easy way.

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[14] Cf. Annex, p. 13-14, for quotes on the precautionary principle and the condition for invoking it.

[15] Cf., Annex, p. 6.

[16] Cf., Annex, p. 17-20.

[17] One may assume that (national) data protection bodies (e. g., information officers) might be more relevant in the process of construction "ethical issues" with regard to ICT. However, data protection bodies are focusing more on the legal than on the ethical aspects. Therefore we have chosen not to include these bodies in our analysis.

One may be tempted to conclude that future projects using a similar methodology might consider not including NEC opinions. As long as most of the NECs are not addressing ICT issues, we may agree to do so. However, for any other topic and especially with regard to health and medical issues the potential influence of NECs should not be underestimated.

2.3.3 (Similar) technology addressed by FP (sub)projects

FP (sub)projects on ethical issues can be considered as an indicator, because they either may have been requested by the funding agency or have been proposed by researchers who feel a need to address the ethical issues of ICT.[18]

Again, it has to be mentioned that it has been a difficult task to identify such (sub)projects despite the public information provided by CORDIS. Our first list of ICT projects has been included as Annex 3 to the Annex to this deliverable. Also, information on EU research projects provided in D.2.2 proved to be helpful as well as the data collected in the ICT coordinator survey.

In analysing various reports, deliverable, websites etc. of EU research projects, we had to recognise that, e.g., several European reports on different ICTs do mention ethical, political and legal issues, but do not address these issues as such. Especially, privacy issues are often presented as legal and not ethical issues. We decided to list such projects in the corresponding section based on the issues, not on the label attached to them.

2.3.4 Value conflicts

Finally, for each technology we provide a list of value conflicts. These lists are not meant to provide an extensive overview of potential conflicts. Rather they aim to demonstrate that there are likely conflicts based on our findings.[19]

The underlying idea is that technology that only has undesirable effects is unlikely to cause any controversy. Therefore, we use these lists to show that any technology in the list may promote certain values while threating others.

3 Common ethical issues of emerging ICTs

As pointed out in D.3.1 some ethical issues are most likely to arise with all most all ICTs, e. g., "privacy issues."[20] In the following section we will discuss some of the "common ethical issues," that needed to be addressed with different kinds of technologies. This is also done for practical reasons, especially to avoid repetition in the evaluations presented in section 4.

However, the list of common ethical issues turned out be include some surprises, like „ICT implants in the human body" or "animal welfare," and therefore is to be considered a valuable outcome of the ethical evaluation.

[18] Cf. Annex, p. 4-6.

[19] These conflicts are modeled after a list of examples provided in the Annex, p. 25-26.

[20] D.3.1, p. 12.

3.1 Human Dignity and ICT implants in the human body

ICT implants in the human body are mentioned within the following "Descriptions of Technologies":

- Ambient Intelligence
- Artificial Intelligence
- Bioelectronics
- Neuroelectronics
- Robotics
- Human-Machine-Symbiosis

Because ICT implants in the human body go along with the tendency to commercialize the human body and treat humans as objects or as 'biomechanical platform,' implants are considered as a potential threat to human dignity in some contexts (e. g., by the EGE in Opinion 20).

Of course, there are differences of what kind of ICT implant is used in what context and how it is connected to what part of the human body. While the research on and the development of such implants appears to be central to the vision of some technologies like Bio- und Neuroelectronics, they seem to play a less prominent role in other perspective like Ambient Intelligence.

We assume that all mentioned technologies may rise concerns about the protection of human dignity for instance in the case of ICT implants in the human body but they certainly do so in different degrees. The EGE "considers that ICT implants are not *per se* a danger to human freedom or dignity but in the case of applications, which entail for instance the possibility of individual and/or group surveillance, the potential restriction of freedom must be carefully evaluated." (Opinion 20, p. 30) [21]

ICT implants might be acceptable in medicine and health care. "However, the EGE insists that […] surveillance applications of ICT implants may only be permitted if the legislator considers that there is an *urgent* and *justified* necessity in a democratic society." (p. 34). The EGE "considers that ICT implants are not *per se* a danger to human freedom or dignity but in the case of applications, which entail for instance the possibility of individual and/or group surveillance, the potential restriction of freedom must be carefully evaluated." (Opinion 20, p. 30) However, the "[…] EGE makes the general point that non-medical applications of ICT implants are a potential threat to human dignity and democratic society. Therefore, such applications should respect in all circumstances the principles of informed consent and proportionality." (p. 32)

Since there are also surveillance applications of ICT implants, please also refer to the following section.

3.2 Surveillance

Surveillance issues have been identified with regard to all most every technology on the list. The exceptions are "Quantum Computing" and "Human-Machine-Symbiosis." This might be the case because it's hard to predict actual applications of

[21] "Intracorporal robotics" is also briefly mentioned in the EGE Opinion No. 21 (Ethical Aspects of Nanomedicine).

"Quantum Computing", and because the focus in "Human-Machine-Symbiosis" is more on the individual.

Therefore, we decided to differentiate between three forms of surveillance:

1. Surveillance applications of ICT implants,
2. Surveillance issues that raise concern about the way data is collected, and
3. Surveillance issues that raise concern because of the likely impact on society ("social sorting").[22]

At times "surveillance" will be mentioned as an issue in the section on "Freedoms," because the issue is the way data is collected. Unsurprisingly, this often goes along with privacy issues. However, at times the likely outcome of surveillance measures on society has been identified as a more important issue. In this case surveillance issues have been addressed in the section on justice in the evaluation.

Finally, the EGE stated in Opinion 20 that for all kinds of surveillance applications of ICT implants there is a strong need to pay attention to the "Principle of Proportionality": "surveillance applications of ICT implants may only be permitted if the legislator considers that there is an urgent and justified necessity in a democratic society (Article 8 of the Human Rights Convention) and there are no less intrusive methods." (Opinion 20, p. 34) Therefore, it is reasonable to rank implant based technologies high, when they have potential or foreseeable surveillance applications.

3.3 Transparency

Since transparency is a common issue with regard to ICT (almost all technologies on the list give rise to transparency issues), we consider transparency is particularly important in technologies that influence directly or indirectly human behaviour (like Affective Computing).

Also, autonomous systems (Robotics, AmI, Affective Computing, and AI) should be designed as transparent as possible. This means that they should increase the options of the users. As stated in the "Ethical Analysis": "Especially for opaque technologies like Affective Computing it is important that it becomes properly disclosed."

3.4 Animal welfare

With Neuro- and Bioelectronics issues of "Animal Welfare" became obvious. Animals might be used for testing in some case, but they may also be turned into cyborgs. With both technologies also issues of environmental protection could be identified.

While these issues only have been identified with regard to two technologies, it might be worth exploring the use of animals and the protection of the environment with regard to the other technologies in our list as well.

Here, we have to point to a strong bias in the current computer and information ethics literature: Since most of the writing is quite human-centric, issues of animal welfare as well as environmental protection are rarely addressed at all. On the other side,

[22] Cf. the contributions in Lyon (2003) on "Surveillance as social sorting: privacy, risk, and digital discrimination."

animal welfare in ICT research has already has become an issue within the EU (see: Annex, p. 5). Issues of environmental protection also have become important issues in the latest opinions of the EGE. Therefore, form the viewpoint of the "Ethics of European Institutions" these issues have to be taken into account and will have an impact of our ranking.

4 Ethical evaluations of technologies

In the following section our ethical evaluations will be presented. These are based on the "Description of Technologies" (available at the ETICA web site) and the "Ethical Analyses" (D.2.2).[23]

4.1 Affective Computing

4.1.1 (Similar) Technology addressed by…

4.1.1.1 EGE

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4.1.1.2 NEC

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4.1.1.3 FP (sub)projects

European Network of Excellence HUMAINE (Human-Machine Interaction Network on Emotion, FP 6)[24]

Within the HUMAINE project WP 10 is dedicated to "Ethics and Good Practice." The project also includes an "Ethical Audit."

SERA (Social Engagement with Robots and Agents, FP7)[25]

Within the SERA project challenges like the measuring and modelling of emotions are addressed.

According to the "Description of Work" (p. 25) ethical guidelines have been produced and signed by the project coordinator and other partners part of Task 6.1.[26]

LIREC (Living with Robots and Interactive Companions, FP7)[27]

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[23] Please consult section 2 for questions concerning our indicators and the underlying methodology. You will find references given in quotations from either the "Descriptions of Technology" or the "Ethical Analyses" in section 7 ("reference"). In same rare cases we have not been able to locate the document quoted. Please, refer to D.2.2 in these cases.

[24] http://emotion-research.net/, last access: August 7, 2010.

[25] http://project-sera.eu/, last access: August 7, 2010.

[26] http://project-sera.eu/publications/others/SERA-dowshort.pdf/at_download/file, last access: August 7, 2010.

The deliverables of the projects include "Preparatory studies and ethics for companion design (D.10.1)". The deliverable "covers three main areas: preparatory studies of companions in everyday, natural and human-centred contexts; ethics issues specific to companion technology; and user-centred design of companions; all with the important focus on companion technology in an everyday, realistic and human-centred context."[28] The results of these studies were taken up in "Guidelines for Companion Design."[29]

LIREC includes aspects of Affective Computing like "Affect Recognition", but the specific issues of affective computing are not addressed in the documents available.

4.1.2 Core Values and Principles

4.1.2.1 Human Dignity

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4.1.2.2 Freedom

Privacy: As stated in the "Ethical Analysis" "Affective Computing" might raise strong concerns about privacy, because "it deals with some of our most personal data, namely our affects and emotions". In the "Ethical Analysis" it is also stated that "a lot of personal data is needed sometimes even from external sources accessed via the web". Thereby, "Affective Computing" might undermine the benchmark of contextual integrity as suggested by Helen Nissenbaum (2010).

Persuasion and coercion: As stated in the "ethical analysis", "[s]ystems using Affective Computing can be even more seductive and manipulative than traditional advertising and media due to their interactive nature and connection with the user's goals and emotions". Since "affective computing" is closely linked with "persuasive technologies", it tends to undermine the autonomy of the individuals affected.

Persuasiveness is a human capability. At times, persuasiveness might be desirable for instance when dealing with health issues. But even if desirable there is a tendency towards paternalism, manipulation, and even coercion.

In contrast to what is stated in the "Ethical Analysis", we would like to argue that "Affective Computing" may not only give rise to concerns with regards to "evil dictatorships" but also in democratic societies given the potentials of manipulation.[30]

Informed consent: Persuasive technologies may become especially problematic if the persuasiveness of system is being used to archive "informed consent" (Nagenborg 2010).

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[27] http://www.lirec.eu/, last access: August 7, 2010.

[28] http://www.lirec.eu/deliverable-reports#d.10.1, last access: November 5, 2010.

[29] http://dl.dropbox.com/u/1103838/Public%20Deliverables/Lirec-D.10.1-Complement.pdf, last access: November 5, 2010.

[30] Marlin (2002) presents a good overview about ethical issues in persuasion.

4.1.2.3 Justice (Equality and Solidarity)

Social inclusion and exclusion: Affective Computing is ambivalent with regard to social inclusion. While certain applications, like the *Gestele* system described in the "Description of Technologies", might be beneficial for people with severe motor and oral communication problems, "anthropomorphic systems can [also] confirm and proliferate generalizations about members of a specific social group by implementing stereotypically features in a system." In the "Ethical Analysis" the ethical challenge of cultural differences in expressing and understanding emotions is also mentioned.

4.1.2.4 Principle of Proportionality

The sensitive nature of the data collected (principle of data minimization) as well as the tendency to manipulation and coercion require a strong justification with regard to the use of Affective Computing tools for specific purposes in specific contexts, especially in case of non-medical applications. Security and surveillance applications, especially if they aim at manipulating persons, might be considered to be similar to ICT implants (EGE Opinion 20).

4.1.2.5 Precautionary Principle

No reason (for now) to apply this principle.

4.1.2.6 Principle of Transparency

Given the sensitive nature of the data used in Affective Computing and the persuasiveness of the systems, a high level of transparency has to be requested and provided.

4.1.3 Value Conflicts

Promotion of Health vs. Privacy and Autonomy: Certain applications of "Affective Computing" might become useful for persons with certain disabilities, but the technology in general is based on the collection and processing of rather sensitive information.

Persuasion vs. Autonomy: While persuasiveness might be desirable in certain contexts, there is also the danger of undermining the autonomy of the users.

4.1.4 Overview of ethical issues

Ethical Issues already discernable	Description	How have these been recognised?
Privacy	"deals with some of our most personal data", "a lot of personal data is needed sometimes even from external sources accessed via the web",	FP Research Academic publications
Manipulation and Coercion	Even if persuasion is desirable there is a tendency towards	Academic publications

	paternalism, manipulation, and even coercion.	
Informed Consent	The persuasiveness of some applications might question the quality of the informed consent given by the users.	Academic publications
Social inclusion	System might be beneficial for people with severe motor and oral communication problems, but may promote stereotypes. Ethical challenges of cultural differences regarding emotions have to be addressed.	FP Research Academic publications
Principle of Proportionality	Collection of sensitive data and potential of manipulating persons require strong justification with regard to means and ends.	EGE Opinion No. 20
Principle of Transparency	A high level of transparency has to be requested.	Academic publications
Likelihood of Ethical Issues	□ Very High / X High / □ Medium / □ Low / □ Very Low	

4.2 Ambient Intelligence (AmI)

4.2.1 (Similar) Technology addressed by…

4.2.1.1 EGE

In the "Description of Technology" it is stated that AmI application in healthcare might include "computers … in your body [monitoring] your health status at all time … ." However, we do not consider ICT implants in the Human body to be central to the AmI vision.

For general remarks on "ICT implants" please refer to section 3. It has to be noted that ICT implants used in AmI are to be considered as 'online devices'. Hence, if ICT implants are part of AmI system they give rise to serious concerns.

4.2.1.2 NEC

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4.2.1.3 FP (sub)projects

SWAMI (Safeguards in a World of Ambient Intelligence, FP6)[31]

The project "aimed to identify and analyse the social, economic, legal, technological and ethical issues related to identify, privacy and security in Ambient Intelligence (AmI)." (SWAMI web site) The following issues were addressed in the final report (Wright 2006): Privacy, Identity related issues, Trust, Security, and the Digital Divide.

4.2.2 Core Values and Principles

4.2.2.1 Human Dignity

In case "ICT implants in the human body" are used within AmI applications, we refer to the general remarks in section 3.

4.2.2.2 Freedom

Privacy: As has been pointed out in the "Ethical Analysis," the issue of "privacy has received the most attention in academic literature. … [T]he technology is perceived to have a clear potential to violate the privacy of the user(s)."

AmI systems may also become part of a larger "surveillant assemblage" (Haggerty and Ericson 2000) if AmI applications become interoperable with other (AmI) systems. For example, the use and exchange of biometric information in such systems is a critical issue because these may enable to track a person in otherwise distinct systems. Therefore, the widespread use of AmI in society and particularly the interconnectivity and interoperationality of such systems have to be considered in the ranking.

Informed Consent: Because AmI systems are designed to become ‚invisible'[32] and are likely to include machine-user-interfaces that are not perceived as such by the users, there is a tendency to undermine the idea of requesting consent of the users except in a very general form. See the remarks on informed consent in section 3.

4.2.2.3 Justice (Equality and Solidarity)

Consumer protection: AmI applications might be considered as tools for monitoring the environment including the detection of safety risks or security issues.[33] At the same time according to the "Ethical Analysis" questions of liability and responsibility are being raised.[34]

Inclusion: As noted in the "Description of Technologies" (p. 2), AmI might be enabling for elderly people or persons with disabilities by providing more adequate interfaces. However, AmI might also lead to "social sorting", including the possibility for racial profiling enabled by the use of biometrics and other forms of identification.

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[31] http://www.isi.fraunhofer.de/isi-en/t/projekte/fri-swami.php, last access: August 7, 2010.

[32] See: 'Transparency' (below)

[33] See: Wright 2006, p. 20.

[34] See also: Wright 2006, p 154-159, on liability law.

With regard to AmI security applications we have to ask, for instance, what criteria will be employed by such systems to make the difference between "normal" and "dangerous" people.

4.2.2.4 Principle of Proportionality

AmI surveillance and security applications might give rise to similar concerns as in case of Affective Computing (see above).

Considering the data used, we would assume that AmI in general is less intrusive than Affective Computing. However, while in AmI there seems to be a tendency to identify individual users, Affective Computing applications might not necessarily identify persons. Depending on the likely future progress of both technologies the ethical ranking might change.

4.2.2.5 Precautionary Principle

No reason to apply this principle (for now).

4.2.2.6 Principle of Transparency

It has been argued in the Computer Ethics literature that the built-in (in)transparency of AmI has to be critically evaluated with regard to different levels (Crutzen 2006, Hubig 2006).

4.2.3 Value Conflicts

While AmI may be used in health care (health) and systems are designed for persons with disabilities (inclusion), AmI has the potential to violate the privacy of users.

AmI provides safety and security, but may foster social exclusion (social sorting, racial profiling).

4.2.4 Overview of ethical issues

Ethical Issues already discernable	Description	How have these been recognised?
Human Dignity / Bodily integrity	While not being a central element in the vision of AmI, ICT implants used in such systems have to be regarded as online devices and may give rise to serious concerns especially in case of non-medical applications.	EU / National documents Academic publications
Privacy	In the Computer Ethics literature AmI is "perceived to have a clear potential to violate the privacy of users." Privacy is also an issue identified by the SWAMI project.	FP Research Academic publications

Informed Consent	Given the 'invisibility' of AmI systems there is a tendency to undermine informed consent.	Academic publications
Consumer protection	AmI may be used to monitor the environment and thus be used to maintain and provide safety and security. AmI also gives rise to questions about liability and responsibility.	FP research Academic publications
Inclusion	AmI often aims for the social inclusion of elderly people and persons with disabilities. But since AmI is also enabling surveillance, it might also lead to social sorting.	FP Research Academic publications
Principle of Proportionality	Surveillance and security AmI applications might give rise to questions of proportionality similar to those voiced with regard to ICT implants in the Human Body.	EU documents
Principle of Transparency	Because of the 'invisible' nature of AmI there might be a strong need for discussing an adequate level of (in)transparency of the systems.	Academic publications
Likelihood of Ethical Issues	X Very High / □ High / □ Medium / □ Low / □ Very Low	

4.3 Artificial Intelligence (AI)

4.3.1 (Similar) Technology addressed by…

4.3.1.1 EGE

There is no specific EGE Opinion on AI. Since the large field of AI does include research on "AI implants", there might be concerns similar to those raised by the use of implants in AmI. Please refer to section 3.1 for general remarks about ICT implants and human dignity.

4.3.1.2 NEC

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4.3.1.3 FP (sub)project

There is little research on the ethical aspects of AI in general.

Ethical issues of military AI applications are addressed in the following project:

EIW3R (The Ethics of Information Warfare: Risks, Rights and Responsibilities, FP7)[35]

On the CORDIS web site, the following description of the project is given: "This is a two-year research project on the ethical implications of information warfare. Information warfare is a new form of conflict characterised by strategies designed to strike at communication nodes and infrastructures, and by the deployment of artificial agents as tools of offence (robotic weapons). It has its roots in the military use of intelligence as a strategic means, but has developed thanks to the revolutionary transformations caused by the pervasive use of Information and Communication Technologies (ICT) and Artificial Intelligence (AI) artefacts on the battlefield."

Since AI is part of all technologies under analysis (with the exception of Quantum Computing which itself addresses an even more fundamental level), most of the FP research mentioned in this report can be seen as addressing issues of AI.

The following projects might consider being more specific on the topic, because AI has been or is addressed in parts of the project:

- *SERA (Social Engagement with Robots and Agents, FP7)* – See: Evaluation of "Affective Computing"
- *LIREC (Living with Robots and Interactive Companions, FP7)* – See: Evaluation of "Affective Computing"
- *Ethicbots (Emerging Technoethics of Human Interaction with Communication, Bionic and Robotic Systems, FP6)* – See: Evaluation of "Human-machine symbiosis" (4.7.1.3).

4.3.2 Core Values and Principles

4.3.2.1 Human Dignity

The visions of "artificial persons" or "artificial (moral) agents" with corresponding rights are to be seen as being in contrast to the emphasis given to *human rights* in the European Union.

We assume that this might be even more the case with anthropomorphic robots (see below). While we do not want to rule out the possibility of "artificial persons" which are not robots (but only "live" in digital environments), we would argue that – given our current knowledge about AI and its potential applications – it is very unlikely that such "persons" will come into existence within the time span relevant for the ETICA project (10-15 years).

[35] http://lib.bioinfo.pl/projects/view/15344, last access: August 8, 2010.

In general, we assume that rather than *AI as a whole* becoming an ethical issue at the European level. Rather, it seems more likely that single applications of AI as part of a larger field will become ethical issues (e.g., robotic military applications).

4.3.2.2 Freedom

Autonomy and responsibility: The idea of "autonomous systems" being responsible for their own decisions etc. contribute to the weakening of the moral responsibilities of human actors (for good or bad). At least, the question of 'machine autonomy' does give rise to questions about human autonomy and responsibility, which have to be taken as serious ethical issues, as is demonstrated by the number of works presented in the "Ethical Analysis" on AI and Robotics.

Privacy: AI is often regarded as a major building block of the surveillance society (data mining, pattern recognition, etc.). Progress in AI does enable other kinds of technologies like 'cloud computing', which maximize the capacity for the storage of data, which in turn enables new forms of surveillance (Ethical Analysis)

4.3.2.3 Justice (Equality and Solidarity)

Cultural Diversity: Artificial moral agents with a strong bias towards a certain cultural identity (e.g., Western values) might be in contrast to a pluralistic society (Ethical Analysis).

Inclusion and exclusion: Depending on the scenario AI might be for the benefit of the rich if expensive hardware is required, but it may also enable a more inclusive society and help to bridge the digital divide by making information and services more accessible (see: Cloud Computing). Intelligent, e.g., speech-based interfaces might also be to the benefit of the illiterate and other persons (Ethical Analysis).

Access to the labour market: As an issue closely linked to "social inclusion", AI systems are likely to replace humans in certain contexts. This matter is addressed in the corresponding section on "Robotics" (see below). – However, especially with non-robotic application of AI knowledge-based jobs (experts, academics, etc.) might be more in the focus than is the case with traditional robots and service robots, which might affect less-skilled workers (Nagenborg et al. 2008).

4.3.2.4 Principle of Proportionality

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4.3.2.5 Precautionary Principle

The idea of Machine Ethics, in the sense that Machines should be designed in such a way that they 'behave' in an ethical manner, might be seen as a mean to take precaution against malicious artificial agents. Since we assume that scenarios like "robots overtaking humankind" (see below) are very unlikely in the next 10-15 years, there is no strong need to invoke the precautionary principle at least in this regard.

The precautionary principle might be invoked, however, with regard to military applications of AI. This might be more so in case of robotic applications (see below). While military applications are not within the scope of ETICA which focuses on R&D undertaken under the European Frame Programme, the potential and likely dual-use of AI applications may become an ethical issue.

4.3.2.6 Principle of Transparency

The potential (bi-directional) dual use of AI systems calls for paying attention to the funding and future use of R&D in the field.

4.3.3 Value Conflicts

It's hard to name value conflicts arising in the broad area of AI. There seems to be a general tension between:

Social Inclusion vs. Privacy: AI application may enable people with certain disabilities and make ICT more accessible to all people, but AI is also a major building block of surveillance society.

4.3.4 Overview of ethical issues

Ethical Issues already discernable	Description	How have these been recognised?
Human Dignity	The visions of "artificial persons" or "artificial (moral) agents" with corresponding rights are to be seen as being in contrast to the emphasis given to *human rights* in the European Union. This might be even stronger the case with anthropomorphic robots.	FP Research Academic publications
Autonomy and responsibility	The question of 'machine autonomy' does give rise to questions about human autonomy and responsibility.	Academic publications
Privacy	AI is one of the major building blocks of surveillance society.	Academic publications
Cultural Diversity	Artificial moral agents with a strong bias towards a certain cultural identity might be in contrast to a pluralistic society.	Academic publications
Inclusion	AI might contribute in making ICT more accessible to many people, but it might also foster the digital divide.	FP Research Academic publications
Access to the labour market	AI systems are likely to replace humans in certain contexts.	FP Research Academic publications

Precautionary Principle	The precautionary principle might be invoked with regard to military applications of AI.	FP Research Academic publications
Principle of Transparency	The potential (bi-directional) dual use of AI systems calls for paying attention to the funding and future use of R&D in the field.	FP Research
Likelihood of Ethical Issues	□ Very High / X High / □ Medium / □ Low / X Very Low	

4.4 Bioelectronics

4.4.1 (Similar) Technology addressed by…

4.4.1.1 EGE

For the use of "ICT implants in the human body", please refer to our remarks in section 3.1.

As far as medical applications at the 'nano' level are concerned, EGE Opinion No. 21 on Nanomedicine becomes relevant.

As far as modified living beings to be released into the environment are concerned, the EGE Opinion No. 25 on Synthetic Biology may become relevant.

4.4.1.2 NEC

The monitoring of body functions via sensors in the context of care has been addressed by the Austrian Commission on Bioethics in the Opinion on "Assistive Technologies – Ethical Aspects of the Development and Use of Assistive Technologies" (13 July 2009).

4.4.1.3 FP (sub)project

There is only one FP7 research project listed with the keyword "bioelectronics" in the CORDIS data base, and this does not address ethical issues.

There is a close link between nanotechnology and bioelectronics. Therefore, ethical issues might be addressed with FP7-research on nanotechnology (which is not within the scope of the ETICA project).

4.4.2 Core Values and Principles

4.4.2.1 Human Dignity

In case ICT implants in the human body are used, issues of "human dignity" might arise (See section 3).

In contrast to neuroelectronics the use of implants in bioelectronics is not limited and also not focused on the human nervous system and the brain. Therefore, bioelectronics does look less of a danger to the protection of human dignity than neuroelectronics.

4.4.2.2 Freedom

Privacy and data protection: Using biosensors to identify humans might be considered a biometric application and may raise therefore questions about privacy protection. Also, bioelectronic applications may become small-sized and look unsuspicious (e.g., research on 'insect cyborgs' in DARPA project HI-MEMS[36]) while in fact being used for surveillance and spying.

Freedom of Research / Dual use: In the "Ethical Analysis" military applications of bioelectronics are mentioned giving rise to the issue of potential dual use. "Biosensors" are, e. g., part of the research carried out by the US military (Monahan and Wall 2007).

Consumer protection: Bioelectronic applications like electronic noses might be used for the detection of explosives and other dangerous goods for example at airports and may be considered as an alternative for more person-centred and thus more privacy sensitive security applications like body scanners. At the same time they may enable new forms of surveillance.

4.4.2.3 Justice (Equality and Solidarity)

Animal welfare: Research on neuroelectronics as well as on bioelectronics may involve animal experiments,[37] thus giving rise to ethical questions about animal welfare especially with non-medical applications. (See also section 3.4 on "Animal Welfare.")

Environmental protection: The use of bioelectronical applications in non-human living beings may give rise to questions about the impact on the natural environment, which might include aspects of (food) safety and sustainability.

Consumer protection: As already pointed out under "Environmental protection," bioelectronics might give rise to concerns about food safety therefore the issue of consumer protection might also be raised.

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[36] Cf. HI-MEMS web site: http://www.darpa.mil/mto/programs/himems/, last access: November 2, 2010. See also: Drummond, Katie: Pentagon Wants Cyborg Insects to Sniff WMD, Offer Free Wi-Fi (June 17, 2009). Online: http://www.wired.com/dangerroom/2009/06/pentagon-wants-cyborg-insects-to-sniff-wmd-offer-wi-fi/, last access: November 2, 2010.

[37] CONTECS, Deliverable 3.1 Part A, p. 88. – Online: http://www.contecs.fraunhofer.de/images/files/contecs_report_complete.pdf, last access: August 8, 2010.

Health: As stated in the "Description of Work" bioelectronical applications like "e-NOSE" are aiming "to determine the physiological status of shock and trauma patients by monitoring their breath for volatile organic compounds" (p. 2). Other potential healthcare applications are mentioned in the description as well (Point-of-care diagnostics etc.).

4.4.2.4 Principle of Proportionality

Surveillance and security applications might call for the application of the Principle of Proportionality.

4.4.2.5 Precautionary Principle

In case of serious environmental and/or food safety issues the "Precautionary Principle" should be applied.

4.4.2.6 Principle of Transparency

Bioelectronics should be subject to public monitoring especially in case of security and surveillance applications and of the release of modified living beings into the environment.

The potential (bi-directional) dual use of bioelectronics calls for paying attention to the funding and future use of R&D in the field.

4.4.3 Value Conflicts

Bioelectronics might contribute to the promotion of health and human well-being by enabling point-of-care diagnostics etc., but it may also raise concerns given its potential impact on the environment and food safety.

Bioelectronics solutions might be used to maintain and provide security, but may also enable new forms of surveillance.

4.4.4 Overview of ethical issues

Ethical Issues already discernable	Description	How have these been recognised?
Human Dignity	If ICT implants in the human body are used, issues of "human dignity" might arise.	EU documents
Privacy and data protection	Using biosensors to identify humans might be considered as a kind of biometric applications. Bioelectronic applications may become small-sized ('insect cyborgs' used for surveillance and spying).	Other (DARPA Research)
Dual use	Military applications of	Academic publications

	bioelectronics are mentioned giving rise to the issue of potential dual use.	
Consumer protection	Bioelectronic applications like electronic noses might be used for the detection of explosives and other dangerous goods.	Academic publications
Animal Welfare	Research on bioelectronics may involve animal experiments.	FP Research
Environmental protection	The use of bioelectronical applications in non-human living beings may give rise to questions about the impact of the natural environment, which might include aspects of (food) safety and sustainability.	Our point.
Consumer protection	Bioelectronics might give rise to questions about food safety and therefore of consumer protection.	Others
Health	Bioelectronics might enable new forms of monitoring body function.	Academic publication
Principle of Proportionality	Surveillance and security applications might call for the application of the Principle of Proportionality, especially if implants are concerned.	Our point.
Principle of Transparency	Bioelectronics should be subject to public monitoring especially in case of security and surveillance applications and the release of modified living beings in the environment.	Our point.
Likelihood of Ethical Issues	□ Very High / X High / □ Medium / □ Low / □ Very Low	

4.5 Cloud Computing

4.5.1 (Similar) Technology addressed by…

4.5.1.1 EGE

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4.5.1.2 NEC

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4.5.1.3 FP (sub)projects

Overall, there is little research on the topic of "Cloud Computing" founded within the FP7 programme, much less related to ethical questions.

However, the European Commission has published a "call for tenders" on "the cloud — understanding the security, privacy and trust challenges" in 2009.[38] Also, in the "Future of Cloud Computing"-Report (Jeffery, Neidecker & Schutzert 2010) several ethical issues are dealt with, but are not addressed as such.

Reservoir (Resources and Services Virtualization without Barriers, FP7)

In the "Expert Position Papers" published by the Reservoir-project security and privacy issues are mentioned.[39] Yet, the project itself does not include any subproject on ethical issues.

4.5.2 Core Values and Principles

4.5.2.1 Human Dignity

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4.5.2.2 Freedom

Autonomy and Control: As stated in the "Ethical Analysis" customers and users of cloud computer services "relinquish control over computation and data … [to a large extent]." At the level of the individual this might undermine the autonomy of the individual user, but there is also the more general issue of who has the control over the data. Hence, Cloud Computing means a severe political challenge in addressing the possible power relationships between public or private providers of Cloud Computing services and the individuals and organisations, including state institutions,

[38] http://cordis.europa.eu/fp7/dc/index.cfm?fuseaction=UserSite.FP7DetailsCallPage&call_id=219, last access: November 6, 2010.

[39] Reservoir project: Expert Position Papers, http://62.149.240.97/index.php?page=expert-position-papers, last access: November 6, 2010.

based on the ownership and control of the 'clouds' and not only the ownership of the data, as stressed in the "Ethical Analysis".[40]

Monopoly & Lock-In: As mentioned in the "Ethical Analysis" there is the possibility that only a handful of Cloud Computing providers will exist, which comes with the risk of unwanted dependency on the side of the users. We have to underline the strong mismatch between providers and individual users, including the opportunity to blackmail individuals, organisations, and even states once they depend on one or only a few providers.

Surveillance and Privacy: Cloud Computing might provide agencies and companies with almost unlimited capacity to store and process data (e.g. needed for video data) and thus might become a key element in future surveillance systems. The issues described under "Autonomy and Control" (see above) address questions regarding privacy (Cavoukian 2008).

4.5.2.3 Justice (Equality and Solidarity)

Inclusion: Since Cloud Computing enables users to access information and services without the need to use expensive hardware, cloud computing might empower poor people especially in rural areas and in developing countries.[41] Also, the costs for software and maintenance might be lower for the individual user.

Environmental Protection / Green-IT: In some articles and reports on Cloud Computing a connection to the idea of "green IT" is made, since Cloud Computing may help to reduce the individual user's need for hardware and energy while being more efficient due to the scalability of the systems.[42]

4.5.2.4 Principle of Proportionality

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4.5.2.5 Precautionary Principle

In the "Ethical Analysis" it is suggested to invoke the precautionary principle because "due [to] a [deperimeterization] of organizations ethics of consequences no longer satisfies 'as consequences may not be foreseeable, their desirability may not be unambiguously assessable, and they cannot be directly ascribed to actions of a single person or a single organisation.'(Pieters 2009, p.13)."

This seems to be a rather strong claim and does not reflect the "precaution" requested to invoke the "precautionary principle" within the European institutions, *where foreseeable negative grave consequences* are the requirement. Hence, it is not enough to point to "consequences [that] may not be foreseeable". At present the amount of data and processing being provided via Cloud Computing is not substantial enough to be considered a severe risk in case of damage or loss. While one may imagine a

[40] These aspects are closely linked with the issues described in the section "2.3 Justice" of the "Ethical Analysis" under the topic of "Monopoly & Lock-In": because people may have only a limited choice over the cloud providers once they have stored their data in one particular cloud.

[41] For a similar argument about 'artificial agents' cf. Nagenborg 2007.

[42] Jeffery, Neidecker & Schutzert (2010), p. 41

situation where societies become strongly dependent on Cloud Computing applications, this will be the product of a process of growing acceptance and use which will take time and hence does offer other means of intervention. Here we want to point to the political dimension of the shift towards Cloud Computing mentioned in our section on "Autonomy and Control" (above).

4.5.2.6 Principle of Transparency

Several of the issues mentioned in the "Ethical Analysis" are related to (in-) transparency, which is no big surprise, because one of the characteristics of Cloud Computing is that one has to worry no longer where the data is stored and processed. Hence, questions of control, liability, responsibility, and privacy arise (see above).

Privacy issues in Cloud Computing might also be understood as the result of unwanted transparency of the data to the providers of such services. Therefore, the issue of trustworthiness becomes central with Cloud Computing as well, and this again may be understood as a question of (in-)transparency concerning who has access to the data etc. while not being able to identify the relevant actors.[43]

4.5.3 Value Conflicts

While Cloud Computing can be considered to promote inclusiveness and might be considered as a "green technology", it gives rise to questions about autonomy and control and may be considered in conflict with the principle of transparency.

4.5.4 Overview of ethical issues

Ethical Issues already discernable	Description	How have these been recognised?
Autonomy and Control	At the level of the individual this might undermine the autonomy of the individual user, but there is also the more general issue of who has the control over the data.	Academic publications Others (Canadian Information Officer)
Surveillance and Privacy	Cloud Computing might provide agencies and companies with almost unlimited capacity to store and process data. Issues of control about 'clouds' and data point to privacy issues as well.	Academic publications Others (Expert Report)
Inclusion	Since Cloud Computing enables	Academic publications

[43] In the "Future of Cloud Computing"-Report (2010) one of the main recommendations is: "Recommendation 1: The EC should stimulate research and technological development in the area of Cloud Computing … [5] (5) trust, security and privacy." (Jeffery, Neidecker & Schutzert 2010, p. 3)

	users to access information and services without the need to use expensive hardware, Cloud Computing might empower poor people especially in rural areas and in developing countries.	
Environmental Protection / Green-IT	Cloud Computing may help to reduce the individual user's need for hardware and energy while being more efficient due to the scalability of the systems.	Others (Expert-Report, magazines)
Principle of Transparency	Several of the issues mentioned in the "Ethical Analysis" are related to (in-)transparency, which is no big surprise, because one of the characteristics of "Cloud Computing" is that one has to worry no longer where the data is stored and processed.	Academic publications Others (Expert Report)
Likelihood of Ethical Issues	□ Very High / □ High / X Medium / □ Low / □ Very Low	

4.6 Future Internet

4.6.1 (Similar) Technology addressed

4.6.1.1 EGE

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4.6.1.2 NEC

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4.6.1.3 FP (sub)projects

The European Future Internet Assembly (FIA)[44]

Under the umbrella of FIA, researchers of 95+ projects are jointly working on technical and non-technical issues. FIA counts today 98 EU funded projects with a total research investment of more than 600 million Euros. [45]

[44] http://ec.europa.eu/information_society/activities/foi/research/fia/index_en.htm, last access: September 18, 2010.

[45] http://ec.europa.eu/information_society/activities/foi/research/fiaprojects/index_en.htm, last access: September 2, 2010.

FIA is promising to address "long term societal trends of future 'online societies'", which includes ethical issues. The following projects, which are part of the FIA, might be mentioned for addressing such issues:

EIFFEL (Evolved Internet Future for European Leadership, Support Action for FP7)[46]

According to the web site of the project:

> *The EIFFEL think tank was established in July 2006 as a group of individual researchers, upon an initiative of the EC DG Information Society, with the intention to address questions as to the how such an ambitious goal as defining the Future Internet can be achieved within the context of pan-European and global research.*

EIFFEL also addresses societal issues (including privacy), e.g. in a white paper named "Starting the Discussion."[47]

PrimeLife (FP7)[48]

According to the web site of the project:

> *PrimeLife will address the core privacy and trust issues pertaining to the aforementioned challenges. Its long-term vision is to counter the trend to life-long personal data trails without compromising on functionality. It will build upon and expand the FP6 project Prime that has shown how privacy technologies can enable citizens to execute their legal rights to control personal information in on-line transactions.*

While the FIA does demonstrate some interest in social and ethical issues, no specific ethics project could be identified.

IOT-I (Internet of Things Initiative, FP7)[49]

One tangible outcome is being described as: "a converged reference model for IoT aligned with other areas of the *Future Internet*, synthesized technology roadmaps identifying longer-term research priorities, strategic application agendas and legal, ethical and socio-economic recommendations for the IoT."[50]

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[46] http://www.fp7-eiffel.eu/, last access: September 18, 2010.

[47] EIFFEL Report: Starting the Discussion. Final Version (July 13, 2009). – Online: http://www.fp7-eiffel.eu/fileadmin/docs/Report_TT2008.pdf, last access: September 18, 2010.

[48] http://www.primelife.eu/, last access: September 18, 2010.

[49] http://www.iot-i.eu/, last access: September 18, 2010.

[50] http://cordis.europa.eu/fetch?CALLER=PROJ_ICT&ACTION=D&DOC=46&CAT=PROJ&QUERY=012ad3941376:6b10:5e01b409&RCN=95102, last access: September 2, 2010

No ethical issues are explicitly dealt with in the following EU Projects on the Internet of things: ASPIRE, COIN, CASAGRAS, CuteLoop, iSurfm SemSorGrid4Env. All of these projects are also members of FIA.[51]

GRIFS (Global RFID Interoperability Forum for Standards, FP7)

Within the GRIFS project technological standards "related to privacy and security issues affecting RFID use, regulatory and otherwise"[52] are addressed, which are becoming more significant as "we move on from localised RFID applications towards the 'Internet of Things'".[53]

IFMP (Interoperable Fare Management Project, FP7)[54]

According to its web site the project aims to make access to public transport networks more user-friendly by facilitating their accessibility.

The project includes a privacy model (WP 2 of the project), that aims at building a set of common rules proposed to all European countries as an appropriate compromise between information needed for an appropriate services management and customers privacy protection, involving transport operators against undue dissemination of personal data. Part of D.2.1 is an analysis of privacy protection regulations and organisation in European countries.[55]

ÆGIS (Open Accessibility Everywhere: Groundwork, Infrastructures, Standards, FP7)[56]

"The ÆGIS project seeks to determine whether 3rd generation access techniques will provide a more accessible, more exploitable and deeply embeddable approach in mainstream ICT (desktop, rich Internet and mobile applications). This approach is developed and explored with the Open Accessibility Framework (OAF) through which aspects of the design, development and deployment of accessible mainstream ICT are addressed."[57]

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[51] http://ec.europa.eu/information_society/activities/foi/research/fiaprojects/index_en.htm, last access: November 19, 2010

[52] http://www.grifs-project.eu/data/File/GRIFSbrochurefinal.pdf, last access: October 17, 2010.

[53] Idb.

[54] http://www.ifm-project.eu/, last accessed: November 5, 2010.

[55] http://www.ifm-project.eu/fileadmin/Deliverables/IFM_project_D2.1_200903.pdf, last accessed: November 5, 2010.

[56] http://www.aegis-project.eu/, last accessed: November 5, 2010.

[57] D.5.6.1 (Project Presentation,) of the ÆGIS project, p.7. Online: http://www.aegis-project.eu/images/docs/accessible/AEGIS_D5.6.1-final_update.pdf, last accessed: November 5, 2010.

The project includes a Work Package on "Ethical and Gender Issues" and has published the "ÆGIS Ethics Manual."[58] In this manual the following "core ethical issues" are identified: Privacy protection and confidentiality, Informed Consent, Transparency, IT-Security and identity management, Risk Assessment (insurance for participants) and Incentives (financial inducements, etc.)." (Ibid., p. 6)

4.6.2 Core Values and Principles

4.6.2.1 Human Dignity

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4.6.2.2 Freedom

Privacy and Security: As argued in the "Ethical Analysis" "With distinctive features of pervasiveness and ubiquity, FI raises the all-important questions of privacy and security. It is undoubted that FI will see the rise of computer integration in everyday life which in turn will increase the fear of privacy infringements." Blurring the boundaries between the public and the private might increase security and privacy infringements turning the positive effects of Future Internet into the opposite.

The ITU report "Internet of Things" (2005) quoted in the "Description of Technology" on future internet mentions as "critical issues" informed consent, data confidentiality and security. It stresses that "protecting privacy must not be limited to technical solutions, but encompass, market-based and socio-ethical considerations."

Surveillance and Informed Consent: Similar to Ambient Intelligence and Cloud Computing, surveillance will be a major issue as underlined in the "Ethical Analysis". This is the reason why surveillance products within the framework of Future Internet should address the issue of explicit consent. New means of privacy protection such as encryption techniques might offer solutions to some of these issues.

Trust: Trust will become a major issue as a corollary of blurring the boundaries between public and private spaces. As rightly stated in the "Ethical Analysis" "users would feel a sense of unease because they do not know what information they actually share with whom triggering the question of trust."

Acceptance: It is an open question how far the whole of the population or some groups will be willing to accept and/or resist to this technology. This might lead to social and cultural conflicts as well as into new societal divisions as pointed out in the "Ethical Analysis"

4.6.2.3 Justice (Equality and Solidarity)

Digital Divide: As stated in the "Ethical Analysis" it is foreseeable that the present digital divide particularly in developing countries but also inside information-rich societies will increase.

[58] http://www.aegis-project.eu/images/docs/accessible/AEGIS_D5.6.1-final_update.pdf, last access: November 5, 2010.

The elimination of the digital divide is addressed in "The BLED Declaration. Towards a European Approach to the Future Internet":[59]

> *EU member states have already committed, through the renewed Lisbon Agenda and the i2010 initiative, 9.1 billion of funding, as part of a public-private partnership, for ICT research over the duration of FP7. However, we must ensure that, within this, continuous and long term* ***SUPPORT*** *is given to the design of the Future Internet as a key element of the future networked society. It is of strategic importance for Europe to fully engage in the conception, development and innovation of a Future Internet ensuring the long term growth of the ICT sector, full support to an ICT based economy, and the elimination of the digital divide for all citizens.*

The work of the *COMEIN* project can be seen as an interesting "future internet style" approach to promote social inclusion.[60]

Openness: FI supports open access to networks leading to a rich dialogue among cultures and societies but it might also lead people to intolerant attitudes concerning for instance content issues. As stated in the "Ethical Analysis" "it and may even accelerate fragmentation and reinforce prejudice which may enhance possibilities for conflicts."

Intellectual Property Rights: Whether Future Internet will increase or not the present problems related with IPR is an open question. As stated in the "Ethical Analysis" the debate concerns on how to keep the current openness and multi-device tendencies of the internet without further infringement in IPR. We believe that solutions to this question do not belong in the hands of designers of FI alone.

Energy: We agree with the "Ethical Analysis" on the issue that "Even though the internet helps in many ways to reduce the carbon footprint for example in reducing need for travelling and optimising business processes, it consumes a lot of energy and take a very material form in data centres and all different kinds of appliances that re-used for going online." Ecological issues of new technologies are seldom considered under an ethical or "ecoethical" aspect.

4.6.2.4 Principle of Proportionality

Surveillance and security applications might call for the application of the Principle of Proportionality.

4.6.2.5 Precautionary Principle

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[59] http://ec.europa.eu/information_society/activities/foi/library/docs/153-08_foi_manifesto.pdf, last access: November 5, 2010.

[60] *Online mobile communities to facilitate the social inclusion of young marginalized people* (COMEIN, FP7). – Web site: http://www.comein-project.eu/, last access: September 18, 2010.

4.6.2.6 Principle of Transparency

Among the important ethical issues that will emerge, Interned fraud together with issues of security of digital black boxes will increase as stated in the "Ethical Analysis" as well as in the "Description of Technology".

4.6.3 Value Conflicts

Privacy and Security: the pervasiveness of Future Internet might increase the freedom in society due to open and general connectivity but it will also raise major issues of privacy infringements and surveillance.

Future Internet is expected to foster equality and solidarity while at the same time it might result in the misuse of data by underlining the value of freedom over privacy issues.

Security and confidentiality issues might conflict with the storage or large amount of data and their use for different societal purposes, positive and negative or even criminal ones.

There is a value conflict between the openness of the internet and new threats to Intellectual Property Rights (IPR) arising from FI.

4.6.4 Overview of ethical issues

Ethical Issues already discernable	Description	How have these been recognised?
Privacy and Security	The pervasiveness of Future Internet might increase the freedom in society due to open and general connectivity but it will also raise major issues of privacy infringements and surveillance.	EU / National documents FP Research Academic publications
Digital Divide	Future Internet might foster equality by increasing the digital divide within a society as well as with other societies	EU / National documents FP Research Academic publications
Security and Confidentiality	FI might foster equality and solidarity while at the same time it might result in the misuse of data by underlining the value of freedom over privacy issues.	EU / National documents FP Research Academic publications
Ownership (IPR)	There is a value conflict between the openness of the internet and new threats to IPR arising from	EU / National documents FP Research

	FI.	Academic publications
Likelihood of Ethical Issues	X Very High / □ High / X Medium / □ Low / □ Very Low	

4.7 Human-machine symbiosis

4.7.1 (Similar) Technology addressed by…

4.7.1.1 EGE

For the use of ICT Implants in the Human Body, we refer to our remarks in section 3.1.

4.7.1.2 NEC

Neural stimulation devices have been addressed by the Austrian Commission on Bioethics' Opinion on "Assistive Technologies – Ethical Aspects of the Development and Use of Assistive Technologies" (July 13, 2009).

4.7.1.3 FP (sub)project

Ethicbots (Emerging Technoethics of Human Interaction with Communication, Bionic and Robotic Systems, FP 6)[61]

According to the ETHICBOTS web site, the project coordinated "a multidisciplinary group of researchers into artificial intelligence, robotics, anthropology, moral philosophy, philosophy of science, psychology, and cognitive science, with the common purpose of identifying and analyzing techno-ethical issues concerning the integration of human beings and artificial (software/hardware) entities."[62]

The project analysed three kinds of integration:

(a) Human-softbot integration, as achieved by AI research on information and communication technologies;

(b) Human-robot, non-invasive integration, as achieved by robotic research on autonomous systems inhabiting human environments;

(c) Physical, invasive integration, as achieved by bionic research.

Human-machine symbiosis was specifically addressed, e.g. in "D 5 Techno-Ethical Case-Studies in Robotics, Bionics, and Related AI Agent Technologies."[63]

[61] http://ethicbots.na.infn.it/index.php, last access: September 2, 2010.

[62] http://ethicbots.na.infn.it/index.php, last access: September 2, 2010.

[63] http://ethicbots.na.infn.it/restricted/doc/D5.pdf, last access: November 5, 2010.

4.7.2 Core Values and Principles

4.7.2.1 Human Dignity

In the "Ethical Analysis" it is argued that "(unrestricted) human enhancement may involve suffering of the concept of human dignity and what it means to be human (Lin 2008; Sandberg 2009)." It is not sufficiently clear what "unrestricted" exactly means, that is to say, what kinds of restrictions, particularly legal ones, are envisaged here.

It is also argued that the desire for enhancement "may lead to ingratitude for what we have and (further) enable an attitude of unquenchable dissatisfaction with one's life."(Sandberg 2009). We think that in some cases it might also be the opposite if the enhancement allows a better individual and/or social life without becoming a threat for others.

The "Ethical Analysis" points out that "discontent may be part of human genetics constantly fuelling our striving to achieve and gain more. People will remain dissatisfied no matter how much we enhance ourselves (Allhoff 2009)." We believe that this is not a very convincing argument since it sounds as if the genes were and should remain masters of our lives.

We believe that the main issue arising from HM symbiosis with regard to human dignity concerns the instrumental view that considers humans as a kind of device or machine to be 'enhanced' being thus viewed "just" as a means and not as an "end in itself" (I. Kant).

This attitude might even be extended to humanity as a whole leading to science fiction dystopian visions of overcoming humanity or degrading it (or the un-enhanced parts of it) into a lower-level (sub-)species. This issue is also addressed in the "Ethical Analysis" on "how these super-humans will treat humans that aren't enhanced? Looking at how humans have treated less intelligent creatures than themselves such as chimpanzees makes a gloomy precedent (Cerqui 2008). Furthermore, it is unlikely that unenhanced humans "fancy the idea of taking up a sub-species role." (Cerqui 2008) So, should the freedom of the individual to choose their own destiny be paramount to the protection of the human species as it is, or to the interests of those who, voluntarily or involuntarily, aren't enhanced? "

But, on the other hand, enhancements might help humans to lead a better life, alleviating suffering and serving society no less than individuals.

4.7.2.2 Freedom

Risk and Responsibility: We agree with the "Ethical Analysis" that "For all forms of enhancement risk is a major concern, both from enhancement itself and its effects. Using internal devices (implants) for human enhancement may involve both short term risks, associated with surgery such as infections and bleeding and long term risks such as immune reactions (McGee, 2008)."

Risk assessment should include individuals as well as society as a whole. It should encompass conflicting risks coming from other technologies as well as public acceptance.

Identity and Personality: As stated in the "Ethical Analysis", "[c]onnecting technology with the human nervous system may not only affect the nature of the individual, it may also affect the meaning 'I' and 'self'."

Autonomy and Freedom of Choice: As argued in the "Ethical Analysis" "human enhancement might cause both an increase and a decrease in autonomy of its users." It might increase individual control and quality of his or her actions but it might also increase the dependency on it by "users getting emotionally attached to the enhancement (Warwick, 2003). After some time a piece of enhancement technology is experienced as part of the body or the self. This attachment will make it difficult for the user to stop using enhancement temporarily or permanently."

Special Groups

Soldiers: Regarding the enhancement of soldiers in the "Ethical Analysis" when it is argued that: "In some cases there may be an obligation or at least a strong argument to enhance. In the military for instance creating cyber-soldiers could facilitate warfare, but forestall the liberty of personnel" we have doubts about the soundness of this argument since it depends on who eventually are the victims of the cyber-soldiers. But military applications not being part of FP7 issues we will not discuss further this issue

Prisoners: The "Ethical Analysis" states that "given that prisoners have forfeited some of their rights, it might be allowed to use enhancements to reduce costs or increase public safety (Allhoff, 2009)." This might not hold true from the perspective of the "Ethics of the European Institutions." As pointed out in section 1.3 this might be regarded as a serious human dignity issue.

Children: In the "Ethical Analysis" it is stated: "As consent by children is legally and morally problematic, parents are largely responsible for the decision to enhance their children, limited however by health and safety concerns related to the child (Allhoff, 2009)." This raises further questions such as whether children will agree later with the enhancement as well as that of the distinction between medical and non-medical applications of enhancements. We consider enhancements of children as contrary to human dignity.

Privacy: We agree with the following description in the "Ethical Analysis" concerning potential threats to privacy due to enhancements: "Enhancement technologies allow for real-time monitoring, not only of biometrics (Bawa, 2008), but also of our thoughts, goals, mood and motivation (McGee, 2008; Marturano, 2004). As this intimate, personal data becomes part of ICT systems, possibilities for breaches of privacy increase accordingly. Interception by third parties for instance might lead to unwanted use of private information (Bawa, 2008)."

4.7.2.3 Justice (Equality and Solidarity)

Equality and Fairness: As stated in the "Ethical Analysis" "access to enhancement might only be available for the wealthy (Steinberg, 2008) creating a situation of social inequality." It would create an "enhancement divide" similar to the digital divide. Existing inequalities might increase. On the other hand, as also argued in the "Ethical Analysis," enhancements might increase diversity in society and help people to reduce existing inequalities as well as giving more choices for a better life. In other words, there is a basic ethical ambivalence regarding enhancements that does not allow simplistic evaluations, particularly ethical ones. We believe that a broad societal

dialogue is needed as well as a case-by-case discussion if the issue at stake is particularly ambivalent

Social disruptions and institutional problems: Enhancements might lead to situations of extreme inequality and therefore to social disruptions and institutional problems as stated in the "Ethical Analysis": "In an extreme case inequality might 'motivate the worse-off masses to revolt against a state or system.' (Steinberg, 2009)"

4.7.2.4 Principle of Proportionality

Particularly non-medical applications should be considered by taking into consideration the Principle of Proportionality.

4.7.2.5 Precautionary Principle

Needs to be addressed both in case of medical and non-medical enhancements due to the broad social impact of HM Symbiosis applications

4.7.2.6 Principle of Transparency

As stated in the "Ethical Analysis": "liability and responsibility issues are raised as human enhancement involves short and long term risks" and are related to the ambivalent individual and social impact of HM Symbiosis particularly when affecting the person's identity and autonomy but also unforeseeable social effects.

4.7.3 Value Conflicts

Human dignity might be in conflict with enhancements particularly concerning the transformation of the individual into a mere "means" to be used for different goals, losing its humanness.

Conceptions of justice and good life might be conflict with individual choices and preferences. This might lead to social and institutional conflicts and exacerbate (but also diminish) different kinds of societal and individual inequalities

4.7.4 Overview of ethical issues

Ethical Issues already discernable	Description	How have these been recognised?
Human Dignity	Human dignity might be in conflict with enhancements particularly concerning the transformation of the individual into a mere "means" to be used for different goals, losing its humanness	EU / National documents FP Research Academic publications Others
Justice	Conceptions of justice and good life might be conflict with individual choices and preferences. This might lead to	EU / National documents FP Research Academic publications

	social and institutional conflicts and exacerbate (but also diminish) different kinds of societal and individual inequalities.	Others
Likelihood of Ethical Issues	X Very High / □ High / □ Medium / □ Low / □ Very Low	

4.8 Neuroelectronics

4.8.1 (Similar) Technology addressed by…

4.8.1.1 EGE

Brain Computer Interfaces (BCIs) have been addressed in Opinion 20 on "ICT implants in the Human Body". Please refer to the remarks on ICT implants and human dignity in section 3.1.

4.8.1.2 NEC

Neural stimulation devices have been addressed by the Austrian Commission on Bioethics' Opinion on "Assistive Technologies – Ethical Aspects of the Development and Use of Assistive Technologies" (2009).

4.8.1.3 FP (sub)project

Ethicbots (Emerging Technoethics of Human Interaction with Communication, Bionic and Robotic Systems, FP6)

BCIs have been addressed within the ETHICBOTS project. – See: Evaluation of "Human-machine symbiosis."

CONTECS (Converging Technologies and their impact on the Social Sciences and Humanities, FP6)[64]

BCIs as well as neuromarketing have been addressed as ethical issues within the CONTECS project.

neuGRID (A Grid-based e-infrastructure for data archiving, communication and computationally intensive applications in the medical sciences, FP7)[65]

According to the project's web site "neuGRID aims to become the "Google for Brain Imaging", providing a centrally-managed, easy-to-use set of tools with which scientists can perform analyses and collaborate."[66]

[64] http://www.contecs.fraunhofer.de/content/view/2/3/, last access: November 5, 2010.

[65] http://www.neugrid.eu/pagine/home.php, last access: November 5, 2010.

In D.2.2 (Rules for Commercial Exploitation of Data, 2008, p. 8) it is said:

"We have proposed an ethical guideline to control potential exploitation of clinical data and images. The suggested guideline for commercial exploitation is set up in the ethical and legal European framework and covers three areas: clinical data/images; services and research results."[67]

4.8.2 Core Values and Principles

4.8.2.1 Human Dignity

For implants based BCIs please refer to our remarks in section 3.1.

The concerns about preserving human dignity are mostly based on the respect of the integrity of the person's body as well as the person's autonomy (see below). Concerns about bodily integrity are less likely to arise with non-invasive applications of neuroelectronics, which still might be considered as a threat to human autonomy.

In contrast to the possible use of ICT implants in AmI (see above) or in bioelectronics, neuroelectronical applications might raise greater ethical concerns since neuroelectronics aims to provide a direct link between computer technology and the human brain as well as the nervous system in general. Especially the use of pre-conscious brain information processing has to be seen as being in conflict with the protection of human dignity as highlighted in the "Ethical Analysis".

It has to be recognised, that (medical applications of) neuroelectronics might also contribute to the welfare of human life and therefore foster human dignity.

4.8.2.2 Freedom

Autonomy: One of the main concerns is that neuroelectronical applications might even more strongly undermine a person's autonomy than other forms of ICT because of the direct link to the human brain and nervous system. These concerns might especially apply to BCI-input devices, that is to say, interfaces that allow giving input into the human nervous system. This is for instance the case with cochlear or optic-nerve implants. However, these "systems could allow people to use signals directly from the brain for communication and control of movement." (EGE Opinion 20, p. 11) Again, non-medical applications might give rise to greater concerns than medical applications.[68]

Neuroimaging technologies employed as tools for neuromarketing might also be considered a potential threat to autonomy if they allow new forms of manipulation, as stated in the "Ethical Analysis."

Privacy and data protection: While neuroimaging should not be confused with "mind reading", the process of neuroimaging still is considered as a major privacy issue. As

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[66] http://www.neugrid.eu/pagine/overview.php, last access: November 5, 2010.

[67] http://www.neugrid.eu/download/deliverables/D2.2Rules_for_commercial_exploitation.pdf, last access: November 5, 2010.

[68] Although, BCI-input devices have not been mentioned in the "Ethical Analysis", Tamburrini (2009) has pointed out that they might become helpful to provide sensory feedback for people using artificial limbs etc.

stated in the "Ethical analysis": "Information about brain process is particularly personal and private, since they may indicate – or even represent – thoughts." While there are good reasons for questioning the methods and not overestimating the results, given potential applications of neuroimaging in marketing strategies (see above) and criminal investigations, such as security and surveillance applications ("pre-crime detection"), (mental) privacy issues still will have to be taken seriously. – This also holds true for BCIs allowing access to information about brain processes.

Informed consent: As stated in the "Ethical Analysis" neuroelectronical applications challenge our basic understanding of "informed consent" at several levels: There is little knowledge about the outcome, hence one does not know to what one is consenting. BCIs also involves risky treatments to humans, hence there is a strong need to obtain an informed consent, which might be difficult from persons with mental illness.

Freedom of research / Dual Use: Like in the field of Bioelectronics, military research in the area of neuroelectronics is well-known.[69] Therefore, issues of dual use are likely to arise.

4.8.2.3 Justice (Equality and Solidarity)

Consumer Protection: BCIs especially raise major safety concerns, but there might also be a need to provide consumers with protection from certain forms of neuromarketing strategies. Following Tamburrini (2009) one may also argue for a special protection for children with regard to entertainment applications of neuroelectronics.

Improvement and protection of health: Neuroelectronics are already used to restore, replace or at least augment functions of the human body. Future applications might extend the use of these kinds of technologies for treatment and assistance. However, one has to be aware of the ethical issues of deep brain stimulation etc.[70]

Equal access to health care and education: BCIs may exacerbate inequities in a society, if no fair access to BCIs can be ensured. As stated in Opinion 20 of the EGE: "There should be fair access to ICT implants for health purposes. This means that such access should be based on health care needs rather than on economic resources or social position." (Opinion 20, p. 32)

Contrary to what is stated in the "Ethical Analysis" (quoting Berger *et al.* 2008) we see no danger of splitting up humanity into different sub-species (in the strict sense of the word) due to the fact that neuroelectronics does not make any changes at the genetic level. Hence, the use of BCIs by one person does not have any direct impact on their offspring.

The concern of an unjust allocation of resources is also raised with regard to neuroimaging in the "Ethical Analysis".

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[69] E.g., DARPA's Revolutionizing Prosthetics programme. See: http://www.darpa.mil/dso/thrusts/bio/restbio_tech/revprost/index.htm, last access: November 5, 2010.

[70] See, e. g., the forthcoming special issue on "Ethical Aspects of Deep Brain Stimulation" of Neuroethics, Vol. 4 (2011), No. 1.

Ownership: Neuroimaging may give rise to questions about the "ownership" of the data acquired.

Animal welfare: Research on neuroelectronics as well as on bioelectronics may involve animal experiments, thus giving rise to ethical questions about animal welfare especially with non-medical applications.[71]

We want to point out that in the "Description of Technology" and in the "Ethical Analysis" neuroelectronics is defined as "the discipline that deals with the interface between the human nervous systems and electronic devices." But, obviously, neuroelectronics might be extended to the interface between electronic devices and non-human nervous systems as well. (See also: Section 3.4 on "Animal Welfare")

4.8.2.4 Principle of Proportionality

In general, the use of neuroelectronics should be guided by the principle of proportionality, given the safety risks involved as well as the privacy and autonomy issues identified so far.

For the use of implants as BCIs, especially in the context of surveillance and security applications, please refer to our remarks in sections 3.1 and 3.2.

4.8.2.5 Precautionary Principle

Neuroelectronics may invoke the precautionary principle because of the potential harm associated with the technology, which includes behaviour control at the individual (safety risks, privacy issues, 'remote control' via BMIs) and the collective levels (neuromarketing, pre-cime). Neuroelectronics may also have a severe effect not only on the personality of persons, but also – particularly in the case of BCIs - on the nervous system as such.

4.8.2.6 Principle of Transparency

As in the case of bioelectronics, neuroelectronics should be subject to public monitoring especially with regard to security and surveillance applications as well as to the release of modified living beings into the environment.

The potential (bi-directional) dual use of neuroelectronics calls for paying attention to the funding and future use of R&D in the field.

4.8.3 Value Conflicts

Neuroelectronics might be used to restore, replace or at least augment functions of the human body and therefore might be used as an assistive or enabling technology. At the same time they give rise to great concerns about autonomy, privacy,

Neuroelectronics might also be used to provide and maintain security and safety, but does give rise to questions about surveillance and privacy.

4.8.4 Overview of ethical issues

[71] CONTECS, Deliverable 3.1 Part A, p. 88.

Ethical Issues already discernable	Description	How have these been recognised?
Human Dignity	In contrast to the possible use of ICT implants in other fields, neuroelectronical applications might raise greater concerns since neuroelectronics aims to provide a direct link between computer technology and the human brain as well as the nervous system in general.	EU / National documents FP Research Academic publications Others
Autonomy	BCI-input devices "could allow people to use signals directly from the brain for communication and control of movement." (EGE Opinion 20) Non-medical applications might give rise to greater concerns than medical applications.	EU documents FP Research Academic publications
Privacy	Given potential applications of neuroimaging in marketing strategies and criminal investigations etc., (mental) privacy issues will have to be taken seriously.	Academic publications
Informed consent	Neuroelectronical applications challenge our basic understanding of "informed consent" at several levels. Especially, BCIs involve risky treatments to humans.	EU documents FP Research Academic publications
Freedom of research / Dual Use	Like in the field of Bioelectronics, military research in the area of Neuroelectronics is well-known. Therefore, issues of dual use are likely to arise.	Others (our point)
Consumer Protection	Especially BCIs raise major safety concerns, but there might also be a need to provide consumers with protection from certain forms of neuromarketing strategies.	EU documents FP Research Academic publications

Improvement and protection of health	Neuroelectronics are already used to restore, replace or at least augment functions of the human body.	FP Research Academic publications
Equal access to health care and education	BCIs may exacerbate inequities in a society, if no fair access to BCIs can be ensured. The concern of an unjust allocation of resources is also raised with regard to neuroimaging in the "Ethical Analysis".	EU documents FP Research Academic publications
Ownership	Neuroimaging may give rise to questions about the "ownership" of the data acquired.	Academic publications
Animal welfare	Research on neuroelectronics may involve animal experiments,	FP Research
Principle of Proportionality	The use of neuroelectronics should be guided by the principle of proportionality, given the safety risks involved as well as the privacy and autonomy issues identified so far.	EU documents
Precautionary Principle	Neuroelectronics may invoke the precautionary principle because of the potential harm associated with the technology, which includes behaviour control at the individual (safety risks, privacy issues, 'remote control' via BMIs) and the collective levels (neuromarketing, pre-cime).	EU documents Academic publications
Principle of Transparency	Neuroelectronics should be subject to public monitoring especially with regard to security and surveillance applications as well as to the release of modified living beings into the environment. The potential (bi-directional) dual use of neuroelectronics calls for paying attention to the funding and future use of R&D in the field.	Other (our point)

Likelihood of Ethical Issues	X Very High / □ High / □ Medium / □ Low / □ Very Low

4.9 Quantum Computing

4.9.1 (Similar) Technology addressed by…

4.9.1.1 EGE

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4.9.1.2 NEC

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4.9.1.3 FP (sub)project

No specific (sub)project on ethical (or social) issues of Quantum Computing could be identified. The FP7 project

QUIE2T (Quantum Information Entanglement-Enabled Technologies, FP7)

states in its Strategic Report:

> *QIPC [= Quantum Information Processing and Communication] research will have a deep impact on several EU strategic priorities. There is significant potential impact on technology, economics and social issues.*[72]

4.9.2 Core Values and Principles

As it has been stated in the "Ethical Analysis" (with reference to Weckert 2002) Quantum Computing – if it ever comes into existence – "will exacerbate existing issues from other technologies." Therefore, most likely most of the ethical issues mentioned in this evaluation report are lifted to a new level.

Therefore, if there are realistic expectations that Quantum Computing will become a reality within the time span of the ETICA project (10-15 years), Quantum Computing should be ranked very high from the perspective of ethics. Otherwise, it can be ranked as very low.

4.9.2.1 Human Dignity

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4.9.2.2 Freedom

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[72] Quantum Information Processing and Communication: Strategic report on current status, visions and goals for research in Europe, http://qurope.eu/content/37-qipc-wider-scientific-and-technological-context, last access: November 19, 2010.

4.9.2.3 Justice (Equality and Solidarity)

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4.9.2.4 Principle of Proportionality

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4.9.2.5 Precautionary Principle

Depending on the likely progress in the field of Quantum Computing there might be reason to invoke the Precautionary Principle.

4.9.2.6 Principle of Transparency

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4.9.3 Value Conflicts

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4.9.4 Overview of ethical issues

Ethical Issues already discernable	Description	How have these been recognised?
Precautionary Principle	Depending on the likely progress in the field of Quantum Computing there might be reason to invoke the Precautionary Principle.	–
Likelihood of Ethical Issues	□ Very High / □ High / □ Medium / □ Low / X Very Low	

4.10 Robotics

4.10.1 (Similar) Technology addressed by…

4.10.1.1 EGE

Implants in the human body might be used as an interface with robotic systems. For ICT implants in the human body, please refer to section 3.

4.10.1.2 NEC

Robots have been addressed by the Austrian Commission on Bioethics in the Opinion on "Assistive Technologies – Ethical Aspects of the Development and Use of Assistive Technologies" (13 July 2009).

Fazekas *et al.* (2007, p. 39) also note that a research project on "the clinical usefulness of the REHAROB Therapeutic System … for patients with spastic hemiparesis … was approved by … the National Scientific and Research Ethics Committee."

4.10.1.3 FP (sub)project

ETHICBOTS (Emerging Technoethics of Human Interaction with Communication, Bionic and Robotic Systems, FP6)[73]

For a brief description of the project refer to 4.7.1.3 (Human-machine symbiosis). "Robotics" was one of the key subjects. The outcome of the project stimulated an edited volume specifically addressing question of "Ethics & Robotics" (Capurro & Nagenborg 2009).

euRobotics (Coordination Action for Robotics in Europe, FP7)

According to a paper on the project, ethical, legal and societal implications will be addressed.[74] At the first joint EURON/EUROP Annual Meeting" (2010) there was at least one presentation on „Ethical and Social Aspects of Service Robots" by Mick Walters, who focused especially on privacy issues.[75]

LIREC (Living with Robots and Interactive Companions, FP7)[76]

Please refer to the corresponding section 4.1.1.3 (Affective Computing) for a description of the project.

Military applications of Robotics are also addressed by the following project:

The Ethics of Information Warfare: Risks, Rights and Responsibilities (EIW3R, FP7)

A short description of the project is given in the corresponding section on "Artificial Intelligence."

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[73] http://ethicbots.na.infn.it/, last access: August 12, 2010

[74] Rainer Bischoff et al., euRobotics – Shaping the future of European robotics, in: In: ITG, VDMA, IFR, DGR (Hrsg.): ISR/ROBOTIK 2010 Proceedings for the joint conference of ISR 2010 (41st Internationel Symposium on Robotics) und ROBOTIK 2010 (6th German Conference on Robotics), 7-9 June 2010 - Parallel to AUTOMATICA. – Online: http://www.eurobotics-project.eu/cms/upload/Publications/euRobotics_ISR_2010.pdf?, last access: August 12, 2010.

[75] http://www.robotics-platform.eu/cms/upload/News/EUROPEURON_meeting_2010/ELS.zip, last access: August 12, 2010.

[76] http://www.lirec.eu/, last access: November 5, 2010.

4.10.2 Core Values and Principles

4.10.2.1 Human Dignity

The anthropomorphism in robotics might be seen as a challenge to the human centred position typical of the European tradition and thus may be interpreted as a challenge to "human dignity." However, this is more an issue at the theoretical level.

In contrast, the incorporation of robotic technology into the human body (cyborg technology) might be seen as a more serious human dignity issue.

The idea of robot rights is also to be seen as being in contrast to the emphasis given to *human rights* in the European Union.

There is a strong tension with regard to the welfare of human life, since robots might replace humans in certain contexts which might be desirable or not depending on the specific circumstances.

4.10.2.2 Freedom

Autonomy: See the corresponding section in the analysis of "Artificial Intelligence."

Autonomy and dependency: Robotic applications might enable people to live a more self-determined life, e.g. assistive systems might enable elderly people to live longer in their own houses. But people might also become dependent on the functionality of the robotic systems, which includes the dependence on systems providing maintenance to the robots (cf. Opinion on "Assistive Technologies" by the Austrian Commission on Bioethics, p. 33).

Freedom of research: Some R&D activities might raise questions about dual use of the technology, since military applications of robotics are well known (see: EIW3R project). Issues of dual use have also been addressed by the ETHICBOTS project.

Privacy and data protection: Given the sensory input needed and the likely use of online functionalities in robotics, robots are most likely to raise concerns about privacy and data protection when being used in public places as well as in private spaces.

Security and surveillance: Certain types of robots (like unmanned aerial vehicles) might be considered as being helpful to provide and maintain security and safety, but have to been discussed as tools of surveillance as well.

4.10.2.3 Justice (Equality and Solidarity)

Robots in general might give rise to questions of distributive justice and participatory equality, as has been stated by the Austrian Commission of Bioethics in the Opinion on "Assistive Technologies."

Participation: While robots might enable people to participate in communal life by providing assistance for example to persons with disabilities or elderly persons, replacing human care givers by robots might as well decrease the number of contacts with humans creating a less inclusive society. – The replacement of humans by robots in certain contexts might also lead to loss of jobs and thus have impact on the ability to participate in communal life of those who have been replaced.

Equal access to health care: Not all kinds of robots might be affordable to all citizens of the EU member states, thus it's likely that we may face a "robotic divide." Given

the issues described under "autonomy and dependency" and "participation" this might have a severe impact on the quality of life of those who can't afford a robot (or can't afford human assistance).

Consumer protection: Autonomous learning robots might become a special challenge with regard to protecting users ("teachers" or "trainers") as well as other people interacting with a robot, whose likely behaviour will be based on training and thus is unforeseeable for third parties not involved in the training process. (Nagenborg *et al.* 2008)

4.10.2.4 Principle of Proportionality

Security and military application might give rise to serious questions about the proportionality (e. g., the use of unmanned aerial vehicles for urban surveillance).

4.10.2.5 Precautionary Principle

Although the scenario of robots overtaking humankind is quite popular in the science-fiction literature on robotics, this seems to be a very unlikely scenario within the time span addressed in the ETICA project (10-15 years).

The precautionary principle might be invoked in case of military applications of robotics which challenge the traditional conventions of warfare due to size, speed, or potential harm. Similar to what is being said on AI in general (see above) there is a strong need to address issues of potential and likely dual-use of robotic applications even for research within the European Framework Programme. The International Committee for Robot Arms Control (established by academics in 2009)[77] is "calling upon the international community to urgently commence discussions about an arms control regime to reduce the threat posed to humanity by these systems."[78]

4.10.2.6 Principle of Transparency

Similar to what is stated in the corresponding section on AI, the potential (bi-directional) dual use of robotic systems calls for attention to the funding and future use of R&D in the field.

4.10.3 Value Conflicts

(1) Robots may be used to provide better health care and care for certain groups of people (elderly persons etc.) and represent an opportunity for a more inclusive society. At the same time they also give rise to questions about dependency of the users on the systems as well as questions of distributive justice, equal participation, and access to health care. This can be extended to questions of equal chance and fair access to the labour market.

(2) Military applications of robots are well-known cases of ethical concerns. While the funding of military research is not part of the European Framework Programme, this nevertheless gives rise to questions of (bi-directional) dual-use and freedom of

[77] ICRAC was founded in 2009 by Noel Sharkey, Robert Sparrow, Juergen Altmann and Peter Asaro.

[78] http://www.icrac.co.cc/index.html, last access: August 12, 2010.

research. This is even more the case with potential civil security applications, which also need to be addressed under the topic of surveillance.

(3) Autonomy and consumer protection: Autonomous robots might enable people to live a more independent life, but there is also a strong need for consumer protection with regard to learning robots trained by others. The idea of autonomous robots does challenge the question of the responsibility of the producers and designers.

4.10.4 Overview of ethical issues

Ethical Issues already discernable	Description	How have these been recognised?
Human Dignity	Anthropomorphism	FP Research (Ethicbots)
Human Dignity	Incorporation of robotic technology in the human body (Cyborg)	EGE opinion, FP Research (Ethicbots)
Human Dignity	Robot rights in contrast to central documents of the EU, which focus on human dignity and human rights	FP Research (Ethicbots)
Autonomy	Change in the way responsibility is attributed to (human) agents	FP Research (Ethicbots) Academic publications
Autonomy	Dependency on robotic systems (especially in health care)	NC (Austria)
Freedom of research	(Bi-directional) dual use	FP Research (Ethicbots) Others (ICARC)
Privacy and data protection	Need for sensory input; Potential (civil) security applications might raise question about surveillance	FP Research (Ethicbots, euRobotics) Academic publications
Participation	Robots may create a more (or less) inclusive society	FP Research (Ethicbots)
Equal access to health care	Given the issues described under “autonomy and dependency” and “participation” this might have a severe impact on the quality of life of those who can’t afford a robot (or can’t afford human assistance).	FP Research (Ethicbots) Other (NEC Austria)

Consumer protection	Autonomous learning robots might become a special challenge with regard to protecting users (‘teachers’ or ‘trainers’) as well as other people interacting with a robot, whose likely behaviour will be based on the training and thus is unforeseeable for third parties not involved in the training process.	FP Research Academic publications
Principle of Proportionality	Security and military application might give rise to serious questions about the proportionality (e. g., the use of unmanned aerial vehicles for urban surveillance).	FP Research (Ethicbots)
Precautionary Principle	The precautionary principle might be invoked in case of military applications of robotics which challenge the traditional conventions of warfare due to size, speed, or potential harm,	FP Research (Ethicbots) Other (International Committee for Robot Arms Control)
Likelihood of Ethical Issues	X Very High / □ High / □ Medium / □ Low / □ Very Low	

4.11 Virtual / Augmented Reality (VR/AR)

Preliminary note:

The “Ethical Analysis” focuses mostly on “virtual reality”, not “augmented reality”. In contrast we will focus more strongly on Augmented Reality, which may raise more serious concerns.

4.11.1 (Similar) Technology addressed by…

4.11.1.1 EGE

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4.11.1.2 NEC

–

4.11.1.3 FP (sub)project

None of the European research projects in the area of VR/AR includes ethical subprojects.

Legal issues (including privacy) are addressed in

VIRTUALLIFE (Secure, trusted and legally ruled collaboration environment in *virtual life*, FP7)[79]

4.11.2 Core Values and Principles

4.11.2.1 Human Dignity

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4.11.2.2 Freedom

Autonomy: With regard to autonomy especially AR is highly ambivalent. One may argue that "the creation of 'smart' environment using augmentation is synonymous with human enhancement as it gives users more control over the environment they act in. At the same time the concern is raised that users of AR run the risk of being controlled by their environment." (Ethical Analysis) – The blurring of the distinction between of the real and the virtual in AR applications also may allow new forms of manipulation (Ethical Analysis). The use of AR applications as Persuasive Technologies may be one example which gives rise to concerns about the autonomy of the users.

Privacy: Virtual worlds are ideal places for total surveillance, because every action of the users can be tracked (e. g., Hoffstadt and Nagenborg 2009). Every form of simulation of real world places, objects or activities does support the need for information about the object or the person to be simulated. Current AR applications (like Layer[80] or Wikitude[81]) also need structured information about the real world. Future AR applications may enable access to information about persons being identified as well.[82] Eventually, location based AR application do also provide information about the users, again allowing tracking of individuals. Therefore, especially AR applications may give rise to major privacy concerns.

Informed consent: Especially in case information about persons is given in AR, informed consent by the person being identified by the AR system is needed. Informed consent is also needed for the representation of real people and objects in virtual worlds.

Freedom of Arts: While virtual worlds may allow new forms of self-expression both for the designers and the users of the systems, users may become witness to actions in VR they at least find unsuitable, such as "violent content" or "virtual rape", or which are banned by international conventions such as child pornography. In this context, the question of the responsibility of designers for the options given to the users has to be raised. There might also be concerns about restrictions of the freedom of the arts.

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[79] http://www.ict-virtuallife.eu/, last access: September 18, 2010.

[80] http://www.layar.com/, last access: August 12, 2010.

[81] http://www.wikitude.org/, last access: August 12, 2010.

[82] E. g., see „Recognizr" demo at: http://www.tat.se/site/showroom/latest_design.html, last access: August 12, 2010.

4.11.2.3 Justice (Equality and Solidarity)

Social Inclusion / Access to Education: One of the potential benefits of widely available AR applications, especially mobile applications using smart phones or similar devices, is the possibility to provide interactive information for instance at places of historical interests, and therefore to give easy access to educational content, promoting education and social inclusion. VR might be also considered as a possible tool of education allowing a vivid representation of non-accessible places. Of course, this goes hand in hand with the well-known challenge of the digital divide.

(Non-)Discrimination: As stated in the "Ethical Analysis": "… diverse assumptions such as stereotypes in the representation of people, things, and events … may be included in [the] design [of virtual worlds]."

Consumer Protection: Concerns have been raised about violent or pornographic content in virtual worlds, which at least can be considered to be harmful for children and young people. There are also concerns about persons becoming addicted to VR. Therefore questions about the necessity of measuring consumer protection arise, which may include the question the potential harm of VR and AR beyond the potential of traditional media. Consumer protection might also concern the varieties of virtual harm caused for example by the theft or destruction of "virtual goods".

Health and Safety: VR applications might be used for training and education, for instance for those working in the areas of Health and Safety. AR application might support medical personal during surgical procedures ("Ethical analysis") (although, this might also become a safety issue from the viewpoint of the patients). VR and AR also might provide a better understanding of health and safety issues for the general public. Eventually, AR might become helpful in emergency situations to provide, e.g., persons with relevant information about the location, that is to say, to find the next emergency exit or where to locate help in unknown environment. At the same time certain VR applications might also be associated with harmful health effects like 'cyber sickness' or – as mentioned above – 'cyber addiction'.

Respect for human rights: In contrast to other ICTs in this analysis, VR and AR do give rise to many questions regarding human rights issues – which include the right to non-discrimination or the right to bodily integrity, which excludes violence towards people. Location-based, mobile applications of AR also seem to undermine the right to privacy as stated above. – However, most of these concerns are closely linked to the fact that VR and AR are closer to traditional media than other ICTs in this analysis. Most of the issues listed are also relevant in the context of traditional media. Therefore one may argue that VR and AR may have an impact on human rights. This strongly depends on the question whether VR and AR will have more impact than other traditional media. But, of course, VR and AR might also promote respect for human rights depending on the content provided.

4.11.2.4 Principle of Proportionality

In case a certain ICT application may raise questions about the use of personal data as well as the way the information is acquired, the representation and use of this kind of information in (mobile) AR applications may add to the need to question proportionality. For example, in the context of security AR devices might provide access to too much personal data when screening and controlling persons which is

against the principle of data minimization. In this case also, the effect of blurring the distinction between the real and the virtual on the users has to be taken into account.

4.11.2.5 Precautionary Principle

–

4.11.2.6 Principle of Transparency

AR applications might give rise to questions about the validity of the data being used. This is especially the case given the issue of blurring the distinction between of the real and the virtual which may allow new forms of manipulation (see: section on "Autonomy", above).

4.11.3 Value Conflicts

While VR and AR might provide better access to or better quality of education and training, they may also – depending on the content – lower the respect for human rights because of, for instance, the use of discriminating stereotypes.

AR applications might be beneficial to deal with emergency situation and, more generally, they might provide assistance in some contexts, but they can also to be used as a tool for surveillance and control leading to new forms of manipulation.

4.11.4 Overview of ethical issues

Ethical Issues already discernable	Description	How have these been recognised?
Autonomy	Especially AR is highly ambivalent. The blurring of the distinction between of the real and the virtual in AR applications also allows new and persuasive forms of manipulation.	EU / National documents FP Research Academic publications Others
Privacy	Virtual worlds are ideal places for total surveillance. Future AR applications may enable access to information about persons being identified as well. Eventually, location based AR applications also provide information about the users, again allowing tracking of individuals.	Academic publications
Informed consent	Especially in case information about persons is given in AR, informed consent by the person	Academic publications

	being identified by the AR system is needed.	
Freedom of Arts	Users may become witness to actions in VR they at least find unsuitable, such as ‘violent content’ or ‘virtual rape.’ They also may become a victim of such virtual harm.	Academic publications
Social Inclusion / Access to Education	VR/AR might be considered as a possible tool of education.	Academic publications
Discrimination	Stereotypes of people, things, and events may be included in the design of virtual worlds.	Academic publications
Consumer Protection	Concerns have been raised about violent or pornographic content in virtual worlds. There are also concerns about persons becoming addicted to VR.	Academic publications
Health and Safety	VR applications might be used for training and education, for instance for those working in the areas of Health and Safety. AR application might support medical personal during surgical procedures.	Academic publications
Respect for human rights	Like traditional media VR and AR applications give rise to question about the promotion of human rights.	Academic publications
Principle of Proportionality	In the context of security AR devices might provide access to too much personal data when screening and controlling persons	Others (our point)
Principle of Transparency	AR application might give rise to questions about the validity of the data being used.	Other (our point)
Likelihood of Ethical Issues	□ Very High / X High / □ Medium / □ Low / □ Very Low	

5 Ranking of technologies

According to this framework we consider the following technologies as having a "very high" degree of likelihood for becoming an ethical issue as far as they concern or might concern human dignity, namely:

- Ambient Intelligence
- Human-machine symbiosis
- Neuroelectronics
- Robotics

Other technologies such as

- Affective Computing
- Artificial Intelligence
- Bioelectronics
- Virtual/Augmented Reality

can be seen, according to our analysis, as having a "high" degree of likelihood.

Cloud Computing and Future Internet were qualified with "medium" and Quantum Computing (for the time being) with a "low" degree.

6 Reflection on Methodology, Recommendations and Conclusion

6.1 Reflection on Methodology

As pointed out in the introduction the aim of task 3.2 of WP3 was to a reasonable estimation of the likelihood of ethical issues at the EU within given budgetary constraints.

We started by analysing the way something is turned into an "ethical issue" in the arena of European politics. The outcome of this analysis is a list of principles and values, which was used to identify issues relevant to estimating the likelihood of a technology becoming an ethical issue based on the analysis of the respective technology within WP 2. The analysis also provided us with further indicators: We assumed that the fact that a (similar) technology has already been addressed by either the EGE, NECs, or FP (sub)projects did raise the likelihood of becoming an ethical issue. We also included the question of conflicting values and principles, because it seems unlikely that a technology which has no negative or no positive implication will become an issue of controversy.

In general we would like to make the claim that our approach proved to be effective in achieving the aim of task 3.2.

However, there were some practical challenges that we will address in the next section on recommendations. We were not able to make use of all findings of our analysis that might be worth exploring in another project. For example, we suggested a model of how to bring together the findings of the current literature on computer ethics (WP2), the discourses within grass root movements, and our evaluations. Due to time limitations there was no opportunity to apply this model within the ETICA project.

An unexpected outcome of the evaluation is the list of common ethical issues that originally was meant as a way to avoid repetitions in the ethical evaluations. However, we did find that some issues were more common than we would have expected at the beginning of our inquiry, for example, "ICT implants in the human body" had to be considered a far more common subject in a range of technologies than expected. It also become obvious when compiling the list that "animal welfare" is a subject largely ignored in the literature on computer and information ethics.

Finally, "Cloud Computing", "Artificial Intelligence", and "Robotics" present interesting challenges to our approach.

Based on the analysis given above, the likelihood of "Cloud Computing" becoming an ethical issue at the European level does not seem to be very high. However, one should be aware that Cloud Computing unlike other technologies in this review is a concept that was developed outside the European research programmes. This is nicely illustrated by the fact that the only FP research project that deals with Cloud Computing was renamed in course of the project. There seems to be a strong interest on side of the ICT business sector (see: "Future of Cloud Computing"-Report) and there might also be a strong interest of European institutions of making use of Cloud Computing applications due to the possibility of cutting costs. Therefore we assume that there is a medium to high likelihood of Cloud Computing becoming an ethical issue at the EU level depending on the interest of EU institutions to make use of applications.

"Artificial Intelligence" and "Robotics" represent a special challenge, because these are rather large categories. And to a certain degree AI as well as robotics are already well-established technologies. Therefore, it seems unlikely that AI or robotics as a whole will become subject of controversy at the EU level, while it seems likely that certain applications like robot care givers or AI applications for border security might cause controversy. In general, we assume that methodology presented in this paper will work best with technologies that do not cover such a wide range of (potential) applications.

6.2 Recommendations

Before we come to our conclusion, we would like to give some recommendations based on the work carried out in WP3, but also on the challenges we have faced during the preparation of our ranking.

Since our ranking is based on NEC opinions as well as information on FP (sub-) projects on ethical issues, we have to state that this kind of information is not always

easy to access. As already stated in section 2.3.2 at present there is no centralized data bank where all opinions produced by NECs are stored and searchable in an easy way.

Therefore, *we recommend creating such a data bank on NEC's opinions* to make the work of NECs more accessible to a wider audience.

With regard to FP7 and FP6 projects the CORDIS web site did prove very helpful in searching information about relevant projects. However, there is no way to identify work packages on ethical issues using the CORDIS web site. Putting aside the implication this had for our work, this also implies that other ethics projects or WPs within the FP7 programme may not know of each other's existence and outcomes. Therefore, *we recommend creating a data bank on ethics within EU research which includes not only projects, but also relevant work packages and deliverables.*

Finally, as we have already pointed out in section 3.4, the current research on Computer and Information Ethics is very much human-centred, which means that there is little to none research on animals or environmental issues. Therefore, *we would like to encourage our colleagues to take some inspirations from the Ethics of the European Institutions and to overcome the bias towards humans.*

6.3 Conclusion

As stated in the introduction, one main indicator for the likelihood of ethical issues in the European Union is a potential conflict with the core values and principles of the EU Charter. Among the European core values we highlighted human dignity, freedom (which includes autonomy, responsibility, persuasion and coercion, informed consent), freedom of research, privacy, justice (which includes autonomy, consumer protection, cultural diversity, environmental protection, safety, ownership, social inclusion) as well as the principle of proportionality, the precautionary principle and the principle of transparency. We called these values and principles an "Ethics of European Institutions" based on the fact that the European Union is often referred as a "community of values."

These values and principles as addressed in official European documents are in many cases not only ethical but legal as well. An ethical debate is by nature open and controversial. It takes place within academic institutions, in the public arena or in a political context as in the case of the European Group on Ethics (EGE) or of National Ethics Committees (NEC). The documents produced by these bodies provide advice to political actors no less than to research institutions and to the public. They are accessible on the Internet to all interested parties. This is no less the case for documents produced by EU ethics research projects such as ETICA itself. The rationale of such ethical bodies and research projects is to deal with potential ethical issues that might arise in the near future (10 to 15 years in case of ETICA) with regard to scientific and technological innovations. This framework conditions the kind of ethical discourse, excluding pragmatically "speculative" ethics, by taking a cautious view with regard to potential "hypes".

Our evaluation took into account the academic discussion of ethical issues as discussed in publications on computer and information ethics (done in D 2.2) looking for correspondences and disparities, even oppositions, when looking at them from the "European angle." According to the "Ethics of European institutions" human dignity is a key ethical issue that, we believe, cannot be isolated from the other ethical values and principles. Within this framework we considered the following technologies as

having a “very high” degree of likelihood of becoming an ethical issue as far as they concern or might concern human dignity, namely: Ambient Intelligence, Human-machine symbiosis, neuroelectronics, and robotics. Other technologies such as Affective Computing, Artificial Intelligence, Bioelectronics and Virtual/Augmented Reality can be seen, according to our analysis, as having a “high” degree of likelihood. Cloud Computing and Future Internet were qualified with “medium” and Quantum Computing (for the time being) with a “low” degree.

Doing an ethical evaluation means interpreting ethical values and principles as well as applying them to specific issues. All mentioned technologies may raise concerns about human dignity to different degrees depending also on what is understood by it. Just as an example of the controversial nature of ethics we would like to mention the present debate on the concept of human dignity as something mainly related to the human person and his/her autonomy in such a way that the person can act freely and be empowered by such a fundamental ethical value. According to some authors, there is a shift in the understanding of this concept from the empowerment of the individual person to the need for protecting the community or even humanity (Resta 2010). Beyleveld and Brownsword, for instance, define human dignity “as a particular practical attitude to be cultivated in the face of human finitude and vulnerability (and, concomitantly, the natural and social adversity that characterizes the human condition)" (Beylefeld & Brownsword 2001, p. 2). Obviously, this kind of in depth analysis of key ethical values and principles is a matter of the academic discourse, while an ethical evaluation as envisaged in this contribution can only point to specific issues that might give rise to controversy not only within the academia but also within in the political and social arena.

Finally, we would like to underline that the “Ethics of European institutions” is a dynamic framework as can be seen in the case of the European Group on Ethics (EGE). Although most National Ethics Committees in Europe and abroad are still mainly oriented towards bioethical issues it is evident that these cannot be separated from questions of computer and information ethics. For future work on ethical evaluations we and others dealing with this matter would wish for a better overview of the ethics opinions produced by NECs and related institutions in Europe (and beyond) as well as critical studies on their methodologies, biases, presuppositions and interpretations of ethical values and principles.

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