Available online at www.sciencedirect.com

SCIENCE DIRECT®

Technological Forecasting & Social Change 73 (2006) 543–558

Technological Forecasting and Social Change

The case for ethical technology assessment (eTA)

Elin Palm *, Sven Ove Hansson

Department of Philosophy and the History of Technology, The Royal Institute of Technology, Teknikringen 78 b, 100 44 Stockholm, Sweden

Received 18 May 2004; received in revised form 13 June 2005; accepted 14 June 2005

Abstract

New technologies often give rise to previously unknown ethical problems, and it often takes many years to fully integrate them in society. We propose a new form of technology assessment that will focus on the ethical implications of new technologies; ethical technology assessment (eTA). Ethical technology assessment will serve as a tool for identifying adverse effects of new technologies at an early stage. It should be undertaken in dialogue with technology developers and have the form of a continuous dialogue rather than a single evaluation at a specific point in time. eTA can be conducted on the basis of a check-list that refers to nine crucial ethical aspects of technology; (1) Dissemination and use of information, (2) Control, influence and power, (3) Impact on social contact patterns, (4) Privacy, (5) Sustainability, (6) Human reproduction, (7) Gender, minorities and justice, (8) International relations, and (9) Impact on human values. Ethical technology assessments should not be committed to any particular moral theory. Instead they should be open to different perspectives and solutions.

Keywords: Ethical technology assessment; Technology assessment; Dialogue; Ethics; Check-list; Technology developers

1. Introduction

In this article we will argue that prevailing forms of *Technology Assessment (TA)* need to be supplemented with a new variant, *Ethical Technology Assessment (eTA)*. Its purpose is to provide indicators of negative ethical implications at an early stage of technological development. The

* Corresponding author.
E-mail address: elinpalm@infra.kth.se (E. Palm).

0040-1625/$ - see front matter © 2005 Elsevier Inc. All rights reserved.
doi:10.1016/j.techfore.2005.06.002

methodology that we propose is based on an ethical check-list that specifies nine important groups of issues that should be considered when developing and implementing a new technology.

In Section 2, previous developments within Technology Assessment are summarized with an emphasis on shortcomings that are relevant for the present proposal. In Section 3 we present our arguments for the need of Ethical Technology Assessment, and in Section 4 some of its methodological preconditions are discussed. The ethical check-list is introduced in Section 5, and some final conclusions are drawn in Section 6.

2. The development of technology assessment

In the 1960s, demands were raised for greater social responsibility in technology development. These demands were largely triggered by an increased awareness of serious social and environmental problems that were conceived to be caused by new technologies. The emergence of organized Technology Assessment (TA) was foremost an attempt to gain political control over the potential negative effects of technological development by means of early warnings. TA was supposed to predict unintended negative consequences of technical innovations in order to facilitate more adequate policy-making. A common expectation on TA has been that it should reveal future consequences of new technology that otherwise would not have been recognized.

The term "technology assessment" seems to have been used for the first time in 1966 by Philip Yeager, who worked for the American congressman Emilio Q Daddario. Daddario worked to improve the basis for political decision-making in questions concerning technological development, and proposed an agency that would help identify technological consequences in advance whereby the negative effects could be limited and positive features amplified and promoted [1].

As a result of these ambitions, the *American Office of Technology Assessment (OTA)* was established in 1972. As the first institution for Technology Assessment it came to set the standard for TA for almost two decades to come. OTA was initiated by the Congress as a response to a need for an objective institute with the task to analyze and predict technological development. A number of controversial policy issues such as the U.S. investment in supersonic transport (SST), the antiballistic missile system (ABM), and the Trans-Alaska pipeline contributed to the creation of OTA [2].

Typically, OTA assessments did not offer specific recommendations, but instead articulated options and consequences of alternative options. Another typical feature was their thoroughgoing and inclusive style. Since the reports were both time- and resource-consuming, an important task was to select among requested assessments and define their scope.

In 1995 OTA was closed down. By that time, the agency had published over 700 reports on a wide variety of topics related to science and technology. Thereafter, the main scene for TA activities shifted to Germany. The institutionalization of Technology Assessment in the United States had almost immediately been followed by proposals for a similar institute in Germany, but the resulting *Office of Technology Assessment at the German Bundestag (TAB)* did not start its activities until 1991 [7]. Today, the independent research institute ITAS (Institute for Technology Assessment and System Analysis) serves as a hob both for German and international TA activities [3].

Furthermore, several European countries have their own parliamentary TA offices, and since the beginning of the 1990s, the importance of TA activities has also been emphasized within the European Parliament, resulting in its own official TA organ *Scientific Technological Options Assessment (STOA)*

[4] and in the *European Parliamentary Technology Assessment Network (EPTA)* [5]. There are also networks with a low degree of institutionalization such as the *European Technology Assessment Network (ETAN)* [6] initiated by the European Commission.

Technology assessment has been criticized along several lines. One common criticism is that TA has unrealistic ambitions to predict future technological development. Critics have also pointed out that technology assessment is resource intensive and that the quality of the outcome seems to be proportionate to the financial means available. A major reason why OTA managed to deliver such an impressive amount of high quality reports was its generous budget. In Europe, TAs have often been performed by university researchers without access to OTA's multidisciplinary staff and extensive system of peer review. Partly due to lack of resources for theoretical and methodological development, European TA activities have largely drawn on the OTA model [7].

The lack of clear criteria for how a proper assessment should be conducted has made it difficult to improve assessment practices and to compare and evaluate the quality of different assessments. A recent initiative to develop a common methodological framework has been made within the Fifth Framework Project: Technology Assessment in Europe, between method and impact (TAMI). TAMI involves some of the major centres for technology assessment [8].[1]

One of the main ideas behind the institutionalization of TA activities was to create neutral instruments for well-informed political decision-making. Presenting future scenarios and concomitant options might seem a non-biased activity, but the interests behind the investigations may be less so. It has been argued that the shape and results of TA activities largely depend on prevailing political interests rather than on actual social needs, and that evaluations of technological development and innovations can–and do–serve as "competitive weapons" [9] (However, OTA has also been criticized for not taking a stand) [10]. The selection of what technologies to assess is subject to (explicit or implicit) value-based criteria. OTA received far more requests than it could accommodate and therefore the selection of issues to assess was a crucial task for its board of directors.

A related line of criticism is that the traditional TA concept is treated as universal while it is in fact strongly tied to the Western world.[2] Current TA practices have emerged in the Western world in the last few decades and are formed by a relatively homogenous social, political, and economical climate. The interests of non-Western nations are seldom taken into consideration.

> The emergence of technology assessment did not occur in a societal or value vacuum; neither did its practice. Today's TA expertise is the outcome of historically located concerns, still unique to a particular narrow space ("Euro America") and narrow time frame (post-1960s). [11].

A general problem for Technology Assessment has been that of keeping even steps with technological developments. From the beginning, it was expected from TA that future consequences of new technology should be revealed that would otherwise not have been recognized. However, the original optimism with respect to technological predictions has faded. In reality, few "complete technology

[1] This network differs from the ones previously mentioned in its emphasis on structure and methods. TAMI will serve as a knowledge base and forum for TA experts to exchange information and experience, to discuss core issues within TA, to compare and evaluate methods and identify "best practices" in TA.

[2] This argument is most often held forth to show the importance of social interaction in the developmental process of new technology, i.e., social shaping of technology. Here the argument is broadened by also pointing out the cultural bias of the TA concept.

assessments" aimed at discovering the total social impact of a technology have been performed. Rather, more limited kinds of TA have been common. Even if many assessments start off with the ambitious agenda to cover economical, social, psychological, ethical and legal dimensions of a technology, the end product is almost always much thinner.

Arguably, the most successful variants of TA are *Environmental Impact Analysis (EIA)* and *Risk Analysis (RA)*. While a general TA usually concerns a technology or technological method in general, an environmental impact analysis or risk analysis concerns one particular implementation of a technology, such as a specific plant or specific product. These types of analysis also refrain from predicting indirect effects of the investigated technology.

One result of the focus in later years on EIAs and RAs rather than on complete Technology Assessments is that the social consequences of technologies largely remain uninvestigated. Therefore a substantial part of the basis needed for ethical analyses of the consequences of technology is left out. Specialized studies of the social consequences of technology occur under the name of *Social Impact Analysis (SIA)*, but they are fairly uncommon. One example is the programme supported by the International Monetary Fund (IMF) that aims at assessing the consequences of policy interventions across social groups, based on such factors as gender, ethnicity, age, land ownership, livelihood, and geographic location [12].

In the 1980s, *participatory Technology Assessment (pTA)* came up as an alternative to traditional TA, foremost in Denmark and The Netherlands. This was a reaction to a demand for a more socially oriented approach to technology and for a greater scope for public influence and participation in decision-making. Typically, pTA involves a broader spectrum of actors than traditional TA, such as politicians, NGOs, trade unions, journalists, scientists, technology developers, and lay people. Nevertheless, the focus is essentially the same as in traditional TA; to stage early warnings of new technologies and their potential consequences and to facilitate political decision-making regarding potential negative effects of new technologies.

The *Danish Technology Council* set the agenda for pTA by its emphasis on participation and its experiments with different methods to represent a variety of actors. Dialogue fora, focus groups, future-panels and consensus conferences are some of the participatory methods that were developed [13]. Today, lay conferences and consensus conferences are commonly used in controversial issues, most frequently in connection with biotechnology and gene technology.

In the mid 1980s, the TA-field was enriched with *Constructive Technology Assessment* (*CTA*) and *Innovative Technology Assessment*(*ITA*) that both focus on interaction with technology developers in order to influence the course of technological development. A central idea in CTA is that the design process should open up to include those affected by technology [14]. Hence, networks are created of actors from technology development, politics, organized interests, and users of the actual technology. Emphasis is put on integrating TA as early as possible in the developmental process of technology. The crucial feature for labeling something CTA rather than pTA is that it has a connection with a design process which it tries to improve in one way or another [15]. CTA originated in the Netherlands.[3] *Innovative Technology Assessment (ITA)* is a German movement with similar aims and practices.[4]

A large number of institutes for medical technology assessment have emerged in different countries. This branch is often labelled *Health Technology Assessment* (*HTA*). An important reason why TA has a

[3] The first attempts in the direction of CTA were made in 1986 by the Netherlands Organization for Technology Assessment (NOTA, today the Rathenau Instituut).

[4] ITA came up as a result of the German TA discussions Germany in the 1980s organized by the Association of German Engineers (VDI).

stronger position in medicine than in other areas is that those who pay for medical treatment–governments and insurance companies–have difficulties keeping the costs down. They also have strong incentives to prevent new technologies from being adopted before their safety and efficacy have been demonstrated. Medical technology assessment has developed a tradition of its own, largely in isolation from other forms of TA.

A more specialized form of TA that has become influential in the last decade is *Privacy Impact Assessment* (*PIA*) that sets forth as its objective to analyze and evaluate the potential implications of a particular activity or technology on privacy. The first PIAs appeared already in the 1970s but did not become common until the early 1990s [16].[5] The process and product are, however, only slowly being formalized. The Government of Canada has worked out a framework for privacy impact assessments. The primary aim of their form of PIA is to help departments and agencies to determine if new technologies, information systems or policies meet basic privacy requirements [17].

Some major trends in the development of technology assessment are summarized in Table 1.

3. The need for ethical technology assessment

Technology's complexity and its potential to impact society have generated a certain ambiguity towards, sometimes even a fear of technology. Technology has become so sophisticated that many people refrain from staging or taking part in discussions of the implementation of new technologies because they feel they lack the insight necessary to formulate the pertinent questions.

Another obstacle is that technology is often treated in public discussions as a self-governing and self-sufficient system, dictating its own laws and developing according to its own logic. The tendency to think of technology as a self-sufficient system is unfortunate in many respects. Technological development cannot be understood without reference to demands and markets for new technologies.

It would be delusive to believe that technology developers are conscious of all the effects of their products. In many cases, negative side effects come as a surprise to technology developers themselves. If they could have anticipated the negative consequences, they would, in the vast majority of the cases, have done their best to avoid them out of social concern or for commercial reasons, or both. In our view, a common reason for failures is the lack of adequate training to identify and address ethical issues in technology development. Engineers are seldom trained to discuss ethical issues in a pre-emptive perspective. The training needed would be that of identifying consequences for different stakeholders at an early stage, that is, to identify the potential problems. Subsequently, technology developers and society share the responsibility for dealing with the ethical issues tied to new technology.

The problem with technology is not so much that society has lost control of a Frankenstein's monster as that the social and legal response is constantly one step behind technological development. The sociologist W.F. Ogburn has discussed this problem in terms of a growing "cultural lag" between the material and the non-material culture [18]. By material culture Ogburn understands physical equipment and the procedures for producing and using it. Religion, ethics, philosophy, belief systems, values, and the law are examples of non-material culture. The cultural lag is the period between the invention of a new technology and the point in time when non-material culture has stabilized its response to it. New technologies often give rise

[5] Another recent type of assessment; Equality Impact Assessments (EQIA) focuses on how certain practices affect equality, and in particular the effects on equality of opportunity between different individuals and groups.

to previously unknown ethical problems and concomitant conflicts concerning permissibility and social organization, and it often takes many years for new technologies to fully integrate in society.

The well-known Karen Ann Quinlan case from 1976 can be used as an example of this. The parents of the (diagnosed) permanently comatose Karen Ann wished to withdraw the life supporting technology since, according to their opinion, it would not benefit their daughter. After extensive juridical and ethical discussions, the Supreme Court permitted the withdrawal of life-sustaining treatment. However, Karen Ann kept breathing after the respirator was removed and remained in coma for almost 10 years [19].

This case gave rise to questions on how the new life-supporting technology should be used. Should caregivers be morally obliged to prolong life? Does a patient whose brain is dead live or not? Should ethical principles be different for active and passive euthanasia? These issues have been discussed by medical professionals, legal scholars, philosophers, theologians, and the public. In this and many other cases, ethical guidelines have developed as a reaction to new technology. However, the emergence of ethical consensus takes time.

Since ethical discussions are a necessary part of social change and adaptation, ethical questions regarding applications of future technologies ought to be raised at an early stage in order to reduce the cultural gap. An important task is to stage reasoned discussions on ethical dilemmas before the technology is too entrenched in society. Previously, the process of social adaptation has in most cases started only when the new technology was implemented. If ethical discussion were a part of the design process from the very beginning there would be a greater chance for constructive interaction between social values and technological potential in which ethical problems could be dealt with at an early stage.

Ethical questions raised by modern technology have foremost been discussed within the fields of medicine and biotechnology. Health Technology Assessment is primarily concerned with the evaluation of alternative methods of treatment in terms of efficiency, side-effects and costs, but also about ethical implications. Ethical aspects of new technologies have been included in assessments e.g. on hormone treatment of children with idiopathic short stature [20], cochlear implants in deaf children [21], and the treatment of obesity [22].

Within the field of medicine, Rogeer Houdemakers and Henk A.M.J. ten Have have argued in favour of integrating systematic ethical reasoning in health technology assessment. They are of the opinion that in the few cases where ethics plays a role in technology assessment it needs repositioning. Ethicists can improve assessments by "*recasting the way problems are defined, by exploring the interrelationship of the technical and non-technical issues, and by analyzing technology itself as problematic*" [23].These authors argue that ethics could and should have a more critical role in assessments, questioning the legitimacy of the technology itself. Rather than beginning with the question of how the development of new technologies should proceed, they propose that we start by asking whether the technology in question is desirable or necessary [24]. ten Have turns against a general uncritical attitude towards technology and against the tendency to regard technology as the result of a planned activity, directed towards problem solving [25]. If the major concern is to provide guidelines for appropriate and morally defensible use, the danger is that a specific technology or technological development is taken for granted and that it is accepted without further examination of more fundamental questions generated by the technology itself. A possibility would therefore be to take a critical stance with regard to the technology itself, exploring and assessing inherent value systems and the various types of moral issues involved in the development of a product. Much in the same vein the Dutch government's Committee on Choices in Health Care argued that not everything in medicine that is technically possible ought necessarily to be introduced into the health care system [26]. New technologies should be evaluated before they are applied.

In the last few years, the European Commission has increasingly emphasized the need to integrate ethical concerns in the regulation of biotechnology. Likewise, increased public involvement in regulatory processes has been asked for [27]. Within the academic environment, the Swiss researchers Barbara Skorupinski and Konrad Ott have emphasized the need for ethics in technology assessment and have worked on a model for integrating ethical concerns in biotechnological research. In their view, TA concepts and their practical applications are impossible to separate from ethical questions [28].

Outside of the fields of medicine and biotechnology, ethics has had a very limited role in TA. True, many TA reports conclude with an emphasis on the need for thoroughgoing discussions of ethical aspects of new technology, but only a few attempts have been made in the direction of a systematic methodological treatment of this problem area.

Günther Ropohl is one of few who have discussed how to integrate ethics in the general TA process. He has pointed out that the normative framework and practice have remained more or less the same since TA was developed in the beginning of the 1970s. OTA's approach seemed to be a winning concept, and a lot of expectations were tied to that model. Since there was little or no interest in reshaping it or working out a new TA model, the role of ethics has remained as small as in the original TA model [29].

One critical voice has been raised against over-confidence in the problem-solving capacity of ethics. Armin Grunwald concedes that technology development needs ethical reflection, but emphasizes also that ethics is not a "universal remedy". Ethics has become a fashion concept and is perceived of as a guarantee for socially acceptable and sustainable technology. Ethical reflection may however be better suited for some problem areas and situation types than others [30]. Moral reflection is foremost demanded in exceptional cases. Grunwald aims at describing in what way ethical reflection is relevant and required. Ethics serves to bring clarity and solve conflicts arising from different moral assumptions. The idea is that:

> steps, decisions and processes in technology development are free from the demand or necessity for ethical reflection if, and only if, there is a comprehensive, clear, commonly accepted and factually acknowledged normative framework, which has to be and factually is followed in technology development [31].

Grunwald pictures a conflict between on the one hand engineering ethics and on the other, a TA approach. The proponents of the latter accuse engineering ethics of not taking into account the constraints of the real world sufficiently well. On the other hand the advocates of engineering ethics hold forth that although technology assessors know much about the world of technology they cannot give orientation because of normative deficits. The solution lies in a combination of these two approaches. Shaping technology should not be a task for either engineering ethics or TA [32].

4. Prolegomena to a methodology for eTA

While successful "complete" TAs have demanded extensive resources, eTA is intended to serve as a low-cost assessment alternative. The aim will be to stay in contact with technology developers during the whole developmental process and discuss different approaches to problems that arise. A single assessment will not succeed in solving a problem finally, and it is insufficient to raise moral claims only on end-

products [33]. Hence, a continuous dialogue and repeated assessments are preferable to one single large-scale assessment.

Since moral implications may arise at all stages of technological development, an ethical assessment should examine its whole *life-cycle*. In order to cover the whole developmental process, the assessment should start with the initial R & D and furthermore include patenting, marketing, testing, and the tests' impact on individual and society [34]. Any viable form of TA should avoid the unrealistic ambitions of the past with respect to predictions. Predicting the future of a technology is a vain undertaking with low chances of success. Ethical technology assessment should therefore avoid crystal ball ambitions. The ambition should not be to see as far as possible into the future, but to investigate continuously the ethical implications of what is known about the technology under development. This can be achieved by means of close interaction with the technology developers. They possess the necessary technical knowledge but are often less well prepared for identifying ethical problems at an early stage.

Since thorough knowledge about the investigated technology is necessary, the insights of CTA/ITA, emphaizing the role of interactive assessments, should be utilized. Preferably, ethical TA should be involved in the development of new technologies already from start, so that the insights gained can influence technological design. In this way, the chances of social shaping of new technology through an interplay between social values and technological potential will be increased. The cultural lag can, to some extent, be shortened and new technologies can be better adjusted to and integrated into their social surroundings.

Important lessons can also be learned from pTA, that has attempted to aid the often long and thorny process towards integration of modern technology by opening up for public participation and influence. This contribution has been of great importance but its focus has often been too narrow, aiming at consensus concerning one particular issue, unifying experts and lay people. In our view, the search for consensus in controversial issues should not be overemphasized since it may lead to the closure of issues at a too early stage. In ethical TA, conflicts and different opinions should be highlighted rather than evened out, which has often been the case when working with consensus as a pre-set goal. It is important not to assume that there is a shared moral framework on which assessments and decisions can be based. "*[T]he moral framework has to be developed hand in hand with technology development — it is exactly the task of ethics to reflect and support this moral development*" [35].

One important lesson from pTA is the importance of involving relevant stakeholders. An ethical TA should seek to identify all relevant stakeholders, i.e., a broad spectrum of agents and therefore also a broad spectrum of responsibilities. Furthermore, the results of an ethical technology assessment should be communicated as widely as possible. The strategies of participation and communication depend on the particular social groups to be addressed. The choice and design of future technologies should not be restricted to a well-educated and articulated elite.

As we have seen, moral reasoning has played a rather peripheral role in the prevailing forms of technology assessment, with a few exceptions from medicine and biotechnology. In cases where ethics has been part of assessments, the discussion has mostly drawn on everyday concepts rather than on moral theory. In our view, ethical technology assessments have need for a systematic use of the tools of moral philosophy. However, this does not mean that assessments should take their starting point in a particular normative ethical theory. It is, for instance, not advisable to approach new technologies armed with a specific moral theory and with a strong conviction that it will solve all the problems that arise. This is one of the lessons we can learn from bioethics and medical ethics. Many of the problems that

emerge from ethical studies of biomedical practice have at most weak connections with the choice between ethical theories such as different variants of deontology or utilitarianism [36]. Both a utilitarian and a deontologist can for instance, be either for or against euthanasia. eTA can benefit from staying theory independent, while using concepts from moral philosophy to characterise the problems more precisely and to develop alternative options and policies.

If an ethical framework is fixed in advance this may limit the space for dialogue with technology producers and decrease the scope for an open discussion with stakeholders. It is also possible that a ready-made philosophical template would miss out on important aspects that have not yet been brought up to discussion within philosophy. Technology often generates new ethical issues that may require innovative thinking for their solution.

We see it as the principal task of eTA to find and characterise the ethical aspects of an emerging technology. This knowledge can be used in a design process to adjust the technology to avoid ethical concerns. It can also be used as a basis for decision-making on a proposed technology.

For the latter purpose one approach would be the consequentialist where potential benefits for individuals and society are weighed against potential harms for individuals, community, and environment. This approach could be exemplified with how privacy has come to stand back for surveillance technology and increased security in the aftermaths of September 11th. An alternative approach would be to act upon certain individual rights such as privacy rights, as absolute principles that cannot be outweighed by benefits for others. Privacy advocates would not necessarily accept trading off privacy for alleged increased security [37]. We do not see it as the task of eTA to choose between these (and other) approaches to the final ethical assessment of new technologies. Rather, the task is to delineate and analyze the issues and point out the alternative approaches for the final analysis that are available.

5. The check-list approach

The primary task of eTA should be to identify potential ethical issues associated with a new technology. By analyzing experiences from modern technologies saddled with ethical implications we have developed a check-list that covers the most common problems. Even if new technology often gives rise to new moral issues, historical experience can help us to identify common problem areas. The check-list can serve as an early warning system and indicate the need for evaluation at an early stage in technology development.

The following is our preliminary version of the ethical check-list:

1. Dissemination and use of information
2. Control, influence and power
3. Impact on social contact patterns
4. Privacy
5. Sustainability
6. Human reproduction
7. Gender, minorities and justice
8. International relations
9. Impact on human values.

This list is intended to cover the critical issues that tend to emerge in connection with new technologies. Coverage has been given priority. Partly as a consequence of that, there is an overlap between some of the items on the list.

5.1. Dissemination and use of information

New technologies have often given rise to new patterns for the dissemination of information. The computerization of public records starting in the 1970s has increased the accessibility of data in these records. The spread and use of information has been further increased and developed by the introduction of Internet. Although dissemination and free access to information has, generally speaking, a positive value, it also has negative consequences that need to be taken into account in an ethical analysis. It is of great importance to analyze the effects of the possibility of acting autonomously or pseudonumously on the Internet. The use of the Internet for spreading pornography and informoation facilitating crime and violence clearly has ethical significance, and so has the unauthorized dissemination of copyrighted or otherwise protected material. New technologies that may have impact on the dissemination of information, such as Internet-accessible GIS (Geographic Information Systems) and new uses of information technology in road traffic need to be analyzed from this viewpoint.

5.2. Control, influence and power

There are many historical examples of how technological change has led to changes in the distribution of control and influence, not least on workplaces. The question whether the Internet has a democratizing effect on society or not has been contested. Deborah Johnson has questioned whether information technology has an inbuilt democratizing effect on society or it is just as likely to fix hierarchical power structures [38]. There is also a lively debate on the importance of accessibility to technology that is central for education and competitive strength. It has for instance been claimed that information is a Rawlsian primary social good without which people are denied equality of opportunity [39]. Human rights movements have demanded a discussion on inequality in access to computers and Internet. In recent years, the *Digital Divide* issue has been brought up on the agenda to meet apprehensions that inequality in access to computers and Internet can lead to inequality in education and in the long run also on the labour market [40].

5.3. Impact on social contact patterns

Communication technologies such as the telegraph, telephone, radio, TV, Internet and cellular phone have affected the way people establish contacts, meet, and communicate. Other technological changes such as new patterns of building and new ways to organize work may have had similar, perhaps somewhat more indirect effects. The general trend in current developments seems to be to provide communication that is direct, cheap and easy to use. However, even if communication is facilitated, it is not self-evident that this will bring people together. There is a tendency for electronically mediated contacts to substitute face-to-face contacts. As a consequence of this, anonymous and pseudonymous contacts are facilitated, in particular on the Internet. The effects of anonymization on social contact patterns remain to investigate. Another important change in contact patterns is the possibility of always being reachable that has followed with the mobile phone.

The computerization of work has led to an increased prevalence of distance work, such as work from home. In view of the central role of work and work-related contacts in many people's lives, this is another example of a technological development with significant effects on human contact patterns.

5.4. Privacy

As a consequence of new and more sophisticated means for identifying and collecting different types of information about individuals, private spaces where individuals may remain free from intrusion seem to diminish. Camera surveillance has become a common feature of the urban environment and sophisticated technological devices such as Biometric authentication technology, Smart Cards, and various types of Big Brotherware, enable employers to monitor employees in detail. Furthermore, drug tests and genetic screening of employees have generated serious ethical questions concerning privacy [41]. There are good reasons to believe that work under surveillance can lead to stress symptoms, decreased efficiency and burnt-out staff. Both workplace surveillance and monitoring of Internet activities constitute an infringement into the personal freedom that is considered an essential part of a democratic way of life.

5.5. Sustainability

It has been increasingly recognized that the decisions we make today should be defensible also in relation to coming generations. Discussions on the depletion of natural resources have opened our eyes to the long-term effects of technological development. As was clarified by the Bruntland commission, it is equally important to also consider the long-term effects of economic and social structures and practices [42]. It is important not to take our present life style for granted and to critically analyze how technology is being developed to satisfy our needs. On a global scale, we accumulate less technological capital than the non-renewable and renewable resources that we consume.

New technologies may affect all three sustainability dimensions through their influence on economical, social, and ecological development. Probably, the ecological dimension of sustainability is easiest to assess, since many of the tools developed for life-cycle analysis and environmental impact assessments are applicable. Often, new technological products can be improved for instance through the use of more recyclable materials and the introduction of efficient methods for implementing recycling. It is more difficult to analyze new technologies from the viewpoint of economic and social sustainability.

5.6. Human reproduction

Some of the most blatant clashes between the one hand social norms and moral values and on the other technological innovations have taken place within the field of reproductive technology. In the past three decades, the development in this field has posed many ethical challenges by altering our understanding of reproduction and fertility. IVF has prolonged women's fertile age. Screening technologies have made it possible to avoid giving birth to children with certain congenital defects, or to choose the sex of one's child. The prospect of using emerging genetic technologies for more sophisticated selection of offspring has given rise to extensive public debates, and so has the more

remote prospect of human cloning. The use of reproductive technology has been questioned by religious authorities according to whom the sanctity of life forbids humans intervene in and manipulate the divine creation. Man can now intervene in questions of life and death in ways "previously exclusive to God" [43]. Such interventions have also been questioned from non-religious perspectives for instance with reference to irreversibility and to the rights of future generations. Our concepts of normality, health and handicap, a healthy life, and a good life are influenced by these developments [44]. There can be no doubt that ethical assessments are particularly called for when new technologies have a potential to change the course of human reproduction.

5.7. Gender, minorities and justice

The advantages and disadvantages of technologies are often unevenly distributed between women and men. As an example of this, in the United States, service work is the work category that has been most frequently put under surveillance. This includes operators, health insurance company employees, reservation clerks working for airlines or hotels, and other service jobs. The majority of workers holding such positions are women [45].

Similar analyses can and should be made with respect to the effects of technology on minority groups such as ethnic, religious, and cultural groups, and homosexuals. Particular attention should also be paid to various groups of handicapped people, since they are often influenced by technological changes. An interesting albeit rather unusual example is the reaction of organizations of the deaf against cochlear implants in children. By means of these implants, deaf children will learn to communicate by interpreting the auditory signals transmitted via an electrode to their acoustic nerve. However, it has been objected that "the technology threatens the slowly obtained recognition and continued existence of the specific culture of the deaf" [46]. Resistance among the deaf to implant technology has given rise to an extended debate on ethical issues such as the rights of parents to pass on cultural characteristics to their children and the moral value of retaining a minority language such as Sign.

5.8. International relations

New technology often changes the relationship between nations and in particular between the developed and the developing world. Human rights groups have raised demands on increased accessibility to certain innovations, foremost medical technology and biotechnology. It has been claimed that for ethical reasons technological innovations should be accessible also to those who cannot afford paying a market price for them. This applies for instance to genetically modified plants and to medical drugs against serious diseases such as AIDS. In the latter case, the demand is based on the idea of a human right to existing treatment against life-threatening disease. In addition, several of the issues mentioned above, such as effects on the distribution of information and power, may have repercussions on international relations. Possible military uses of new technologies should also be assessed in this context.

5.9. Impact on human values

There are many ways in which technological development affects the way we live, the way we understand ourselves and our moral values and principles. In the case of biotechnology, skeptics have

warned against the negative consequences of commodification of e.g., genes and embryos. It is feared that trade in human building blocks will lead to reduced respect for human personhood [47].

The accessibility of personal information may decrease our respect for privacy. The wide distribution via the Internet and other media of pornography and violent material may have influence on our values. The changes of social contact patterns mentioned in Section 5.3 including internationalization and increased anonymization may also have influences on moral development. Informatics that supports human decision-making, e.g. clinical decision-making, challenges our understanding of human responsibility [48].

It is difficult to evaluate the effects of these various influences on human values, but the issue is nevertheless urgent enough for the future of human society to make this an important research issue and one of the major motivations of ethical technology assessment.

6. Conclusions

The past three decades' development have shown an increase in public participation and interaction with technology developers, in particular the most recent development within technology assessment (CTA and ITA), emphasizing the importance of close interaction with technology developers has been an important step in the direction of increasing the practical impact of technology assessment. However, even in these new forms technology assessment has not been able to deal with the serious ethical ramifications of many new technologies. Since technology developers lack training in identifying and analyzing potential of ethical problems, systematic analyses of ethical implications of new technologies are needed. We propose that they take place in the form of a new type of technology assessment, ethical technology assessment (eTA). As a basis for the development of eTA we propose a check-list that refers to nine crucial ethical aspects of technology:

1. Dissemination and use of information
2. Control, influence and power
3. Impact on social contact patterns
4. Privacy
5. Sustainability
6. Human reproduction
7. Gender, minorities and justice
8. International relations
9. Impact on human values.

Ethical technology assessment is meant to be a realistic and balanced approach to technology and a service for technology developers, not only for political decision-makers. Ethical technology assessment aims at detecting potential ethical problems by means of a continuous dialogue rather than a point-wise evaluation of a specific technology. It should not be committed to any particular moral theory, but should instead be open to different perspectives, interests and solutions and to direct involvement in the developmental process. We believe that that there is a good chance of establishing a constructive dialogue with technology developers since it is in their interest to avoid negative social implications, both for economic and strategic reasons and out of social concern. Hopefully eTA can become a quality mark, serving as a sign of social concern like the various Fair Trade symbols.

Appendix A

Table 1

Period	US	Germany	Other countries
1960s	The term "technology assessment" is used for the first time		
1970s	TA becomes synonymous with the OTA praxis-classical TA	Technology Assessment is started with OTA as the role model	
1980s	OTA continues to dominate the field	TA is developed as a strategical framework concept and Innovative TA (ITA) is first discussed	Participatory TA (pTA) emerges in Denmark and Constructive TA (CTA) in the Netherlands
1990s	In 1995, OTA is closed down.	ITA becomes influential. Interactive TA is discussed under various names	Privacy Impact Assessments (PIA) becomes common
2000s			Tentative attempts to introduce ethical issues in technology assessment

References

[1] G. Ropohl, Ethik und Technikbewertung, Suhrkamp Verlag, Frankfurt am Main, 1996, 168 pp.
[2] G.C. Kunkle, New challenge or the past revisited? The office of technology assessment in historical context, Technol. Soc. 17 (2) (1995) 175–196.
[3] http://www.europarl.eu.int/stoa/default_en.htm?redirected=1.
[4] http://www.itas.fzk.de/.
[5] http://www.eptanetwork.org/EPTA/.
[6] http://www.cordis.lu/etan/home.html.
[7] G. Ropohl, Ethik und Technikbewertung, Suhrkamp Verlag, Frankfurt am Main, 1996, 172 pp.
[8] http://www.europaeische-akademie-aw.de/pages/arbeitsgruppen_forschung/pdf/tami02.pdf and http://www.ta-swiss.ch/www-remain/reports_archive/publications/2004/040224_TAMI_finalreport.pdf.
[9] E. Kowalski, Möglichkeiten und Grenzen des Technology Assessment, Schweizerischer Wissenschaftsrat, Bern, 1994, TA 3/1994.
[10] A. Grunwald, Technology assessment or ethics of technology? Reflections on technology development between social sciences and philosophy, Ethical Perspect. 6 (2) (1999) 171–182 (p. 176).
[11] S. Goonatilake, Technology assessment: some questions from a developing country perspective, Technol. Forecast. Soc. Change 45 (1994) 63–77.
[12] http://www.imf.org/external/np/exr/facts/sia.htm.
[13] L. K Klüver, M. Nentwich, W. Peissl, H. Torgersen, F. Gloede, L. Hennen, J. van Eijndhoven, J. van Est, S. Joss, S. Belucci, D. Bütschi, European participatory technology assessment, Participatory Methods in Technology Assessment and Technology Decision-Making, Report to the European Commission, 2000, downloaded from www.tekno.dk/europta in January 2001.
[14] J. Schot, Constructive technology assessment comes of age, in: A. Jamison (Ed.), The Birth of New Politics of Technology, in Technology Policy Meets the Public, Aalborg University, 1998.
[15] J. Schot, A. Rip, The Past and Future of Constructive Technology Assessment, Technol. Forecast. Soc. Change 54 2 (3) (1997) 251-268.
[16] R. Clarke, 'Privacy Impact Assessments' February 1998, http://www.anu.edu.au/people/Roger.Clarke/DV/PIA.html, 1998.
[17] C. Bennett, Computers, personal data and theories of technology: comparative approaches to privacy protection in the 1990s, Sci. Technol. Human Values 16 (1) (1991) 51–69.
[18] W.F. Ogburn (Ed.), Social Change with Regard to Cultural and Original Nature, NY, 1996.

[19] In Re Quinlan: In the matter of Karen Quinlan, an alleged incompetent, Supreme Court of New Jersey. 70 N.J. 10;355 A.2d 647; 1976 N.J. LEXIS 181; 79 A.L.R. 3d 205.
[20] M. Verweij, F. Kortmann, Moral assessment of growth hormone therapy for children with idiopathic short stature, J. Med. Ethics 23 (1997) 305–309.
[21] R. Reuzel, Interactive technology assessment of paediatric cochlear implantation, Poiesis and Praxis: International Journal of Technology Assessment and Ethics of Science 2 (2004) 119–137;
H.A.M.J. ten Have, Medical technology assessment and ethics, ambivalent relations, Hastings Cent. Rep. 25 (5) (1995) 13–19.
[22] J. Östman, M. Britton, E. Jonsson, Treating and Preventing Obesity. An Evidence Based Review, Wiley-VCH, 2004.
[23] H.A.M.J. ten Have, Medical technology assessment and ethics, ambivalent relations, Hastings Cent. Rep. 25 (5) (1995) 13–19 (p. 18).
[24] R. Hoedemaekers, Commercialization, patents and moral assessment of biotechnology products, J. Med. Philos. 2 (3) (2001) 273–284;
H.A.M.J. ten Have, Medical technology assessment and ethics, ambivalent relations, Hastings Cent. Rep. 25 (5) (1995) 13–19.
[25] H.A.M.J. ten Have, Medical technology assessment and ethics, ambivalent relations, Hastings Cent. Rep. 25 (5) (1995) 13–19.
[26] H.A.M.J. ten Have, Medical technology assessment and ethics, ambivalent relations, Hastings Cent. Rep. 25 (5) (1995) 13–19 (p. 13).
[27] http://europa.eu.int/comm/biotechnology/introduction_en.html.
[28] B. Skorupinski, K. Ott, Technikfolgenabschätzung und Ethik, Vdf Hochschulverlag AG, Zürich, 2000.
[29] G. Ropohl, Ethik und Technikbewertung, Suhrkamp Verlag, Frankfurt am Main, 1996 (172 pp).
[30] A. Grunwald, Against over-estimating the role of ethics in technology development, Sci. Eng. Ethics 6 (2) (2000) 181–196.
[31] A. Grunwald, Against over-estimating the role of ethics in technology development, Sci. Eng. Ethics 6 (2) (2000) 181–196 (p. 188).
[32] A. Grunwald, Technology assessment or ethics of technology? Reflections on technology development between social sciences and philosophy, Ethical Perspect. 6 (2) (1999) 171–182.
[33] R. Hoedemaekers, Commercialization, patents and moral assessment of biotechnology products, J. Med. Philos. 2 (3) (2001) 273–284 (p. 274).
[34] R. Hoedemaekers, Commercialization, patents and moral assessment of biotechnology products, J. Med. Philos. 2 (3) (2001) 273–284 (274 pp).
[35] A. Grunwald, Against over-estimating the role of ethics in technology development, Sci. Eng. Ethics 6 (2) (2000) 181–196 (p. 190).
[36] S. Toulmin, The tyranny of principles — regaining the ethics of discretion, Hastings Cent. Rep. 11 (1981) 31–38;
D. Heyd, Experimenting with embryos: can philosophy help? Bioethics 10 (1996) 292–309;
W. Kymlicka, Moral philosophy and public policy: the case of the new reproductive technologies, Bioethics 7 (1993) 1–26.
[37] S.O. Hansson, Weighing risks and benefits, Topoi 23 (2004) 145–152.
[38] D. Johnson, Computer Ethics, Prentice Hall, 1994.
[39] P. Brey, in: J. van den Hoven (Ed.), The Politics of Computer Systems And The Ethics of Design, in Computer Ethics: Philosophical Enquiry '97, Erasmus University Press, 1998.
[40] http://portal.unesco.org/en/ev.php-URL_D=6060 & URL_DO=DO_PRINTPAGE&URL_SECTION=201.html.
[41] S.O. Hansson, E. Palm (Eds.), The Ethics of Workplace Privacy, P.I.E. Lang, 2005.
[42] G. Bruntland, Our Common Future: The World Commission on Environment and Development, Oxford University Press, 1987.
[43] U. Beck, Risk Society, Towards a new modernity, Sage, London, 1992.
[44] K. Zeiler, Transgressive technologies in reproductive medicine: do they call for a revision of notions of health? in: L. Nordenfelt, P.E. Liss (Eds.), Dimensions of Health and Health Promotion, Rodopi Publishers, Amsterdam, 2003.
[45] C. Botan, Communication work and electronic surveillance: a model for predicting panoptic effects, Commun. Monogr. 63 (1996) 293–313.
[46] H.A.M.J. ten Have, Medical technology assessment and ethics, ambivalent relations, Hastings Cent. Rep. 25 (5) (1995) 13–19.

[47] D.M. Bruce, Stem cells, embryos and cloning — unravelling the ethics of a knotty debate, J. Mol. Biol. 319 (2002) 917–925.
[48] P. Barroso, Ethical problems generated by the use of informatics in medicine, in: G. Collste (Ed.), Ethics in the Age of Information Technology, Centre for Applied Ethics, Studies in Applied Ethics, vol. 7, Linköpings Universitet, 2000.

Elin Palm is a PhD student in Philosophy at the Department of Philosophy, The Royal Institute of Technology, Stockholm, Sweden. Homepage:http://www.infra.kth.se/~elinpalm/.

Sven Ove Hansson is professor of Philosophy and head of department at the Royal Institute of Technology, Stockholm. He is also a member of the Swedish government's advisory board of researchers. His most recent books are *Setting the Limit. Occupational Health Standards and the Limits of Science* (Oxford UP 1998), *A Textbook of Belief Dynamics. Theory Change and Database Updating* (Kluwer 1999), and *The Structures of Values and Norms* (Cambridge UP 2001). Homepage:http://www.infra.kth.se/~soh.