Teaching Computer Ethics

Steps towards Slow Tech, a Good, Clean, and Fair ICT

NORBERTO PATRIGNANI
Abstract

Information and Communication Technologies (ICT) are critically impacting society and the environment. They are now an integral part of the challenges posed by the current Anthropocene era. To help in facing these enormous challenges, the entire ICT supply chain (from design to development, manufacturing, usage, deployment, and disposal) should take into account the three dimensions of social desirability, environmental sustainability, and ethical acceptability. In this thesis these concepts are proposed as a joint requirement for a new approach to ICT and with a more precise focus: a good, clean, and fair ICT. A good ICT is designed with a human-centred approach, a clean ICT is environmentally sustainable and minimizes the impact on the planet, and a fair ICT takes into account the working conditions of people along the entire supply-chain. These characteristics represent a triple condition that in this thesis is called Slow Tech (inspired by the Slow Food movement that uses good, clean, and fair with reference to food).

Among the many stakeholders of the ICT world, this thesis concentrates on the engineers, the designers of the complex systems (hardware, software, networks) that are shaping our society: in short, computer professionals. They usually work inside organizations and companies, but their skills, competencies, and professional code of ethics are the sources of fundamental design choices. In particular, this thesis identifies ethics as one of the new competencies needed by the next generation of computer professionals and, strongly related to it, complementing their university education with a subject that, for simplicity, will be referred as "Computer Ethics". Two fundamental questions are: how can this requirement for an ethical competence be fulfilled? How can universities prepare the next generation of computer professionals so that they are "ethically grounded"? This grounding in teaching and training is the main reason for the overall title of this thesis: "Teaching Computer Ethics". The main point of this thesis is that the reflections stimulated by the analysis of the ICT stakeholders' network and the use of the three Slow Tech questions are two important tools for improving the ethical skills and competencies of computer professionals. The methodology and my empirical experience of teaching Computer Ethics at the Politecnico of Torino described in this thesis provides interesting results in this direction.

Keywords: Teaching, Computer Ethics, Slow Tech

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to all the ones
who enabled me to study
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List of Papers

This thesis is based on the following papers, which are referred to in the text by their Roman numerals.


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## Abbreviations

<table>
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<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>ICT</td>
<td>Information and Communication Technologies</td>
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<tr>
<td>IFIP</td>
<td>International Federation for Information Processing</td>
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<tr>
<td>IP3</td>
<td>International Professional Practice Partnership</td>
</tr>
<tr>
<td>RRI</td>
<td>Responsible Research and Innovation</td>
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Introduction

"... the idea of freedom is inseparably connected with the conception of autonomy"
Immanuel Kant, 1785


"... Tech Workers Now Want to Know: What are We Building This For?"
Conger K., Metz C., 2018

Background

Information and Communication Technologies (ICT) are critically impacting society and the environment. They are now an integral part of the challenges posed by the current Anthropocene era (Steffen et al., 2007). To help in facing these enormous challenges, the entire ICT supply chain (from design to development, manufacturing, usage, deployment, and disposal) should take into account the three dimensions of social desirability, environmental sustainability, and ethical acceptability. These dimensions were introduced in relation to Responsible Research and Innovation (RRI) in ICT, by René Von Schomberg in 2011 (Von Schomberg, 2011, p.9).

In this thesis, these three concepts are proposed as a joint requirement for a new approach to ICT but with a more precise focus than RRI: a good, clean, and fair ICT. A good ICT is designed with a human-centred approach, a clean ICT is environmentally sustainable and minimizes the impact on the planet, and a fair ICT takes into account the working conditions of people along the entire supply-chain. These characteristics represent a triple condition that in this document is called Slow Tech (inspired by the Slow Food movement that uses good, clean, and fair with reference to food).
Since the ICT world is a complex one, what is the starting point for considering the stakeholders involved in Slow Tech? Among the many stakeholders involved in this scenario where high-tech artifacts are designed for managing data, information, and knowledge, this thesis concentrates on the engineers, and the designers of the complex systems (hardware, software, networks) that are shaping our society: in short, computer professionals. Of course, in the ICT scenario there are also other important stakeholders: such as policy makers, users, and ICT vendors. Computer professionals usually work inside organizations and companies, but their skills, competencies, and professional code of ethics are the sources of fundamental design choices. For this reason this document focuses on them. In particular, this thesis identifies ethics as one of the new competencies needed by the next generation of computer professionals and, strongly related to it, complementing their university education with a subject that, for simplicity, will be referred to as "Computer Ethics".

For computer professionals, ethical competence is now also a requirement at international level, the revised (2015) Definition for the Computing Professionals by IFIP (the International Federation for Information Processing) is now: "... given the reach of ICT in our lives, it is important for an ICT Professional to be: Technically Strong (in order to use the Right Technology for the Relevant Problem), Ethically Grounded (to ensure that the Technology is put to the Right Use), Socially Conscious (so that the technical solution takes into consideration elements of Sustainability), Business Savvy (to ensure commercial viability, which is required for Social Prosperity and Funding of New Developments)" (IFIP-IP3, 2015, p.47). As a result, two fundamental questions are: How can this requirement for an ethical competence be fulfilled? How can universities prepare the next generation of computer professionals so that they are "ethically grounded"?

This grounding in teaching and training is the main reason for the overall title of this thesis: "Teaching Computer Ethics".

Aims and scope

Even if the "social and ethical implications of computing" were very clear to the founders of the computer age (Wiener, 1950) it was only in 1991 that these subjects were introduced into Computer Science curricula (Turner, 1991). Since then, very few volumes have justified the introduction of this new subject. Despite the various experiences in the teaching of this subject for many years already, there has been little research into its justification, methodologies, or reviews of it. In one of the major systematic literature reviews regarding teaching ethics in engineering schools, the authors write:
"... there is neither a consensus throughout the engineering education community regarding which strategies are most effective towards which ends, nor which ends are most important." (Hess and Fore, 2018). And, even if there are now some common methods recognized for integrating ethics into engineering curricula, such as exposing students to codes and standards or utilizing case studies, findings indicate that "... there is limited empirical work on ethics education within engineering" (Hess and Fore, 2018, p.551).

The aim of this document is therefore to search for a stronger basis for this challenging task of "Teaching Computer Ethics" to computer engineers by means of the concept of Slow Tech. In short, Slow Tech provides computer professionals with three key questions to ask when designing a computing artifact: Is it good? Is it clean? Is it fair?

The main point of this thesis is that the reflections stimulated by the analysis of the ICT stakeholders' network and the use of the three Slow Tech questions are two important tools for improving the ethical skills and competencies of computer professionals. The methodology and my empirical experience of teaching Computer Ethics at Politecnico of Torino, Italy, described in the third chapter of this document provide interesting results in this direction.

Research questions

In the domain of ICT, one of the most difficult challenges is "what is right and what is wrong?" What are the ethical dilemmas related to ICT? What can computer engineers do in this regard? Even if the debates related to teaching "Computer Ethics" in Computer Science departments are not new (Quinn, 2006), the aim of this thesis is to focus on these four main questions:

*Can we teach ethics to engineers? And how?*

*What are the ethical competencies they need to acquire? And how?*

The Slow Tech approach is introduced, when justifying the need for introducing these new subjects in the curriculum and, in particular, suggesting stimulating approaches for cultivating the ethical competencies and skills of computer professionals.
Outline of the thesis

This work is divided into three main chapters.

The first chapter provides a short historical overview of the discipline called "Computer Ethics". It outlines its development from Moor's concept of "policy vacuum" (Moor, 1985) to Johnson's view of computer systems as "socio-technical systems" (Johnson, 1985). Then it introduces the concept of "proactive computer ethics": since technology is not neutral and technology and society co-shape each other, this means that the designers of computer systems have the opportunity to make choices at the design stage of computing technologies.

The main focus of the first chapter is the identification of a "turning point" in the history of Computer Ethics: a moment when there was a recognition of a "co-shaping" between technology and society which introduces new responsibilities from the societal point of view. It implied in what directions should computer professionals steer their design choices?

This part is also the main content of the Paper I.

The second chapter proposes the concept of Slow Tech, an ICT that is "good, clean, and fair", as a possible guideline for designers. It then presents a roadmap for the dissemination of the Slow Tech concept among the different actors of the ICT stakeholders' network. Once engineers become the focus of analysis, since their choices will shape future systems they are also the starting point for the roadmap dissemination of the Slow Tech approach. But this situation raises two questions: How can be designed complex systems that are socially desirable, environmentally sustainable, and ethically acceptable? Who is the first stakeholder to initiate the Slow Tech "journey"?

This is the main content put forward in Paper II and Paper III.

The third chapter focuses on the difficult task of teaching Computer Ethics to engineers: What are the philosophical and pedagogical bases for this kind of "ethics education"? What are the tools for training engineers' capability to "question technology" and enhance their philosophical skills? Two approaches - Virtue Ethics and Future Ethics - are proposed as theoretical backgrounds.

A methodology used in teaching Computer Ethics at the Politecnico of Torino (Italy) is then presented alongside some results from the field experience.

This is the main content of Paper IV and Paper V.
Main contribution from the papers

The papers included in this compilation thesis are located in the Appendix of the physical version. Reprints were made with permission from the respective publishers.

In this part of the thesis, I will briefly summarize in what way each paper contributes to the main thrust of the arguments in the thesis as well as my contributions to the research presented in the papers.

In Paper I the concept of Slow Tech, an ICT "good, clean and fair" is introduced. A kind of a bridge between Slow Tech and Slow Food is proposed by these three principles that were originally related to food. As the single author of this paper, my effort was concentrated on the identification of a kind of "turning point" in the history of Computer Ethics identified in the works of Deborah Johnson. With Johnson's definition of "socio-technical systems", in which she deeply questioned the assumption about technologies' "neutrality" (and so the relationship with the "policy vacuum" introduced by Moor), she opens the opportunity for designers of computer systems for steering innovations. This where the opportunity for a Slow Tech approach starts to play a role. My contributions include the outline of the paper, the literature review of Computer Ethics history, and the writing.

In Paper II the term Slow Tech is defined as technologies that are human centred (good), environmentally sustainable (clean), and that focus on the fairness and equity of the conditions of workers involved in the computing manufacturing processes (fair). Based on the concept of limits of the human beings and of the planet, Slow Tech is proposed as a new design paradigm that implies a long-term view.

My major contributions include the outline of the paper, the framing of the issues, the literature review of social and ethical impact of technologies, the case study, and the writing. Diane Whitehouse provided minor contributions on the conclusions and on the editing.

In Paper III, Slow Tech's ideas are taken a step further to explore how a roadmap and concrete checklist of activities can be developed. We investigated the challenges related to the dissemination of Slow Tech for the actors involved in the ICT domain.

My major contributions include the outline of the paper, the literature review on ICT supply chain and stakeholders' identification, and the writing. Diane Whitehouse contributed by compiling conclusions and made minor contributions through the writing and editing.
In *Paper IV*, the challenges of teaching computer ethics to engineers are described. Among the many stakeholders in the ICT world, computer professionals are proposed as the starting point for the dissemination of the *Slow Tech* approach. A methodology for teaching *Computer Ethics* is then proposed.

My major contributions include the literature review on ethics education, the outline of the paper, the description of the methodology and related results from the field experience, and the writing. Iordanis Kavathatzopoulos contributed with the theoretical foundations of ethics education and minor contributions on the writing.

In *Paper V*, the challenges of designing sustainable ICT systems, the difficulties related the global scale of the ICT supply-chain, the difficult dilemma facing computer professionals about balancing the positive and negative impact of ICT systems, the ethical competencies needed and the skills and methods for acquiring them, are all addressed.

My major contributions include the outline of the paper, the literature review on ICT supply-chain and on ICT sustainability, the framing of the issues, and the writing. Iordanis Kavathatzopoulos contributed by improving the focus of the paper and with minor contributions on the writing.

**Connections with the book "Slow Tech"

Even if this thesis work has been produced after the book:


was published, it has of course many connections with it. It it therefore worthwhile to clarify the main differences between these two volumes and fair to clarify my contribution to the book as a whole.

The concept of *Slow Tech* in ICT is presented in more detail in the book whereas, in this document, it is used as a "heuristic compass" for teaching *Computer Ethics*, and as a reference for providing advice to computer professionals about how to move in the direction of a "good, clean, and fair" ICT. This thesis is much more focused on the complex task of the *teaching of computer ethics* and its theoretical foundation.
My contribution to the book is on the main structure, the development of the chapters, and the writing. Diane Whitehouse provided a great deal of her time in conversations that helped to develop the *Slow Tech* concept: these many hours of conversations were key to the energy for writing the book. She also provided minor contributions on the social impact of computing and was instrumental in improving the quality of the written text with revisions.
1. Computer Ethics: from Policy Vacuum to Slow Tech

"Ethical problems are too complex and too fluid to solve algorithmically in human time"
Walter Maner, 2002

This chapter introduces a short history of Computer Ethics, starting from the early days of computing (1950) and moving forward to today's cloud computing era. The limits of the original Computer Ethics approach, based on the concept of Moor's "policy vacuum" (Moor, 1985), are investigated. The new approach to Computer Ethics, enabled by the view of computer systems as "socio-technical systems" (Johnson, 1985), also opened up a path from a "reactive Computer Ethics" towards a "proactive Computer Ethics". A proactive approach means that technology is not neutral, but rather that technology and society co-shape each other. It also provides some good challenges for computer professionals that are fundamentally related to the same questions embedded in Slow Tech: How can complex systems be designed that are socially desirable, environmentally sustainable, and ethically acceptable?

This chapter relates to the paper I in the appendix.

1.1. Computer ethics and policy vacuum

A critical thinking approach to techno-determinism and about the relationship between technology and society has been proposed by philosophers and social researchers since the 1930s (e.g. Mumford, 1934; Ellul, 1954; 2014).

The main questions about the social and ethical challenges related to the introduction of computers in society arose from the very dawn of the computer age. One of the leading computer scientists of that era, the MIT (Massachusetts Institute of Technology) researcher, Professor Norbert Wiener launched the discussion about the potential impacts of computers on society, in particular on workers, and the risks of unemployment due to
automation (Wiener, 1950). For this reason, he is famous not only for being the founder of Cybernetics, but also of Computer Ethics. He invited computer scientists to move "from know-how to know-what", to focus attention away from the answer to the question in itself and to query the problem and its context.

Almost two decades later, another leading computer expert, Donn Parker, studied the effects of computers on people's behaviour and, in an historical article, containing the words "ethics" and "computer" for the first time together, he wrote: "It seemed that when people entered the computer center they left their ethics at the door" (Parker, 1968).

At that period, reflections about the relationship between ICT and society were always "ex-post", or "a posteriori": they arose after the deployment of new technologies into society. The technology evolution and its directions were never questioned of themselves, before the introduction of the technology. For many years, technology innovation was always considered good. Technology was considered as "neutral".

In the decade that followed, Professor Joseph Weizenbaum renewed the discussion about the controversial relationship between computers and society. He listed a number of principles for avoiding or minimizing the risks of misuses of computers and for steering researchers and developers towards a correct application of computers. He wrote about those human functions (e.g. judgement, respect, understanding, caring and love) that should not be delegated to computers. He also reflected on applications which have irreversible, not entirely foreseeable, side effects and that do not meet pressing human needs, which ought not to be undertaken without very careful forethought. He stated: "... the question is not whether such a thing can be done, but whether it is appropriate to delegate this hitherto human function to a machine" (Weizenbaum, 1976, p.207).

At a time when artificial intelligence applications are spreading throughout society, recalling Weizenbaum's recommendations is becoming crucial: technology is not neutral and deep ethical choices should not be delegated to machines but should remain in human hands. To support this position, Weizenbaum proposed the distinction between deciding - a computational activity that can ultimately be programmed and then executed by computers, and choosing - an activity that cannot be addressed by computational thinking, since it is the product of judgement, not calculation; it is the capacity to choose that ultimately makes people human, so that it is choice that has to be undertaken only by human beings.
At the same time period, an important contribution to the philosophical debate about technologies was provided by Hans Jonas: he proposed to introduce into the ethical debate the planet and future generations, because of the dramatic impact of the immense power of technologies on nature (Jonas, 1979). ICT is now part of this original scenario. This thesis therefore takes into account the suggestion made by Jonas and introduces into the reflections on ICT their potential effects on the future of the planet and people. A view very close to the so called "quintuple innovation helix framework", where beside academia, industry and government (the "triple innovation helix") are included also civil society and the environment as constituent elements (Carayannis and Campbell, 2010).

Despite these efforts, society is often still considered just as a "receiver" of ICT innovations. As a consequence, since the speed of technological innovation is orders of magnitude greater than the time required for society to cope with these continuous "revolutions" people are always faced with a kind of a "gap".

This gap is recalled in the definition of "Computer Ethics", a term proposed by Walter Maner: "... computers generate wholly new ethics problems that would not have existed if computers had not been invented... there should be a new branch of applied ethics... decided to name the proposed new field Computer Ethics... a new field that studies ethical problems aggravated, transformed or created by computer technology" (Maner, 1980). The main criticism of this definition could be addressed to the subject itself. Rather than "... computers generate" – the expression should be "... the choices made by designers of computers generate", since computers are just machines that execute algorithms designed by human beings. This human responsibility cannot be escaped by delegating it to machines.

In the same years, in Palo Alto, an international association called Computer Professionals for Social Responsibility was established. It addressed the growing area of military applications of computers. The computer scientist David Parnas underlined the risks of delegating to computers the critical choice of launching intercontinental missiles: "... Software is released for use, not when it is known to be correct, but when the rate of discovering new errors slows down to one that management considers acceptable. ... Because of the extreme demands on the system and our inability to test it, we will never be able to believe, with any confidence, that we have succeeded." (Parnas, 1985). The debate about the social and ethical impacts of computers left the academic world, with the first signs of a critical thinking applied to ICT applications.

In 1985, it was James Moor who used the concept of this gap between technology and society to define the core mission of Computer Ethics: "A
typical problem in Computer Ethics arises because there is a policy vacuum about how computer technology should be used. Computers provide us with new capabilities and these in turn give us new choices for action. Often, either no policies for conduct in these situations exist or existing policies seem inadequate. A central task of Computer Ethics is to determine what we should do in such cases, that is, formulate policies to guide our actions ..." (Moor, 1985).

In those years, this "policy vacuum" concept was generally accepted. Nobody questioned the technology itself.

Computer Ethics was considered to be helpful because technologies evolve very rapidly and society may face unexpected scenarios where there are no clear policies or guidelines: in these completely new situations, it is very difficult to decide what is right and what is wrong. The basic assumption was that technology is neutral and does not result from complex interactions with society, a consequence of human choices, an artifact embedding values. From this point of view, Computer Ethics is a compensatory or a reactive form of ethics.

Nevertheless, even this reactive approach played a crucial role as an area of applied ethics and supported the definition of many policies related to ICT. For example, in 1992 it was defined by the ACM (Association for Computing Machinery) its Code of Ethics and Professional Conduct (ACM, 1992).

1.2. Towards Slow Tech

In the 1980s, thank to the works of Deborah Johnson, this assumption about information technology "neutrality" was deeply questioned. She wrote: "Recognition that technology is not just artifacts, but rather artifacts embedded in social practices and infused with social meaning, are essential to understanding the connection between Ethics and IT" (Johnson, 1985). According to Johnson, technology is not neutral, computer-based systems are socio-technical systems, and technology and society are continuously co-shaping each other. As a consequence, if ICT and computer systems are "socio-technical systems", then computer professionals have the opportunity (and responsibility) of steering them in the right directions and, if they are not beneficial to society, they (and their negative impacts) should not be passively designed and used.

For the first time, the debate among researchers, teachers, computer scientists, computer professionals, and designers started to focus on the new horizons opened up by the opportunity of steering these "socio-technical systems" in
appropriate directions. In this new context, what is the role of universities and engineering schools in preparing the next generations of computer experts? This is the main anchor point adopted by this thesis.

In 1991, an ACM/IEEE joint committee was established and produced a new curriculum for computer science that included in it Computer Ethics. For the first time, "a significant component of computer ethics" was included in the required subjects for Computer Science (Turner, 1991).

Other contributions towards "value-sensitive design" in computing were due to Batya Friedman (Friedman, 1996) and Helen Nissenbaum (Nissenbaum, 1998).

In the year 1989, the World Wide Web was first developed at CERN (European Organization for Nuclear Research) in Geneva. As a result, the impact of ICT on society became pervasive, cyberspace was "navigable" with just a "point & click" interface, and even people without any form of technology literacy could now use it.

In 1991, the first conference on "Computing and Values" was organized in New Haven (CT, USA): Computer Ethics became a discipline in its own right with its own conferences, journals, and research centers. Values can be equated with ethics.

In 1999, a fundamental contribution to the definition of the role and responsibilities of computer professionals was provided by Lawrence Lessig, Professor of Law at Harvard Law School. In his model based on four dimensions – market, law, education, and architecture – it is very clear that a good governance of complex systems usually emerges from the right blending of these four approaches. But at the same time, Lessig underlined the growing shift of many governance systems towards "architecture": the norms are more and more embedded, and incorporated into technologies. In ICT systems, in particular, the risks of delegating to "black boxes" (or algorithms), with little transparency, the norms that rule human beings and society are very high. His recommendation is synthesized in the dazzling statement that "code is law". The responsibility facing the society for the designers of future computer socio-technical systems became very evident (Lessig, 1999). Law, regulations and computer ethics became intertwined.

So, if computer professionals can steer socio-technical systems in the "right" direction, precisely which is the right direction?

Even if used since 1970s by several authors (Sheppard, 1971; Toffler, 1980) the term "infosphere" started to play a role in the ICT and ethics debate
(Floridi, 1999a), by whom it was defined as "the whole informational environment constituted by all informational entities" (Floridi, 1999b).

Other, more recent important contributions in the last decade connected an historical perspective with future challenges (Vacura, 2015) and with a definition of the themes of Computer Ethics as a research field (Taddeo, 2016).

In Europe, the same debate about teaching Computer Ethics to engineers began and, in several countries, ethics was embedded in ICT curricula (Duquenoy et al., 2010). In 1995, the Centre for Computing and Social Responsibility (CCSR) was founded at De Montfort University (United Kingdom) with Professors Simon Rogerson, Terry Ward Bynum, and Don Gotterbarn among the staff. Rogerson became Europe's first Professor in Computer Ethics in 1998. Indeed, Rogerson himself provided an important contribution to the historical debate about the impact of strategic, managerial, and ethical issues of ICT inside organizations (Rogerson, 2011).

The debate around Computer Ethics has in fact been present in Europe since the 1970s in several countries. For example, in France there were studies on the pedagogical issues related to teaching "informatique et société" (Paoletti, 1993). In Belgium, Prof. Jacques Berleur at Namur University worked on the subjects of "Informatique et rationalité, questions épitémologiques", "Ethique de l'informatique" (Berleur, Brunnstein, 1996). In the Scandinavian countries, the impact of computers in the workplace was studied in depth and Participatory Design (PD) methodology was used in computer systems design. This is a design methodology in which the users, who are going to use the systems under development, participate as co-designers in the design process. It is strongly based on a democratic approach where the future systems are the result of collective efforts, a kind of negotiation between designers and users. These approaches were introduced thanks to the work, among many other researchers and computer scientists, of Pelle Ehn, Kristen Nygaard, and Susanne Bodker (Nygaard, 1996; Bodker et al. 1987).

Given the concern of this thesis for the introduction of Computer Ethics into the Italian context, it is especially important to consider what directions have been taken on the Italian scene.

In Italy, in 1973 Prof. Stefano Rodotà of University of Rome "La Sapienza" published a fundamental book: "Computers and Social Control" (Rodotà 1973). In 2012 he received the prestigious Namur Award from IFIP, the International Federation for Information Processing, for his "... outstanding contribution with international impact to the awareness of the social implications of information technology" (IFIP, 2012). In Italy, the visionary entrepreneur Adriano Olivetti published in Italian the works of Lewis
Mumford about the reflections on technology and society (Mumford, 1953). In 2003, the course "Deontologia ed etica delle tecnologie dell'informazione" ("Deontology and ethics of information technologies") was introduced by Prof. Piercarlo Maggiolini at the Politecnico of Milano and in 2008 the course Computer Ethics was introduced at the Politecnico of Torino (Patrignani, 2009). The first anthology of Computer Ethics in Italian was published in 2010 (Di Guardo et al., 2010).

Today all over the world, Computer Ethics (or "Digital Ethics") is studied in the main engineering schools in their "Science, Technology and Society" (STS) departments.

Many of these developments are profoundly associated with similar philosophical and practical approaches described in the Slow Tech approach. It is for this precise reason that the thesis now explores in detail the Slow Tech concept.
2. Slow Tech: a Good, Clean, and Fair ICT

"Computers and information technology should help and serve people and society. Where they do not, they should not be passively accepted"  
Richard T. De George, 2003  
The Ethics of Information Technology and Business,  
Blackwell Publishing, 2003, p.ix

The task of teaching Computer Ethics to engineers starts from a recognition of the need to overcome the reactive form of Computer Ethics and move towards its proactive form: this is the red line that runs throughout this thesis and which is supported by the published papers reproduced in the appendix.

But this shift raises a number of questions: How to support computer professionals in this effort? What are the ethical competencies they need to acquire, and how? What are the most promising questions for them to ask in the future? Here the Slow Tech approach comes into play. The main questions for computer professionals, when starting on a new ICT project or system could be: Is this development socially desirable and designed with a human-centred approach? Is this development environmentally sustainable and does it minimize its impact on the planet? Is this development fair and does take into account the working conditions of people along the entire supply-chain?

From this perspective, some authors have interestingly proposed an ethical technology assessment (eTA) which is focused on the ethical implications of ICT: it may be useful as a "tool" to be used by technology developers for an early identification of the effects of new technologies (Palm and Hansson, 2006).

The questions implicit in the Slow Tech approach are in line with these suggestions, but concentrate on three dimensions: an ICT that is "good, clean, and fair".

Slow Tech is used here as an "intuition pump" as suggested by Dennett: a thought experiment that triggers intuition to facilitate the reasoning about complex subjects (Dennett, 2014). In this case, Slow Tech uses the same three
characteristics good, clean, and fair, with reference to ICT, used by the *Slow Food* movement in relation to food.

*Slow Tech* can be seen also as a "heuristic compass". A "compass" (from the Latin *com-* 'together' + *passus* 'a step or pace'), is an "acus magnetica" (a magnetic needle), which shows a person the most promising direction in which to move when looking for an orientation, and "heuristic" (from the Greek 'heuriskein', 'to find') implies that it is functional to find out, or to discover, an informal procedure that can lead to a solution in some cases.

This chapter relates to the content of paper II and paper III in the appendix.

### 2.1. Slow Tech as a Proactive Computer Ethics

In the present era of "proactive computer ethics" it has become crucial to identify some of the possible directions for steering the co-shaping between technology and society.

This thesis therefore examines the *Slow Tech* approach to the pervasiveness of ICT, and how it can counterbalance not only the speed of development of ICT, values, and design. Contrasting forms of technological design are explored, with a focus on the importance of "technological mediation" and the significance of participatory design.

A starting point can be the recognition that ICT have now reached such a pervasive dissemination that they are shaping both society and the planet. They play an important role in the challenges of the *Anthropocene* era, the era where human beings and their artifacts have a significant impact on the planet and ecosystems, including *climate change*. For example, the contribution of ICT to global Greenhouse Gas Emissions (GHGE) could grow from about 4% in 2010 up to more than 10% by 2040, thus reaching half of the impact of the transport sector (Belkhir and Elmeligi, 2018). Social networks in ICT also have a pervasive impact on communities and on democracy (Hajli, 2018).

In the *Anthropocene* era, ICT and related stakeholders could play an important role by adopting a *systemic view* that enables the design of ICT systems and applications that are *socially desirable, environmentally sustainable* and *ethically acceptable*. These three dimensions can also be described by the three, simple words "good, clean, and fair", the terms introduced with reference to food by the *Slow Food* movement which also inspires the *Slow Tech* approach.
The Slow Food philosophy is based on a comprehensive view of the entire food value-chain: food must be **good** (based on good quality, healthy, based on old recipes), **clean** (so that it minimizes its environmental impact), and **fair** (respectful of the rights of farmers) (Petrini, 2007; 2011). Slow Tech can be seen as forming a bridge with the Italian (and now worldwide) Slow Food movement since it shares the same three basic principles.

The concept of **Slow Tech** as related to ICT is introduced as "... a new starting point for systems design:... based on a long-term view of the desirability and social importance of technologies, their environmental impact and sustainability, and the fairness and equity of the conditions of workers" (see paper II and paper III in the Appendix). Slow Tech is a "good, clean, and fair" ICT that it is proposed as a form of XXI century guideline for steering ICT companies, designers, computer professionals, users, and policy makers towards an ICT that is **good** for human beings, **clean** for the environment and **fair** for the workers.

A metaphor that contrasts speed and slowness can be introduced into this vision of ICT. It is possible to use "Indianapolis" as the most appropriate metaphor for the myth of speed (the city is the capital of the state of Indiana, USA, and is famous for its car racing events), and to take speed as one of the strongest myths of ICT: the "technological Indianapolis" is a symbol of the current rush to an ever faster life enabled by ICT.

In contrast, however, using a Slow Tech approach in the design of ICT systems implicitly provides people with "the brakes required in the technological Indianapolis" (see paper II and paper III in the Appendix), it offers computer professionals more time for reflection so as to take into account the limits of both human beings and the planet. As Rogerson states: "computer and information ethics is defined as integrating ICT and human values in such a way that ICT advances and protects human values" (Rogerson, 2011). This thesis takes inspiration from these words, and complements this approach by joining "human values" (a good ICT), with the environmental issues of ICT (a clean ICT) and equitable working conditions in the ICT industry (a fair ICT).

**Slow Tech** as "heuristic compass" can be also seen as connected with the writings of Peter-Paul Verbeek in the areas in which he investigates the values embedded in technologies and, in particular, the area of "designing the morality of things" (Verbeek, 2011; 2017).

In this area, there are two well known approaches: "persuasive technologies" and "nudging". The first approach, persuasive technologies, uses ICT applications that explicitly persuade people to behave in a specific way (Fogg, 2003). However, this approach raises deep ethical considerations. Influencing
people without either their awareness or consent is not seen as a sound form of "persuasion". Instead of cultivating people's autonomy, there is a risk of developing technologies that have a strong push towards heteronomy, and the influence of people's actions through external forces. The use of persuasive technologies can be seen as very different from a "participatory design" approach, where people are directly involved in the design process. The second approach, the nudging approach, proposes to design artifacts in such a way that influences people in a "positive" direction (Thaler and Sunstein, 2008). It is based on the concept of "choice architectures", that is, where situations involving choices are organized and where human decisions are pre-structured. Since people are still free to make their choice(s), they are not forced but are just "nudged". This approach is also called "libertarian paternalism".

According to Verbeek, in both approaches the "democratic challenge" is still open since technologies are always affecting human behaviour, regardless of their will. As a consequence, it would seem more sensible to design the inevitable influences of technologies in such a way that they can count on sufficient democratic support. Since technology and human actions are inseparably interwoven, designers are charged with the responsibility to develop technology that influences human actions in desirable directions. The question is to understand what is "desirable". According to Verbeek, therefore, technology design is an inherently moral activity: if ethics is about the question of how to act, and designers help to shape how technologies mediate action, designing is in fact "ethics by other means". Designers can "augment the ethics of technologies" with the approach of technological mediation by actively shaping them. Designers can design technologies in terms of their mediating roles, inscribing desirable mediating effects in technologies (Verbeek, 2011; 2017). The question of understanding what is "desirable" is, however, still an open one.

In this area related to "designing the morality of things", another critique of "nudging" comes from Hertwig and Grüne-Yanoff (2016; 2017). These researchers propose a different "behaviorally informed approach": they move from the "nudges" (interventions designed to steer people in a particular direction while preserving their freedom of choice) to another non-fiscal and non-coercive intervention: "boosts". Their approach is based on a long-term approach: to foster people's competence to make their own choices, that is, to exercise their own agency. Human cognitive architectures are malleable, and so functional cognitive processes and motivational processes are also fluid and worth developing. Instead of just acknowledging people's bounds (limits) and imperfections, these researchers identify human competencies and ways to foster them through changes in skills, knowledge, decision tools, or external environments. Their approach implies that effects should persist once a
(successful) intervention has been removed: the autonomy of people is thus improved, individuals become equipped with domain-specific or generalizable competences. Finally, this approach is necessarily transparent and requires cooperation, a view that is very close to "participatory design" (Grüne-Yanoff and Hertwig, 2016; Hertwig and Grüne-Yanoff, 2017).

The Slow Tech approach is more in line with this "transparent and cooperative" view of design. Its focus is on the "process of decision making" rather than on outcomes, a "philosophizing" approach to ethics. The more the design process is inclusive, the more the result will be "desirable". The more stakeholders are involved (for example, by including also the environment as a stakeholder), the more the design process will be more inclusive, even if more challenging. Overall, the Slow Tech approach is a form of a proactive ethics.

The Slow Tech "heuristic compass" can be useful at exactly this point: as a tool in the hand of designers for "good, clean, and fair" technological mediation, as in the concept introduced by Verbeek (2011). The main contribution of Slow Tech is that it complements this "mediation" by including, beyond the use of ICT for desirable goals, the impact of ICT in itself on the environment (clean ICT) and on workers and society (fair ICT).

Many aspects of systems design are explored in each of the three fields of good, clean, and fair ICT.

2.2. Good ICT

A good ICT can be defined as socially desirable: a collection of systems, processes and applications that are designed with a human-centred approach. According to the philosopher, who is considered to be the founder of the Business Ethics discipline (De George, 1982; 2019): "Computers and information technology should help and serve people and society. Where they do not, they should not be passively accepted" (De George, 2003).

Among the several design techniques to be borne in mind are: human beings at the centre; "habeas data" and privacy-by-design; avoidance of overload; being hospitable; participation; and openness.

In an era of hyper-connectivity, a fundamental part in the ICT design process should be to consider the limits of the human mind and attention. One of the risks of advanced online ICT systems is to flood people with waves of data, thereby overburdening them with an information overload. This creates a situation which challenges the human mind's capability to filter, from among multiple signals, the most relevant information for survival. Education can
probably provide the competencies and skills for the next generations of people to cope with this growing amount of signals and data, by extracting the *structured data* that is important for human beings. The designers of advanced human computer interactions, of good ICT, should take into account all these issues by taking human beings as the starting point.

The principle of "*habeas corpus*" represented a big leap in progress in the history of human rights (it was introduced in the *Magna Carta* in 1215, which - for the first time - recognized the right of people to be in control of their physical body, as a safeguard against arbitrary powers). Nowadays, the principle of "*habeas data*" is becoming mandatory in the infosphere. This data-based principle was introduced in 1981 in the Council of Europe Convention on the Protection of Personal Data, and it continues today to recognize the right of people to transparency about the use of their personal data, including the deletion of data (EU, 2019a). In the onlife era (a word created from a blend of online and offline life) (Floridi, 2015), personal data are becoming the "oil of the XXI century". The principle of "*habeas data*" will become an integral part of a good ICT, also by embedding "privacy-by-design" principles (Rodotà, 2005).

Systems should be "hospitable", a term borrowed from the Japanese "*omotenashi*" (Kanamaru et al. 2015) which implies the wholehearted entertainment of guests. Systems' interfaces should be designed by using human-aware or human-centric approaches, and by taking into account the principles of universal access and design-for-all. Seven examples include: fairness (usable by anyone), flexibility (can be adapted to different abilities), simplicity (is simple, intuitive, and easy to understand), perceptibility (transmits sensory information), fault tolerance (minimizes risks and unwanted actions), low physical effort (minimizes physical effort), space-aware (space is suitable for access and use) (CFUD, 2019). A hospitable ICT is very attentive to the human experience, people's enjoyment, and aesthetics. With an hospitable approach the user is no longer considered as simply a "button pusher" or a passive user. For example, can a system which is based on the total surveillance of human beings ever be considered a good ICT, when people are unaware, and have no possibilities of controlling who is collecting their personal data or why?

For example, a good ICT will provide very personalised, multimodal interfaces for people with special needs, providing users with ways of interacting through several alternative channels and tools to use both input and output data: a basic concept for overcoming sensorial barriers.

Many companies, policy makers, and users are also recognizing the benefits of an "*open innovation and design*" approach (Von Hippel, 2006): this
approach is *socially desirable* since it is driven by a community of shared interests built up between designers and users. The openness can be seen as applied to both *products* and *processes*. The most important example in ICT design is the "*participatory design*" approach (Nygaard, 1996; Bodker et al. 1987; Bjerknes and Bratteteig, 1995) where users are involved in the project team itself.

There is also a strong connection between the concept of a *good ICT* and the *Constructive Technology Assessment* (CTA) approach. CTA is based on the inclusion of social actors in design and implementation processes, since their experiences can bring values and social aspects into the technology domain, thus, the technology assessment becomes a learning process (Grin and De Graaf, 1996). The *proactive Computer Ethics* approach described in this thesis and based on the concept of *socio-technical systems*, also implies a strong connection between social practices and design practices.

A *good ICT* can help people to find an appropriate balance between their work time and their free time or leisure, between *otium* (in Latin, free time, leisure or idleness, dedicated to intellectual speculation) and *negotium* (its opposite, not-leisure, which is dedicated to business activities or to public affairs (Cicero, 1998)). Over time, *otium* has gained an unfortunate reputation (and is equated with laziness or sloth) while activities related to *negotium* play and increasing part in people's lives through the introduction of technologies that are *always-on*. But there is now a growing interest in using ICT to find a more affordable boundary between *otium* and *negotium* (Siegert and Lowstedt, 2019) and to enhance the well-being and well-living of persons and communities. This focus on balance can also provide an escape from the mantra of faster and faster technologies, where the fascination with speed is combined with more technological features (Lennefors, 2013).

A *good ICT* is highly *reliable*, in particular where ICT is at the core of life-critical applications. In life-critical systems, technology assessments become mandatory, considering the risks that can arise in relation to complex software systems (Rogerson and Gotterbarn, 1998; Gotterbarn, 1992).

A *good ICT* should contribute to social and economic development through its innovation potential. Innovation potential in ICT is strongly based on its *openness*. If ICT systems are based on openly defined layers, other people can use and reuse these systems and technologies, can develop and improve them, and spread the fruits of the innovation potential.

Throughout the history of innovation, there are some very important examples of this flourishing of innovation potential. One of the most famous is the open standard for an *inter-modal freight container* used for transportation (the very
Applying the same concept of openness to ICT, at least three examples can be cited. The most famous open standard is the well-known Internet protocol: TCP/IP (Cerf and Kahn 1974). This historical open definition of inter-networking and interoperability is considered to be one of the major contributions to spreading the social and economic benefits of the Internet, by enabling everyone to develop new applications on top of the TCP/IP's open interface, and by providing new ways of moving packets of bits on new channels. Another example of openness in ICT is the "free and open software" defined by the Free Software Foundation in 1985 as: "... related to users' freedom to run, copy, distribute, study, change, and improve software" (Stallman, 1985). It has been estimated that the contribution of open source software to the economy of the European Union is more than 400 Billion Euro per year (Daffara, 2012). The social benefits provided by these open forms of software are interesting not only for the public sector, but also for stimulating the creation of new (local) high-tech companies. Another new and interesting example of openness in ICT is "open hardware", it is based on hardware design that is open to all (including the schematics, materials, printed and integrated circuits), and of course the software needed to run it (Lahart, 2009).

2.3. Clean ICT

A clean ICT can be defined as environmentally sustainable. In the era of hyper-connectivity, the limits of human minds to digest the tsunami of bits coming from the infosphere can be observed, yet planetary limits have been described since the 1970s.

The first alarm raised about the long-term consequences of the actions of humans on the planet came from Rachel Carson and her concerns about the environmental problems caused by synthetic pesticides (Carson, 1962). But the first study about the impact of human activities at the global scale was commissioned by the Club of Rome from MIT in 1972: for the first time in history, a scientific study introduced the concept of the limits to growth on a finite planet (Meadows et al., 1972).

The environmental impact of ICT is one of the most complex issues to analyse for Computer Ethics. This challenge is also investigated in the paper V in the appendix.
Among the design techniques to be borne in mind when considering clean ICT are: further evaluation of design consumption throughout the ICT life-cycle; addressing the whole of the ICT life-cycle; inclusion of approaches like recyclable-by-design and repairable-by-design; knowledge of the circular economy; and the holding of research and educational conferences and workshops.

The power consumption of the immense number of users connected to the infosphere (about 4.2 billions of users in 2018), their devices, networks' components, and data centers is growing and producing more than 4% of all CO₂ (Belkhir and Elmeligi, 2018). It is also true, however, that many ICT applications can help in energy saving, and reducing pollution and the release of CO₂ into the atmosphere. For example, by 2030, a wise use of ICT in areas like power generation, transports, mobility, agriculture, buildings, energy management, and manufacturing could save more than 10 GtonCO₂ (even when taking into account the pollution generated by powering users' devices, voice and data networks, and data centers) (GeSI, 2019). Certainly, further research is needed to evaluate the global impact of ICT and evaluate the impact of their entire life-cycle: from production, to the growing number of data centers, and the growing mountain of e-waste (Patrignani et al., 2011; Hilty, 2008).

A clean ICT approach should address the whole ICT life-cycle: producing, powering and disposing (recycling) ICT. Starting from production, electronic devices require a large amount of materials (most of them are precious, rare minerals ("rare-earths"); and high-tech chips generate toxic hazards during the manufacturing process. All electronic devices require electricity. In 2016, just to power data centers, more than 400 TWh were consumed (Ericsson, 2016). To manufacture, use, and distribute the more than 7 billion smart phones produced since 2007, more than 900 TWh have been consumed. At the end of their life, all devices need to be disposed in some way: over time, most of it was transported to Africa at a rate of 215,000 tons per year (Bernhardt and Gysi, 2013); in 2017, the production of 50 million tons of e-waste have been estimated (Ahmed, 2016).

To build a clean ICT, new approaches like recyclable-by-design and repairable-by-design are needed by computer professionals: these are becoming a requirement in the long-term, indicating a shift from the former use-and-dispose model of technology based on the take-make-dispose model of production, to the intermediate use-and-recycle, and to the increasing popular and well-known circular economy model (EMAF, 2012).

Knowledge and application of the four basic principles of the circular economy (long-lasting design, maintainability, repairability, reusability that
enable re-manufacturing, refurbishing, and recycling / upcycling) are among the main competencies needed by future computer professionals.

Over the past seven years, since 2013, several series of conferences have been dedicated to ICT sustainability: researchers are concentrating their attention on the efforts needed to decrease the impact of ICT and proposing instead the potential positive contribution of ICT to long-term sustainability (ICT4S, 2013).

Another important stream of studies for a clean ICT has been triggered by the "LIMITS" workshops. Since 2016, they have investigated "the impact of present or future ecological, material, energetic, and/or societal limits on computing" (LIMITS, 2019).

2.4. Fair ICT

A fair ICT can be defined as ethically acceptable. Since at least 1950, Computer Ethics has attempted to address the ethical issues related to workers in ICT. As in many areas of philosophy, there is no magic formula for solving these ethical dilemmas surrounding the design of work. However, an inclusive process can help in dealing with these complex questions. This process can start by identifying all the possible stakeholders in the ICT life-cycle. Highly important, but often forgotten, stakeholders in the ICT life-cycle are the workers who, in real-life, are involved in the manufacturing of electronic devices. A fair ICT should take into account their working conditions, their lives, their dignity, and their rights.

Several areas of work related to ICT production and manufacture need to be considered.

Geographically, what is happening in both Africa and Asia is of concern. A first area to investigate is the source of the minerals used in ICT production: most of the materials needed in ICT come from Central Africa, where mining firms are suspected of using child labour (OECD, 2004). The mineral mica is essential for the electronic industry for its unique properties of low thermal and electrical conductivity, and high dielectric strength. The mining of mica, in India and other countries, is well known for its high risk of involving child labour and other human rights violations (Schipper and Cowan, 2018).

In Europe, in 2016, an agreement was reached on conflicts minerals, such as tin, tantalum, tungsten, and gold. The agreement aims to ensure sustainable and responsible sourcing for European imports of these minerals essential for
the electronic industry: "... a huge step forward in our efforts to stop human rights abuses and armed conflict financed by trade in minerals." (EU, 2016).

Another important area to look into is the toxic hazards of workers in the chip manufacturing process: in 1985, for the first time, a Silicon Valley newspaper published a report on the health of semiconductor workers. The report described higher illness rates (and women's miscarriage rates that were significantly higher than in other industries) (SJMN, 1985). Unfortunately, the outsourcing of many chip manufacturing plants to the South-East of Asia does not resolve the occurrence of these dangers (Simpson, 2017).

In 2012, the conditions of workers in the ICT industry in the South-East of Asia reached the headlines of the New York Times: journalists described the horrific working conditions of many Asian ICT workers (Barboza and Bradsher, 2012). Unfortunately, more recent reports continue to confirm the critical working conditions in the megafactories of the electronics industry in South-East Asia, including: exploitation through excessive hours and poor wages, employment of underage and illegal workers, and the availability of only poor living standards (CLW, 2018; Condiffe, 2018).

Last but not least, an important contribution to this debate about fair employment was provided in 1999, by the Soesterberg conference in the Netherlands, where the conditions of workers in ICT manufacturing and life-cycle came under scrutiny. For the first time, the "principles for electronic sustainability commitment" were defined: "... each new generation of technical improvements in electronic products should include parallel and proportional improvements in environmental, health and safety, as well as social justice attributes" (Soesterberg, 1999).

In summary Slow Tech is described in the picture in Fig.1.
2.5. Towards a new computer science education

In the age of a "proactive computer ethics", Slow Tech can be a useful way for embedding "good, clean, and fair" values into the design of ICT systems. This can act as a contribution to a more fruitful co-shaping relationship between technology and society.

Particular importance needs to be paid in the building of a new computer science education to the role of an ICT stakeholders' network.

Of course, the ICT stakeholders' network is a complex one, and the dissemination of the Slow Tech concept is a real challenge, taking into account that ICT value-chains are indeed global networks of companies and stakeholders.

Identifying and addressing many of these issues requires examining the production, manufacturing, distribution, and use of ICT. Since the potential harms of the technology affect both the developed world and emerging economies, there is a growing need to involve international organizations like the United Nations, the European Commission, the International Standards Organization, and the International Labour Organization.
Looking at the roles of many stakeholders, it is easy to identify many potential and actual conflicts, in particular between companies with a weak social responsibility strategy and social actors such as users (e.g. due to poor design), the environment (e.g. due to ICT devices and applications with high levels of consumption in terms of materials and power), and the workers (e.g. due to poor working conditions in developing countries).

Indeed, Slow Tech could be seen as an approach that either naively tries to address these immense global issues or attempts to connect business strategies with corporate social responsibility, like the concept of creating shared value (Porter and Kramer, 2011). However, this thesis is humbly focused on the role that computer professionals could play in this complex scenario and the kinds of education and training needed to develop such an approach.

At a deeper level, there is a need for a reflexivity skill on the part of computer professionals on actual ICT usage and for an introduction of a longer-term view to counterbalance the immediacy and "short-termism" prevalent in the ICT world. Reflexivity has become a fundamental skill for computer professionals: the capability of looking at deep human belief structures, where cause and effect affect each other, and where the forces that shape the relationship between ICT and society are investigated.

Thus, a future roadmap for Slow Tech needs to identify all the major stakeholders and to identify possible future actions in the Slow Tech direction starting from universities and moving towards policy makers:

- universities

Universities could introduce a new computer science curriculum with "Social and Ethical Implications of Computing" as a core subject, to provide the Slow Tech "compass" to the next generation of future computer professionals alongside the basics of a Code of Ethics (ACM, 2018). In the academic world, there is an interesting connection between the Slow Tech concept in the ICT domain and the reflections on "fast-food research", which is based on the role of the "sustainable scholar". This is a scholar who is not focused on short-term research results, as in "fast-food research", but who concentrates on producing great works: "The defining feature of any great work is not so much how long it took to produce but how long it continues to be used" (Marinetto, 2018). Similarly, maybe "ICT sustainable scholars" will be needed?

- ICT vendors and cloud providers

This category of stakeholders includes involving all the main providers, hardware manufacturers, software developers, network providers, cloud
service providers, social network platform providers, in a debate about their corporate social responsibility. The issues to be addressed cover: workers' conditions, hardware repairability, the transparency of algorithms, standard data formats, the use of renewable energies in data centers, and extensions of this kind of analysis to their suppliers.

- users

Users are needed to raise the awareness of the opportunity to experience and enjoy: a human-centred ICT through being included in participatory design teams; awareness of the entire life-cycle of ICT from power consumption to repairability; the search for a more balanced life between online and offline; taking the Slow Tech opportunity to become informed ICT users.

- policy makers

Policy makers could define new guidelines and norms using the Slow Tech paradigm as a general ethical approach to ICT (which could have an impact on the entire ICT industry). They could define international norms to control the e-waste traffic involving the countries that pay the highest prices as dumping sites. Policy makers could include into the debate about ICT long-term sustainability new stakeholders like the planet and future generations via environmental advocacy organizations. Policy makers could establish market observatories and introduce a kind of "Slow Tech for ICT" assessment to new products and services.

In this complex scenario computer professionals play a central role. Even large companies are relying on the competencies and skills of computer professionals. This category of people is becoming more and more aware of its central role in the XXI century (Conger and Metz, 2018). Policy makers, users, and society in general will also play important roles. However, the focus of this thesis is on the role, the competencies and skills needed by computer professionals to build a Slow Tech approach in ICT.

The questions become: How can computer professionals be prepared for this future crucial future role? How can they acquire their ethical competencies and skills? What kinds of research and teaching activities are needed in universities? How can Computer Ethics be introduced as a basic competence into Computer Science and Engineering curricula?
3. Teaching Computer Ethics to Engineers

"Technology shapes and is shaped by society. They're inextricably intertwined. We have to keep stressing that engineering is a social activity"

Deborah G. Johnson
(Johnson, 2017a)

Society is asking more and more digital services from ICT providers and, at the end, from computer professionals, who are the core node of the ICT domain (see Fig.1). Engineers will need the skills to handle the multitude of complex issues faced by society, including the ability to run the process of thinking in the right way. In short, society is asking computer professionals to be ethically competent, but how can they become ethically competent?

Around the globe this ethical challenge is well recognized, and many engineering schools are introducing ethics in the curricula of computer science and engineering (Pretz, 2018). However, it does raise other related challenges including: How can teachers stimulate an ethical way of thinking, a right way of thinking, and a philosophical way of thinking? How can the complex relationship between technology and society be investigated so as to reason appropriately about what is right and what is wrong in ICT projects?

Recognizing the need of a proactive form of Computer Ethics, in Chapters 1 and 2, the Slow Tech approach to ICT has been discussed by posing a number of core questions: How can ICT be socially desirable? What is a good ICT? How can ICT be environmentally sustainable? What is a clean ICT? And how can ICT be ethically acceptable? What is a fair ICT? All six of these questions refer to the competencies and skills needed by computer professionals. Yet, what - more precisely - are the ethical competencies that computer professionals need to acquire and how?

In this third chapter of the thesis, the focus is on the task of teaching computer ethics to engineers; the philosophical and pedagogical bases of "ethics education", and the tools for training engineers' capability to question
technology, enlarging the context of technology view, drawing a complex ICT stakeholders' network, and improving their philosophical skills. In support of resolving a number of these challenges, several reference works are introduced. In particular, the two approaches of Virtue Ethics and Future Ethics are proposed as good theoretical backgrounds for future engineers to handle the challenges that they face.

A methodology for teaching Computer Ethics is proposed. It is a case-based approach that is divided into four steps:

- a description of a scenario involving an ICT development,
- the drawing of the stakeholders' network related to the case,
- a reflection on the nodes and relationships of the network aiming at the identification of potential ethical issues, and
- a final step through which students can express themselves with proposals for facing these challenges and dilemmas.

Some results from the field, that have emerged from ten years of experience in teaching Computer Ethics at the Politecnico of Torino (Italy), are discussed at the end of the chapter.

This chapter relates to paper IV and paper V in the appendix.

3.1. Philosophical background to teaching computer ethics

Engineers and computer scientists come from many years of study in a domain where the scientific method is based on experiments and the central question is "What is true? What is false?". One of the first masters on questions of truth or falsehood was Zeno of Elea (495-435 B.C., see Fig.2), a pre-Socratic philosopher considered by Aristotle to be the inventor of dialectic.
Despite changing shifts in scientific paradigms throughout history (Kuhn, 1962), the focus for scientists, in particular for engineers, is that when the Galilean process (observation, theory, prediction, and evidence) leads to positive test results through experiments, they search for applications. The innovation process (creativity, feasibility, prototyping, and engineering) begins here; then new products and services are deployed in society. The reliability of this process is based on evidence: all scientists agree to expose their claims to "... the demanding objections of competent colleagues" (Stengers, 2018).

The approach changes completely when one comes to ethics. In ethics, the central question becomes "What is right? What is wrong?". This branch of philosophy, which provides a process for studying the objective, rational backgrounds of thought and actions, enables the elaboration of norms of behaviour. It distinguishes and rules the choice between right and wrong.

The difference between these two sets of approaches is the main difficulty faced by engineers and computer scientists when coming to Computer Ethics. Yet this dilemma is also becoming a fundamental area of education and training for the future computer professionals.

While scientists or engineers are familiar with handling experiments that search for evidence, by analysing true or false scientific statements, it is much more difficult for them to deal with right or wrong value statements. In the true/false dimension, there is the possibility of finding a common ground for collaboration; however, the right/wrong dimension - the common ground, for example, of universal human rights - it is complicated by the existence of different beliefs, cultures, histories, religions, morals, and education systems.

In the true/false domain, a good example of peaceful collaboration among scientists is the CERN (the European Organization for Nuclear Research), that
has since 1954 represented the largest collaborative research project in history, hosting scientists from all over the world (CERN, 2014).

In the right/wrong domain, the need for a global ethics framework for facing at the global level ethical dilemmas, like scarce resources, migration, climate change, global trade, global pandemics, was recognised just a decade ago and needs more time to establish a solid background (Widdows, 2011).

In science, and in particular with ICT, the challenge is even greater, due to their continuously rapid evolution into unknown territories of knowledge.

A fundamental question arises: "Can we teach ethics?". A number of interesting contributions from different fields and eras of philosophy, as well as engineering itself, help to cast light of finding a response to this query.

One of the interesting connections between rationality and critical reasoning comes from Baruch Spinoza (1632, 1677). In his most famous work, "Ethics - demonstrated in geometrical order", Spinoza draws a correlation between the moral progress of human beings and their intellectual progress, their autonomy. Passions, at the opposite end, place humans under the domination of things that lie outside of them, a shift towards heteronomy. According to Spinoza, good choices and happiness are the fruits of critical reasoning, of rationality and not of passion: "...Without intelligence there is not rational life: and things are only good, in so far as they aid man in his enjoyment of the intellectual life, which is defined by intelligence" (Spinoza, 1677). Following Spinoza's proposals, it looks like ethics can be taught, but this implies that one is teaching "critical reasoning" in order to cultivate "moral autonomy".

An interesting different contribution can be found in the works of David Hume (1711-1776). Hume suggested to introduce the scientific method to study not just the physical word, but also the better understanding of human beings, that is, to develop knowledge about humans starting from experience, not from theoretical a-priori ideas (Hume, 1738). In particular, Hume views about ethics are located his work entitled "An Enquiry Concerning the Principles of Morals": moral decisions are grounded in moral sentiment, so ethical actions are not governed by knowledge, but by sentiment, and reason cannot be behind morality. Morals cannot have a rational basis (Hume, 1751). This position complicates the scenario even more for engineers.

The crucial question "Can we teach ethics?", specifically in the engineering field, obtains different answers (Johnson, 2017) depending on whether the issue is explored by sceptics or non-sceptics (that is those who are confident that ethics can be taught to engineers).
There are different intensities of scepticism. Among sceptics there is a belief that ethical behaviour is neither a matter of reasoning or reflection but is more primitive. According to them, ethics is something that a person either has or does not have. All the training, teaching, studying, reading, or sitting in lectures on ethics will not make a person more ethical if he or she does not possess these core values to begin with (Worthington, 2010). Another strong sceptical position comes from Karl Stephan, a professor of engineering: "... if eighteen-year-old kids don't know right from wrong by the time we get them, they're not going to learn it from us." (Stephan, 2004). A more subtle form of scepticism about teaching ethics is founded on the assumption that ethical decision making is based on moral intuitions, not reasoning; moral judgment is caused by quick moral intuitions and is followed (when needed) by slow, ex post facto moral reasoning (Haidt, 2001).

Despite sceptics, there are many researchers who are confident about the possibility of teaching ethics to engineers. They share the belief that ethics education is focused on ethical reasoning and it tries to provide students with information, ideas, and experiences that will develop their ethical reasoning skills. Indeed, ethics' skills, is a requirement for engineers: the ABET (Accreditation Board for Engineering and Technology) in the USA requires training in ethics as part of the curriculum: "... an understanding of professional and ethical responsibility" (ABET, 2014).

According to Deborah Johnson, engineers often encounter difficult and controversial situations, ethical dilemmas for which there are no already formed intuitions: thus, the old question about "what is going on internally when a person makes a moral decision?" remains open to debate (Johnson, 2017). Indeed, this debate has deep historical roots in philosophy, going back to Plato (in the Symposium): Is the reason a slave of the passions? Or are the passions a slave to reason? (Plato, 2019a). For Johnson, therefore the question is then not if we can teach ethics, but what can and should be the goals of engineering ethics education? How can they be achieved?

Johnson makes an interesting proposal that, whatever characters student engineers already have, ethics education is a set of activities that provides them with basic knowledge about "codes of ethics and standards of behaviour", develops their skill at interpreting and applying these codes and standards, and increases the likelihood that the students will be prepared to handle ethical issues once they enter in their professional lives (Johnson, 2017).

The use of scenarios from real situations is one of the possibilities. Thus, the idea of teaching ethics can be organised around exposure to case studies, based
on the hope of increasing the likelihood that new engineers will identify an ethical issue early on before a project becomes too advanced (Abaté, 2011).

At the same time, Johnson admits that real-world situations are often complex and require more than simply following rules, and it is crucial to improve students’ ethical decision-making skills.

In conclusion, according to Johnson, ethics can be taught to engineering students, by providing with knowledge (codes and standards), skills (the ability to identify ethical issues), but the students also need reasoning capability (the ability to make moral decisions) and motivations (the will to take action) (Johnson, 2017).

3.2. Protagoras and Socrates: how can ethics be taught?

After recognising the arguments in favour of the need for an ethics education for engineers, and the fact that it can be taught, how can it be implemented?

The dialogue between Socrates and Protagoras is a wonderful discussion about the possibility of teaching values and also about the right methods to use. It enables clarity about the implementation of ethics teaching and learning.

The question "Can we teach ethics?" is one of the oldest in the history of philosophy: in 390 B.C., in the Protagoras dialogue by Plato, the question is addressed as to whether "can virtue be taught?" (Plato, 2019b).

The dialogue takes place between Socrates and Protagoras, a clever man, one of the main sophists. In ancient Greece, the sophists were teachers specialised in using the tools of rhetoric. They claimed to teach "virtue" and they were often employed by wealthy people to educate young nobles.

The dialogue, which is one of the most famous of those by Plato, raises the question of what is really the subject of Protagoras' teaching? Is he just teaching the ability to make a good speech? Protagoras is selling his knowledge, but in what sense knowledge can be sold? And why should one buy knowledge?

Socrates underlines that the risk related to buying knowledge is greater than the risk of buying food. In the case of food, one can analyse and test it, while in the case of knowledge one must test it on one's self, into one's soul. Food simply satisfies a cyclical physical need for survival. Knowledge can change or damage one's life forever, irreversibly: to know means to change. According
to Socrates, knowledge cannot be evaluated as can be a physical object. A *sophist* sells something, but he can be misleading in praising his merchandise, without worrying about the good or bad effects on his clients. This risk becomes too high when knowledge in "*on sale*", since knowledge has a deeper effect on human beings than food, since it enables humans beings to *judge* everything.

The question as to whether *virtue* can be taught leads to the related question of whether virtue is "*wisdom*" or "*knowledge*". However, the crucial point in this dialogue is what is the *process of teaching virtue*.

The teaching style of *sophists* like Protagoras does not need dialogue since the speaker just describes in better words what others already know: political and ethical knowledge are assumed to be already present, and therefore do not need to be built through dialogue. According to Protagoras, justice and modesty can be considered the *language of living together*, and the *sophists* are special since they can help humans to use this "*language*" in an excellent way. *Sophists* share the same knowledge as others, but have a special skill for teaching it to others.

Socrates underlines that many public speakers are able to make long speeches, but knowledge communicated only one-way, without dialogue, is superficial knowledge or even an exercise of power. Socrates raises the issue of the power relation in a dialogue: if knowledge is "*on sale*" and part of a competition among the best *sophists*, then the speaker will choose the more advantageous form of communication. Long speeches, and speeches without dialogue, are tricks for keeping other people silent and making it difficult for them to follow and criticise certain logical passages. It is the preferred means of communication by forms of centralized power since do not favour interaction.

But Protagoras is the best *sophist*, he sells his knowledge in a competitive market. His communication must monopolise the time and the attentiveness of his audience. *Sophists* cannot afford to use the *dialogic principle*, a *collaborative approach* and *critiques*. If knowledge is "*for sale*", then other people are either *competitors* or *clients*! Sophists cannot consider others as peers searching for knowledge.

Socrates' major claim is that all virtues have *wisdom* as their essential component. Each virtue can have a different character, but a *virtue* *is a virtue since it has the basic components of knowledge and wisdom*. But, how can science and virtue be taught?

Training for gaining knowledge and wisdom is crucial, it is not just to expose something better that is already known but it is to *govern one's own life*
through wisdom. If virtue is knowledge and self-government, it can be developed only through one's own personal awareness and not through passively hearing long propaganda monologues.

That is why Socrates prefers the myth of Prometheus, god of techne, since it is he who gives autonomy to humans. Virtue as knowledge cannot be bought by money and cannot be just passively received, but everyone, dialoguing with other humans, must understand and build it him or herself.

According to Socrates a "teachable virtue" is an exercise in critique and awareness which is very different from the traditional one-way of teaching of sophists. A habit or a character is acquired, it is not teachable. However, how to think in the right way is teachable: dialoguing with others and with oneself.

Again, the issue is not if we can teach ethics, but how.

This ancient dialogue provides some useful hints about the process of teaching ethics to engineers. Ethics teaching and learning cannot be a passive experience for students, they need to interact and participate actively in the classroom in order to gain a "moral autonomy".

Interestingly, Aristotle in the Nicomachean Ethics (book VII) criticises Socrates's position by saying that the problem is not only to know what is good or bad (since there are people who know very well the bad consequences of an action, but nevertheless go ahead anyway). According to Aristotle, the challenge is that one does not always know what one is supposed to know. To learn matters without internalising them will not help in following the good (Aristotle, 2019). Internalisation is crucial.

So, the method of learning is also of extreme importance, as is the way in which one is educated. The education process becomes important: it is particularly interesting as a basis for the following fundamental questions about teaching ethics to engineers.

3.3. Development of ethical competence

The question about the acquisition of ethical competencies, and knowing what is right and what is wrong, is also investigated in psychology. One of the most important psychologists of the XXth century was Jean Piaget (1896-1980) well known for his work on child development, in particular on the importance of the education of children. In his fundamental book "The Moral Judgement of the Child", he explored the construction of the system of rules in the child (Piaget, 1932): what is known as moral autonomy.
If morality is a system of rules, then it is interesting to study how children develop these rules and how their mind comes to respect these rules.

Piaget studies two phenomena related to these rules: the practice of rules (how the rules are applied at different ages) and the consciousness of rules (how the rules are considered by children: Are the rules sacred? Can they be changed? Are they considered through an approach that focused on autonomy or heteronomy?).

In investigating the relationships between practice and consciousness, Piaget positions the background for defining the psychological nature of moral realities. This investigation was performed in the field by interviewing children of different ages, in the city of Geneva, about the rules of the game of marbles.

In the practice or application of rules, Piaget identifies four different stages: 1st stage (the rule is executed with a "motor" or "individual" approach, the child applies a ritualized schema, the play is purely individual), 2nd stage (between the ages of 2 and 5, the "egocentric" stage, the child receives codified rules from outside, children are still concentrated on themselves, they play alone even if they are in the presence of others), 3rd stage (ages 7 and 8, is
defined as the "cooperation" stage, when each child tries to win and begins to be concerned about rules and mutual control, yet their ideas about rules are still vague), 4th stage (ages 11 and 12, is defined as the "codification of rules", when children know the rules very well but, most importantly, they start to think about possible variations, since the rules are no more sacred in themselves).

In the consciousness of the rules, Piaget identifies a progression of three stages: 1st stage (rules are not yet coercive, they are just received and kept as "interesting examples"), 2nd stage (begins during the egocentric stage and ends in the middle of the cooperation stage: rules are sacred and untouchable, they emanate from adults), 3rd stage (covers the end of cooperation stage and the codification of rules), rules are seen as a result of mutual consent.

The correlation between the two dimensions is clear (see Fig.3). The collective rule at the beginning is "external" to the person, and is consequently "sacred". Gradually, as the individual starts to build rules on his or her own, the rules start to be seen as thinking in the right way, and as representing the ability to think on a rational basis (to have an autonomous conscience).

As Piaget defines this sequence: democracy follows on from theocracy (the state when rules come from God) and gerontocracy (adults define rules): "... The moment a child decides that the rules can be changed, he ceases to believe in their endless past and in their adult origin" (Piaget, 1932, p.66).

In short, autonomy follows on from heteronomy.

Interestingly, Piaget continues his investigation by questioning the gender dimension of rules and learning: Are girls following the same progression? He uses the game of "Marelle" or "Semaine" (hopscotch and the thinker game) and reaches the conclusion that "we find the same process at work...".

The conclusion of Piaget is that there is a correlation between cooperation and the consciousness of autonomy. When children really start to submit to rules and to apply them with an approach of genuine cooperation, they acquire a new conception of rules: again, autonomy succeeds heteronomy.

Piaget's research can be useful in ethics education: when an engineer acquires some kind of autonomy (e.g. by carefully analysing all the stakeholders involved in a system's design) then he/she would be able to identify new moral dimensions and master norms. This competence is even more important nowadays since many complex systems incorporate norms and rules in software codes, "code is law" (Lessig, 1999). Thus, the work of Piaget is central to the development of Computer Ethics education: it is fundamental.
for understanding how engineers can think, view, create, change, revise norms, how their moral thinking develops, and how they can be trained.

Another psychologist, Kohlberg, also worked on moral education. He advanced the ideas of Piaget further. He described the approach to moral education that he called the "Just Community Approach" (Kohlberg, 1985). It is based on the concept of moral education in terms of six moral stages aggregated in three phases: Phase I (Preconventional Level, at Phase I the child responds to rules in terms of physical consequences as Stage 1: Punishment-and-obedience orientation, goodness and badness are determined only by their physical consequences, independently of the meaning or value of these consequences; Stage 2: Instrumental-relativist orientation, the right action is the one that satisfies one's own needs and occasionally the needs of others; some elements of reciprocity are present, but only in a physical and pragmatic way.;), Phase II (Conventional Level, the attitude is to conform to personal expectations, social order, and apply loyalty to it through Stage 3: Interpersonal concordance or "good-boy, nice-girl" orientation, good behaviour is the one that pleases, helps and is approved by others; one earns approval by being "nice"; Stage 4: "Law and order" orientation, right behaviour is doing one's duty and respecting authority, rules and social order); in Phase III (Postconventional, Autonomous, or Principal Level) it becomes important to define abstract moral values and principles as valid, independently of the individual as Stage 5: Social-contract legalistic orientation, when the emphasis is on the "legal point of view" but with the possibility of changing the law in terms of rational considerations of social utility; Stage 6: Universal-ethical-principal orientation, the right decision is the one that is consistent with self-chosen ethical principles, logical comprehensiveness, universality, and consistency like justice, reciprocity, equality of human rights, dignity of human beings as individual persons.

This model is based on the assumptions that the process of education is defined by a development and that a higher stage is a step towards universal principles.

Kohlberg's proposes moral education not as being based on a "one-way street" view, but as a reciprocal collaboration with the main actors involved, like teachers.

The practical experiments of participatory democracy executed in classrooms assume the teacher as simply one member of a democratic political community: the "just community". This approach is based on the notion of justice according to:
- Rawls (who wrote of justice as a social contract by rational actors who choose principles of justice and rightness which they would accept independently of their social position, the famous Rawls' "veil of ignorance") (Rawls, 1971),

- Kohlberg (the "ideal role taking" or "moral musical chairs") (Kohlberg, 1981; 1984), and

- Habermas ("discursive with formation" or mutual modification of claims and needs in light of the claims and needs of others, through a dialogue process manifested in an ideal communication situation, free of domination or manipulation) (Habermas, 1989).

The just community is based on the integration of the concepts of justice and community, since, according to Kohlberg "collective moral education is compatible with participatory democracy" (Kohlberg, 1985, p.44).

Kohlberg presents experiments and examples of "just communities" like the Cambridge Cluster School and Scarsdale Alternative School. The experiments studied the development of the several phases and stages of a just community through the three dimensions of the:

- Degree of Collectiveness of a rule (from "me" to "we"),

- Constituency of the Norm and

- Prescriptivity of the Norm.

Kohlberg's conclusion was that the "just community" is in line with the Habermas' concept of "ideal speech": where a universal speech ethics applies in an ideal speech situation involving the possibility of unlimited discussion in which moral claims can be "redeemed" or justified by open argumentation among philosophers, for example (Habermas, 1989).

The "just community" is a process that enables and increases moral autonomy with "collective socialization". Students learn not that "I must conform to the group" but that "We are legislating norms and if we all legislate these norms we must all act upon them". It is similar to the Kantian notion of autonomy, "the property of the will by which it is a law to itself" (Kant, 1785).

How can the works of Piaget and Kohlberg be of interest in the context of this thesis about teaching computer ethics to engineers? Their works can be useful in ethics education for the following reasons: a good level of autonomy and a good dialogue among participants can be an experience that facilitates the
identification of ethical issues in a complex scenario (like the ones that are evident in discussions of "ethics for engineers"), improves their awareness about conflicts, develops their "thinking in the right way", and their capability of thinking about potential alternative scenarios that address those ethical issues. An analogy with software development is immediate: are the software designers directly involved in a dialogue with the potential users of the software application?

Training for ethical competence

Several studies concentrate on the ethical competencies of ICT engineers and on how to integrate ethics into ICT design. Some of them are focused on the importance of the process of ethical decision making, which places an emphasis on the path (process) that it takes to reach conclusions as being more important than the conclusions themselves (Kavathatzopoulos, 1991; 1993).

Kavathatzopoulos's studies concentrate on "moral development", starting from the works of Kohlberg and Piaget. He underlines that while Kohlberg studies the characteristics of the concrete-abstract dimension of the development of moral thinking on a person's way of discovering of moral principles ("... a movement to higher more abstract and universal moral principles which regulate the moral thinking and action of the individual"), Piaget focuses his interest on the formation of the autonomous moral function, on the process of development of (independent) moral thinking and action. Piaget's theory is a constructivist theory, a theory of construction of moral autonomy: "... each individual's moral structures are constructed by him while he is acting upon the social world he lives in" (Kavathatzopoulos, 1991, p.48): this is progressive and adaptive process to social reality.

Kavathatzopoulos introduces into this process the role of instruction and its positive impact on the acceleration of development. He argues that it is possible to stimulate the acceleration of the development of moral thinking through suitable instructions. Several empirical studies demonstrate this phenomenon, independent of the sex and age of participants and they also show that the personal authority of the instructor/tester did not influence the effect of the instruction. These studies show that it is possible to accelerate the development towards Piagetian moral autonomy by using suitable instruction, but this effect can be studied only in a social situation where both thinking and action are involved (Kavathatzopoulos, 1988).

These are the typical working conditions of an engineer: thinking and acting. Looking at different stakeholders from different point of views, analysing the many dimensions or aspects of a complex scenario with an open dialogue, can therefore be useful for the ethics education of engineering students. As a result,
a number of examples of tools and methods to teach computer ethics to engineers are explored in what follows. They include the notion of stakeholders' network especially in the field of ecology, decision support tools, the process of decision-making, and the importance of philosophy - in particular, the two approaches of virtue ethics and future ethics.

The complexity of the ICT stakeholders' network requires to computer professionals to take a global view, since many of the suppliers are indeed global networks of providers.

Teaching ethics to engineers starts from the assumption that there are also some examples of good practices around the world that are inspirational ones.

For example, if one looks at the "clean" side of ICT, that is, to the environmental issues like repairability and recyclability, then very few ICT companies adopt innovative and future-proof approaches in line with the circular economy principles. One of the rare examples is the Dutch company that designed the Fairphone, a smartphone that is considered to be the first "ethical and modular smartphone" (Fairphone, 2019) since it is based on the approaches of long-lasting design, and on using fair materials, taking care of the good working conditions of people, and reducing and recycling of e-waste. On another front, the international environmental advocacy organisation, Greenpeace, focuses attention on ICT in a detailed report with a ranking among the world's leading ICT vendors, with reference to their environmental impacts by evaluating energy use, resource consumption, and chemical elimination (Greenpeace, 2017).

What is clearly emerging is the need for a new competence for engineers: the capability of making choices in a complex scenario, in which there are many stakeholders and (maybe conflicting) relationships: they need an ethical competence.

Other researchers concentrate on the potential use of ICT systems as decision support tools, in particular in dealing with complex decision-making processes. Indeed, ICT can be useful technical supports since: "... to make moral decisions, it is important to have reasonable alternatives, and access to all relevant information" (Laaksoharju, 2014). It is important to underline that the decision maker needs tools for evaluating arguments for different alternative decisions. ICT can provide the technical possibilities to support information gathering, and to explore alternative scenarios. All stakeholders ought to be described in as full a way as possible, including the relationships among them (what are their interests?). This kind of technical tool for sure increases the autonomy of the decision-maker since "... autonomy is the
necessary disposition to achieve true ethical competence" (Laaksoharju, 2014).

So the several normative philosophies become less important for the decision-maker than the identification of the most relevant aspects of the moral problem in front of him/her. The process is more important than the result.

These works provide the background for an approach to teaching ethics that could be improved by suitable instructions and activities, and in which it is possible to use ICT applications as ethical decision support systems.

Another important contribution to ethics education for ICT engineers underlines the need for incorporating ethics into the ICT systems development process itself, by integrating the three domains of computer science, philosophy, and management. In this context: "... a major concern is to make the humanities accessible to engineers and IT innovation teams" (Spiekermann, 2015).

Other researchers focus on professionalism and for them ethics education should focus on practical applications, on the ability to solve ethical problems morally or technically, and on the importance of: "... the values that guide the day-to-day activities of computing professionals" (Gotterbarn, 1991). Having a knowledge of a professional code of ethics is becoming a requirement in ICT ethics education (Gotterbarn and Miller, 2001). In this light, it is very interesting to examine the evolution of the ACM Code of Ethics with its last release in 2018 (Gotterbarn et al., 2018a), at the definition of "thinking professionally" in ICT (Gotterbarn et al., 2018b), and at the fundamental importance of ethics for computer professionals in real contexts, also by increasing their awareness about the risks of unethical practices (Rogerson, 2018).

In recent years the interdependency of all countries worldwide and their interconnection via global networks is also becoming an important aspect towards teaching ethics in a global dimension (Collste, 2016).

Historically, looking back at the beginning of the Computer Ethics discipline and its very first definition, it begins with a "Starter Kit in Computer Ethics" (Maner, 1980). At that time, the starter kit represented an important resource that contained curriculum materials and pedagogical advice for university teachers who wished to develop Computer Ethics courses. It included suggested course descriptions, justifications for offering these courses, objectives, teaching tips, and discussions of topics. Many universities introduced this subject thank to the work of Maner (SEP, 2019).
Last but not least, there are many ethical approaches that have been described throughout the history of philosophy. Among the main ones are: consequentialism (the focus is on the consequences of actions), deontology (the focus is on the actions themselves), virtue ethics (the focus is on the actor [the acting person] and his/her character traits), and future ethics (the focus is on the potential impact on future generations and the planet).

In particular, the last two, virtue ethics (what are the ethical skills needed by computer professionals?) and future ethics (how is possible to take care of the impact of our actions on the future?) are the most promising approaches for teaching ethics in engineering schools. They can provide engineers with the basic competencies of analysing the ICT stakeholders' network and for understanding of the complex relationships between ICT systems and the planet.

3.4. Virtue Ethics and Future Ethics
Two forms of ethics can be of particular use to engineers, when they are being taught computer ethics. They are virtue ethics and future ethics.

Virtue Ethics
Virtue ethics emphasises the virtues of the person's mind and character. The philosophical debate is concentrated around the definition of these virtues, how they are acquired, and how can they be applied in real life scenarios. The related key concepts of virtues are "arete" (excellence or virtue, a character positive trait, a specific disposition of the person), "phronesis" (practical or moral wisdom, an acquired trait that enables the person to act in complex situations, with a sensitivity about what is needed in a situation), "eudaimonia" (flourishing, the "well-lived life", a useful quality in human communities; according to Aristotle, it is the proper goal of human life: "... an activity of the soul in accordance with perfect virtue") (Aristotle, 2019).

Even if virtue ethics was formulated by Aristotle in 350 B.C., it is still relevant for computer professionals today. In the context of ethics for engineers, probably the most appropriate virtue to develop is "phronesis": thinking and acting in complex situations.

Looking at the multi-dimensional challenges of ICT long-term sustainability, it is clear that a complex collection of virtues is needed by engineers. They need: expertise/professionalism, clear and informative communication, cooperation, willingness to make compromises, objectivity, being open to criticism, stamina, creativity, striving for quality, having an eye for details, and having the habit of reporting on work carefully (Pritchard, 2001).
The aspect of the practical wisdom involved in virtue ethics is required by engineers: they need the ability to make ethical judgments in complex situations, in a real context (Van de Poel and Royakkers, 2011).

They need the ability "to think like a God", thinking in the right way, having the skills to handle a multitude of complex issues, that is, essentially, they need the virtue of phronesis (Aristotle, 2019). Engineers need the ability to make choices when facing of complex situations that feature many, possibly conflicting, pressures. As a consequence, ICT ethics education should concentrate on developing in people the skills to think in the right way. Engineers need an "active thinking", a way of thinking proposed by Hannah Arendt (Arendt, 2003), to overcome the ancient opposition of reason and passion, a thinking that is deeply intertwined with the world, so as to prepare responsible participation in the real world. This is a commitment to think responsibly, tools for bringing new awareness into one's own actions, to become capable of judging and acting in the real world, as in Ancient Greece, where philosophy and politics were inseparable (Arendt, 2003).

Accordingly, ethics education should prepare computer professionals to act in real projects, in the real world. Computer professionals cannot say "I am just an engineer", asking implicitly to be considered "neutral" in the co-shaping between technology and society. Responsible computer professionals take care of the consequences of their design choices when developing powerful tools (Hutson, 2018). As the distance between technology development and society is becoming smaller, the separation between the design stage and the deployment of innovations in the society is blurring. Virtues such as practical wisdom, considered as a skill, are useful to engineers for facing the challenges of the future. Virtue ethics can be the "platform" for "future ethics", the skill needed in future contexts.

Future ethics

The view about long-term sustainability is strongly related to the future of the planet and future generations.

One of the first philosophers to introduce these planetary and generational dimensions was Hans Jonas: he underlined the need for appropriate technological choices with regard to the planet and future generations. In his fundamental book,"The Imperative of Responsibility: In Search of Ethics for the Technological Age", he focused on social and ethical problems created by technologies and on the need, for the survival of human beings, to care for the planet and its future (Jonas, 1979). Future generations are included in the ethical debate, and they have to be introduced as a new stakeholder in the network for ethical reflection.
The speed of exponential ICT evolution is introducing another challenging characteristic to this long term view of technology. An ethical approach is needed that takes into account these characteristics is the "future ethics".

*Future ethics* concentrates on the key problem of "uncertainty" related to the proactive ethical assessment of technologies, in particular in complex systems development. What kind of consequences could uncertainty have for ethics (Sollie, 2007)?

More recently, other authors propose *future ethics* as a collection of advice and recommendations about how to handle controversial technologies such as: algorithmic bias, persuasive technologies, and autonomous war (Bowles, 2018).

In this thesis the concept of *future ethics* is focused on the urgent need for a long-term view of ICT. The extreme consequences of the industrial revolution have brought humanity into the *Anthropocene* era, the current geological age, the epoch during which human activity is the dominant influence on climate and the environment, and which has significant human impact on ecosystems. Indeed the start of the *Anthropocene* is conventionally put at July 16, 1945, the date of the first detonation of a nuclear weapon.

For the first time in history, humanity could be in a situation to imagine a future world "without us". Can one really imagine this scenario? And how does this future vision influence present behaviour? What kind of ethics is therefore needed? What are the norms that will steer humanity in the right direction? What can computer professionals learn from *future ethics*?

For example, in terms of climate-change, CO₂, a by-product generated from the combustion of fossil fuels, is the main component of greenhouse gases. By increasing their concentration in the atmosphere, these gases cause an increase in the world's average temperature, the so called "green-house effect": "The existential threat from human-caused global warming is ominous and getting worse" (BAS, 2019). What is the relationship between ICT and climate change? As seen in the *Clean ICT* chapter on *Slow Tech*, ICT is contributing to this green-house effect. As a result, *future ethics* is becoming a competence needed by computer professionals: it should steer them towards the long-term sustainability of ICT systems.

What are the common characteristics of these various challenges? The commonalities are their risk of irreversibility and their serious impact on future generations. Here, the time dimension starts to play a role in the ethical analysis. Being aware of something in the future becomes the trigger for taking action in present time. But how can the future be introduced into an
ethical analysis? Jonas suggests to introduce "new stakeholders" in the philosophical and ethical debate: the planet and future generations. Are humans acting in a responsible way in front of them? This way of thinking will push people in the direction of a new, outcomes-driven ethics, in which present actions are driven by an urgency that is posed by some forecast scenarios. In this context, the term "scenario" is used accordingly with the recent definitions coming from the field of "scenario analysis": "scenarios should be possible and plausible ... and they exist in sets that are systematically prepared to coexist as meaningful alternatives to one another" (Spaniol and Rowland, 2019).

But the difficulty arises when present computer professionals have to find the right balance among the rights of living and future generations: the core problem of future ethics.

How can ICT designers, policy-makers, and users take action now, changing their choices and decisions now, and taking into account these future risks? As a side effect of this urgency, there is the very actual risk of assuming a kind of fatalism and a refusal to think.

It is common to apply ethics to human relationships, to living entities in the present time. But ICT systems have also some consequences in a distant future, and humans can miss detecting the consequences of their actions. They can imagine some impact on the next generation, but what about long-distant future generations?

The impact of actions is historically focused in terms of scope and time. In the present era, some ICT systems and applications have a potential impact on the entire planet and on many future generations. Future ethics represents a challenge for philosophers, ethicists, researchers, and for the entire society: how can people develop a new stage of ethics when the consequences of their acts are so far distant in the future? (Birnbacher, 2006).

In ethics education for engineers, this means introducing new stakeholders into the ICT stakeholders' network: the planet and future generations. This is exactly one of the new skills needed, to be able to see more aspects of a problem, to discover new stakeholders and new relationships. This also opens a new way to address the difficulties of training for future ethics: if it is impossible to forecast future problems, then it is better to concentrate efforts on the skills needed by engineers such as the virtue of "Phronesis"!
3.5. A methodology for teaching Computer Ethics

In 2008, a Computer Ethics course was introduced at the Doctorate School of Politecnico of Torino (Italy). A description is offered of the approach of the course from beginning to end, the published material used, and the pedagogical approaches. The description ends with an example use case involving graphene.

Students on the course are engineers emerging from many years of education in science and technology. For many of them, it is the first opportunity in their life to get in touch with ethics.

The very first lectures of the course are dedicated to a familiarisation with the capability of questioning technology: engineers are very smart in the art of finding answers to problems (the Latin "Ars respondendi", the art of responding, finding solutions), they consider themselves to be "problem solvers", but they are not familiar with the art of questioning (the Latin "Ars interrogandi").

On the course, there are several initial ways of capturing engineers' interest in ethics. The provocative motto from Lovins is quite surprising for them: "Technology is the answer! (But what was the question?)" (Lovins, 1991). The famous joke by Picasso about computers maybe useful for triggering a brainstorming session in the class: "Computers,... But they are useless. They can only give you answers" (Picasso, 1962). The works of Kranzberg, one of the main experts in the history of technology, are introduced. His famous "law" is another good starting point for a dialogue with engineering students: "Technology is neither good nor bad; nor is it neutral" (Kranzberg, 1986).

Examples of the stances of previous scientists can be useful. In the initial part of the course, some very interesting examples of scientists who have reflected on the potential impacts and consequences of their works are presented. Probably the most famous is Leonardo Da Vinci, who refused to publish his works on submarines in 1506 because of the risks of military applications: "I do not publish nor divulge these, by reason of the evil nature of men, who would use them for assassinations at the bottom of the sea" (Da Vinci, 2002). Or more recently, the founder of Computer Ethics, Norbert Wiener declared in 1947 in the Atlantic Monthly: "I do not expect to publish any future work of mine which may do damage in the hands of irresponsible militarists..." (Wiener, 1947).

Published materials to be used on the course range in time over at least the past thirty years. In the first part of the Computer Ethics course, materials from the collection of course syllabi on "Computing and Social Responsibility"
prepared by the international association *Computer Professionals for Social Responsibility* in the 1990s are fundamental in preparing the background for the initial ethical reflections about ICT (Friedman and Winograd, 1990).

The course then focuses on a set of core subjects, and continuing the dialogue with students by introducing real cases that they analyse together in the class. The materials from the "*Teaching Computer Ethics*" handbook published in 1991 are still very useful (Bynum et al., 1991). In particular, the approach of a "*Capstone course in Computer Ethics*" by Gotterbarn suggests also some practical activities for acquiring "ethical competencies": "... The goals of the course include: student socialization into professional norms, recognition of role responsibilities, awareness of the nature of the profession, ability to anticipate ethical issues, ability to reason from professional standards to practical applications, ability to solve ethical problems morally or technically" (Gotterbarn, 1991). A good reference on "professional norms" is provided by the recently released, 17 July 2018, ACM (Association for Computing Machinery) Code of Ethics (ACM, 2018).

*A Methodology based on the ICT Stakeholders' Network*

What is a stakeholders' network? One of the fundamental tools for triggering a reflection about potential ICT ethical issues is the *ICT stakeholders' network*. It is the visual representation of a graph with *nodes* and *arcs* of all the entities, persons, groups, or organisations (the *nodes*) involved in some way in a development, and their *relationships* (the *connections* or *arcs*). See a typical one in Fig. 4.
These arcs have arrows on one side only when the relationship is mainly "one way" (e.g. hardware makers provide equipment to other nodes), and on both sides when the relationship is bidirectional (e.g. policy makers define the norms for users, then users provide comments and feedback to policy makers).

These arcs and arrows are a key part of the stakeholders' network since they describe a possible asymmetry, power relations, and impacts among the stakeholders: they will be the base for the later ethics analysis undertaken by the engineering students. The ICT stakeholders' network can be considered a facilitator for analysing the many connections and relationships among the very different actors, and for identifying conflicting values and moral issues.

At the nucleus of every ICT stakeholders' network there are the three nodes representing "technology developers" (usually ICT vendors, the ones dedicated to developing ICT), "users", and "policy makers". This can be seen as a common property of all ICT scenarios: there are at least these three actors: the developers of technology, the users, and of course the policy makers. These three nodes are the "embryo" of the ICT stakeholders' network (see Fig. 5).
Fig. 5 - The "embryo" of an ICT stakeholders' network

In the application of the methodology, these three nodes will be connected with other stakeholders nodes identified in the process: the network will "grow" as the analysis of the case under discussion proceeds.

The core part of the Computer Ethics course at the Politecnico of Torino is the application of a "case-based" methodology (see paper IV in the appendix).

The methodology is based on four steps (see Fig. 6).
Fig. 6 - A Methodology for Introducing Computer Ethics, Scuola di Dottorato, Politecnico di Torino (Patrignani and Kavathatzopoulos, 2017)

This methodology proposes a real case to the engineering students. The class is then divided into three main "simulated groups" of stakeholders: developers, users, and policy makers.

A brainstorming session among these three different stakeholder actors enables students to start with the four steps described in Fig. 6.

The first step is to describe the scenario under analysis precisely, but just in a plain text, with no technical details, formulas or diagrams.

The goal is to produce a description of the case (involving complex computer systems) that is understandable to a lay person. In this step, students develop the skill of "social analysis" at many levels: from individuals to communities, from organisations to cultures, institutions, and at national and global levels. What kind of impact will the ICT systems under analysis have on these social actors?

The second step is the "core" of the methodology: to draw the complete stakeholders' network related to the case. This step offers the opportunity to locate the many stakeholders impacted by the system that is going to be
developed. When completed, this drawing provides an illuminating and reflective tool, potentially able to trigger an initial ethical awareness and an opportunity to cultivate new skills (Kavathatzopoulos, 2012). The stakeholders' network is also closely connected with the possibility of using a computerised ethical decision support system (Kavathatzopoulos and Laaksoharju, 2010).

After some reflection time is spent looking at all the stakeholders and, in particular, at the relationships (the connections among the nodes), the third step starts. In this step, the students can acquire the first ethics skills and competencies: an initial ethical awareness. The focus here should be on the connections among nodes: usually they are bi-directional, but this does not mean "symmetrical". They are relationships with very different meanings in terms of power, dimension, role, values, and desires.

The third step is dedicated to identifying ethical issues, to cultivate the ability of detecting conflicting relationships, values, desires, and willingnesses. The role of the teacher here is very important since, for many engineers, it is the first time that they are dealing with ethics. In this step, they use the reflection time to analyse the stakeholders' network in order to identify possible conflicts and ethical dilemmas. The dialogue among the engineers is a good exercise to train their capability of looking at the issue from many points of view (at least from the developers, the users, and the policy makers point of view): they develop the social and ethical skills.

Once engineers identify ethical issues in the stakeholders' network, one could propose "normative" approach: let's use codes and standards, soft law and hard law. But in the context of ICT this solution hardly works: often designers are exposed to completely new scenarios, and sometimes they need to take difficult positions, to make choices in a very little time. That is why probably new blended professions are needed, like "engineers-philosophers", based on more cross-disciplinary approaches (Singer, 2018).

The fourth and final step is a very important task for students. They are asked to make some proposals or maybe just elaborate possible different, alternative scenarios. They can propose some recommendations to users, to the designers and projects' teams (in terms of new direction of development), to organisations (in terms of soft laws, like ethical guidelines or code of ethics) and to policy-makers (requiring hard laws established by public authorities).

The engineering students are not required to solve the case that has been presented to them (rather, ethics is a process), but to exercise their creativity by envisaging alternative scenarios that could mitigate the ethical dilemmas identified. In this context, they combine their skill of "phronesis", their habit,
their character (ethos), with their future ethics. And vice versa, their ability to anticipate issues, their envisioning skills with a "phronesis" skill, their ability to translate thinking into actions. Also, the Slow Tech "heuristic compass" may be useful as a proactive Computer Ethics approach.

During the stakeholders' network exercises, the direction of the teacher is important for stimulating the debate through probing questions. The discussion usually progresses at three different levels:

- a brainstorming level (free discussion),

- a "soft law" level (can a Code of Ethics be used?),

- a "hard law" level (can a new legal framework be required?).

All the main points of the dialogue are recorded by keeping notes on a blackboard by the teacher.

During the discussion, in particular at the fourth and last step, where a "proposal" approach is needed, the four different dimensions of Lessig's Model of architecture, education, market, and law generally emerge (Lessig, 1999). Some students propose a typical "techno-fix" approach: technology creates and "solves" ethical dilemmas, by incorporating the norm in the technology itself. Some underline the importance of education of users and society for a wise use of technology. Other head in the direction of a "liberal" market-based approach, the market "spontaneously" will find a solution. And, finally, someone asks for an "authority" able to enforce a norm, a true law.

An approach based on case analysis for ethical decision making in Computer Ethics is also proposed by Ward Bynum in a very detailed list of eight steps (Bynum, 2004). The approach list of four steps presented in this thesis is simpler and more focused on the analysis of the ICT stakeholders' network.

*The use of Responsible Research and Innovation in the Methodology*

An important phase in the application of this methodology is the reflection on Responsible Research and Innovation (RRI). Once the four steps (scenario, stakeholders' network, ethics issues, alternative scenarios) are executed, the methodology used at the Politecnico of Torino, introduces a simple RRI model with the goal of fine-tuning the stakeholders' network (that is, some actors missing?). This additional phases poses interesting questions, and develops an applied RRI concept in interactive sessions with students.
What is RRI? Ethics is usually considered a separate field from science and technology, or often just a brake or a nuisance for real projects and activities related to research and innovation. Indeed, since any ICT artifact can be seen as a "socio-technical system", in the classroom the relationship between technology and society is investigated by using the RRI approach proposed by the European Commission for all research programmes. RRI is defined as: "... scientific research and technological development processes that take into account effects and potential impacts on the environment and society" (EU-RRI, 2019). RRI can be considered as an ethical approach that could enable even better research and development projects to be run.

Questions remain: How can these nice definitions be applied in real scenarios like the ones involved with ICT complex systems? And how the ethics competence and skills can be developed?

A Model for Responsible Research & Innovation

<table>
<thead>
<tr>
<th>6. Act &amp; Respond</th>
<th>1. Identify</th>
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<tbody>
<tr>
<td>(change Direction of R&amp;I Processes)</td>
<td>Stakeholders and design the</td>
</tr>
<tr>
<td>(in response to Stakeholders feedback)</td>
<td>Stakeholders’ Network</td>
</tr>
<tr>
<td>5. Anticipate</td>
<td>2. Engage</td>
</tr>
<tr>
<td>Social, Environmental, and Ethical Effects</td>
<td>with all Stakeholders</td>
</tr>
<tr>
<td>4. Include</td>
<td>3. Reflect</td>
</tr>
<tr>
<td>considerations on all dimensions of Innovation in Research &amp; Innovation Processes</td>
<td>with involved Stakeholders on all dimensions of Innovation</td>
</tr>
</tbody>
</table>

Fig.7 - A Model for RRI (Patrignani and Whitehouse, 2018, p.74)

The reflections with students are facilitated by a simple model. The model is based on a closed loop, a circular process (see Fig. 7). This model is based on the contributions of contemporary researchers in the fields of RRI in ICT (Stilgoe et al., 2013; FRIICT, 2014; Stahl et al., 2014). It is a continuous feedback process that enables rapid adjustments along the life-cycle of a
project due to the emergence of some social and ethical issues, and incorporating feedback from stakeholders.

The six steps of this process are:

- **identification** of all stakeholders (at this stage the students check the ICT stakeholders' network),

- **engage** with all relevant stakeholders (ideally there is a dialogue among developers, users, policy makers, where the students act out a role as in "role play"),

- **reflect** with the stakeholders involved (on all the dimensions of innovation),

- **include** and incorporate the emerged considerations in the process,

- **anticipate** the social, environmental, and ethical effects of the project,

- **act and respond** by adjusting the direction of the initiative.

In a way, all these six steps can be considered as forming the core method for applying RRI in a real context. The dynamic characteristics of the model enable a **process** that facilitates the participation of different stakeholders, and makes it clear that the focus is not on content but on **process**. Ethics can be seen as the result, an "emerging property" of a continuous fine-tuning of this **process**.

The methodology for teaching **Computer Ethics** used at the Politecnico of Torino (visually described by Fig. 6 and Fig. 7) can be summarised as a proposal for developing and training the "**phronesis**" skill in order for the student engineers to be better prepared to apply this skill when facing the social and ethical issues posed by ICT, the challenges of **Anthropocene**, and the challenges of future ethics.

(See paper IV and paper V).

**Case Study: "artificial retina" (based on the material graphene)**

An example can be useful to provide an overview of the entire methodology used when teaching computer ethics to engineering students: an "**artificial retina**" device offers a potential application of the new material called **graphene**. Graphene is a two-dimensional material with unique properties: it
is very thin (just few layers of carbon atoms), strong and resistant, light, conductive (heat and electricity), transparent, and has other interesting physical properties (see graphene-flagship.eu). One of the many intriguing potential new applications of graphene is as an "artificial retina", a futuristic eye implant that promises a wide range of innovative applications (Choi et al., 2017).

Let's start by applying the four steps of the stakeholder methodology to this particular case study.

- Step 1: scenario description

An artificial retina is one of the most challenging and interesting applications of the new material, graphene. There are promising applications of it for people with visual impairments or people who are blind.

- Step 2: stakeholders' network

Starting from the "embryo" network, including technology developers, users, and policy makers, it is easy to enlarge the network to other stakeholders like: the user's family, doctors, and professional users. Policy makers include public authorities like the national health systems. Technology developers cover standards organisations, hardware and software developers, and financing organisations, etc. The high personalisation of this type of device implies a collection of data about users involving cloud service providers, etc. Developers also need a reliable source of high-quality graphene (see Fig. 8).
- Step 3: reflection and ethical issues identification

The wide collection of stakeholders including those related to the future) involved in the artificial retina scenario suggests a very challenging list of questions: Is this device applicable also to other scenarios like use in the military (e.g. extending the bandwidth to infrared), or by surgeons, or for human enhancement? Even restricting the application to people who are blind, is the device affordable? Is it certified? It is safe? Are the costs to be covered by the national health system? Is it interoperable in terms of standards? What are its legal requirements? What kind of reliability is guaranteed? What kind of hardware, software, and data management are needed? Who is the owner of data collected by the device? What kind of life-cycle assessment is needed for the device? Is it disposable? Is it repairable/recyclable?

- Step 4: alternative scenarios

A possible scenario for mitigating some of the many ethical issues posed by an artificial retina is one where the device is bio-safe, compliant with international standards, with costs that are (at least partially) covered by the national health system, interoperable (the user can switch to a different provider), the user can keep the control of the data ownership, and reliability
is guaranteed by a third party code audit/review, the dual use is strictly limited and the bandwidth does not include infrared.

In this example, the application of the RRI model to this example case study could be used to fine-tune the reflection, check the inclusion of all important stakeholders, and take their interests and values into account in the technology development.

3.6. Empirical results from the field experience

At the end of the Computer Ethics course at the Politecnico of Torino, the students have to write a report for the final exam: here they demonstrate the acquisition of the ethical skills and competencies. They show the skills they have acquired for identifying different stakeholders and relationships, various interests and conflicts, and what can be "right or wrong". They also enhance their capability to propose something different, their design choices, in particular by identifying the role of the computer professionals involved in the case.

![Computer Ethics Report: Subjects Selected by Students](image)

Fig.9 - Subjects selected by students for the final report
Each student prepares a report on a subject of their choice. It is interesting to see what are the most popular subjects and controversial ICT applications selected by students (see Fig. 9).

This picture describes the most popular subjects selected by students over a total population of more than five hundred students distributed throughout a decade of teaching experience at the Politecnico of Torino. Interestingly the top three subjects are: privacy, drones and "autonomous" cars.

Another important empirical result is the average number of stakeholders described in the stakeholders' network: eight. This means that, starting from the three minimum regular "core stakeholders" present in all networks (technology providers, policy makers, users), the students have enlarged their landscape, on average, by five more stakeholders. The larger dimension of the stakeholders' network, the greater number of stakeholders and relationships provide also a wider horizon for reflection.

The students also gain familiarity with the Ethical Review procedures for European research projects (EU, 2019b). These include the concept of a moratorium which can be introduced in the case of very challenging ethical issues, and with the Precautionary Principle "... when scientific evidence about an environmental or human health hazard is uncertain and the stakes are high" (EU, 2019c).

At the end of the course, there is an interactive session with students when important feedback received from them is discussed. This feedback is fundamental for refining the process embedded in the methodology and updating the material for the course in the following academic year. The feedback is mainly on two components: the methodology itself, and the Slow Tech concept. After students have provided their feedback, the interactive session enables them to share their views with their peers.

Some examples of feedback on the methodology include: the first step (scenario) is "difficult only at the first attempt", the second step (the stakeholders' network) is "very useful" for analysing the case, the third step (identification of ethical issues) is "quite complex, but affordable" and requires most of the discussion time, and the fourth step (alternative scenarios) is "the most challenging one" since it requires some "actions", "choices", not just observations.

Some examples of feedback about the use of Slow Tech as a "proactive computer ethics" and a "heuristic compass" are useful to examine. The following are the most important Slow Tech issues identified by students among the many discussed in the course.
The first question posed to the students was: What are the main characteristics of a good ICT? The main keywords mentioned by students in relation to this first dimension are: data protection / location, Design-for-All, HCI design, Participatory Design, Precautionary Principle, privacy-by-design, Responsible Research and Innovation (RRI), social desirability, otium-negotium, Web accessibility, open data, open hardware, open software.

The second question posed to students was: What are the main characteristics of a clean ICT? In the clean ICT dimension, the keywords used in the answers were: supply-chain certification, environmental sustainability, power consumption minimization, modular design, power sources of renewable energies, transparency about power sources, recyclable-by-design, repairability, source material minimisation, Life-Cycle assessment (LCA).

And, finally, the third question was: What can be considered a fair ICT? In response to fair ICT, students identified: fair working conditions, fair working conditions extended to all suppliers, compliance to Corporate Social Responsibility standards, location of suppliers, transparency of supply-chain.

This dialogue with the students enables the refining of the otherwise difficult definition of Slow Tech as a good, clean, and fair ICT.

More interestingly, these feedbacks were useful for students to demonstrate their capability of "thinking in the right way", that is, to apply their ethical competencies to real world conflicts. At the end of the course they show increased ethical skills, in the written reports and in the live interactive sessions.

If, according to Socrates, a "teachable virtue" is an "exercise of critique and awareness", this teaching methodology is based on the assumption that "how to think in the right way is teachable: dialoguing with others and with oneself".
Conclusions

This work describes a methodology for introducing a "proactive Computer Ethics" approach in engineering schools based on the concept of Slow Tech.

It presents a short history of Computer Ethics from the concept of there being a "policy vacuum" to the turning point of the view of computer systems as "socio-technical systems" in which technology is not viewed as neutral but, rather, it is acknowledged that technology and society co-shape each other.

This new Slow Tech view arises from questions such as: How can computer professionals develop systems that are socially desirable, environmentally sustainable, and ethically acceptable? What kind of ethical competencies do they need? And how can they acquire these competencies and skills? The idea of Slow Tech, a good, clean and fair ICT is proposed as a "heuristic compass", a possible guideline in this direction towards a new way of teaching computer ethics. Finally, a methodology for teaching Computer Ethics is described, complemented by some empirical results from real "field experience" at the Politecnico of Torino in Italy.

Of course, further studies are required to enhance computer ethics education, in particular in very complex ICT scenarios. Ethics education is an area where various tools and procedures have the goal of supporting "thinking in the right way" in order to handle ICT ethics issues. Ethical competencies for computer professionals have to be developed, but there are multiple solutions about how these ethical competencies can be acquired. Many of the world's most important academic institutions have now recognized the need to introduce the foundations of ethics in computer science as a mandatory subject (Singer, 2018).

The next generations of computer professionals need to be not just experts in their own subject matter, but also to be more generally aware of the social and ethical impacts of ICT. A deeper set of environmental questions remain to challenge them about sustainability and survivability: ICT can help human beings in facing the challenges of the Anthropocene, for example, through de-materialization, and ICT needs to be recyclable-by-design, but is it enough to "close the cycles"? Or does society also need to slow down the ICT consumption cycles?
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