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MATTI PARIKKA, AKI RASINEN & ARTO OJALA

TECHNOLOGY EDUCATION

The Ethical Challenge

Introduction

In everyday thinking and discussion, the concepts of technique (technical methods, as in a craft or in scientific research) and technology are often regarded as synonymous. On closer analysis, one realizes that this is not the truth of the matter. On the contrary, the difference in the concepts introduces the ethical viewpoint. Technique, which generally refers to tools, equipment and machines or know-how about their use or control, is an instrument which, as such, does not inherently have good or bad qualities. However, the results depend on where and how it is used (Parikka & Rasinen, 1994). Technique becomes technology when it is applied to a certain task. Thus, only technology can be analyzed and observed from ethical viewpoints, which in turn are related to values. For instance, in a technological system, product or service, value statements indicating both negative and positive effects are included.

Based on the above discussion, it will be challenging for schools to become conscious of and to analyze the ideals, values and ways of thinking and models of acting which are based on the essence of future technology. It will be important to look for viewpoints and methods which can be implemented in everyday school life to motivate pupils for ethical-moral studies. In this chapter, we aim to discuss the basic concepts. However, we challenge researchers, teachers and students to take a stand in their teaching amidst the present ideology of unlimited growth and “faith in technology”, which is based mainly on high tech and controlled by market forces. The various ethical viewpoints are not discussed in this chapter. Here the question is rather of ‘practical ethics’, which hopefully can be implemented in everyday school life.

TECHNOLOGY AS A PROCESS

In a broad sense, technology can be understood as something that is ambiguous and multiply valued. To one person, it may mean everything that is good and worth aiming for, to another something threatening, something that destroys living conditions and therefore should be opposed. Both viewpoints are justified in the light of the present research in the field of developing technology education and in the light of practical experiences. At the same time, they are very prejudiced ways of examining the phenomena. To clarify the situation a wide-ranging and open

debate should take place on the values deriving from the omnipotence of technology. In schools, it means a thorough discussion on the positive and negative consequences of a technological lifestyle and changes in learning routines in different subject areas.

In several countries technology education is, at least to some extent, part of general education. In this article we consider the matter from a Finnish point of view. As early as 1994, the national framework curriculum for comprehensive schools (Peruskoulun opetussuunnitelman perusteet, 1994) stated that: "one of the aims is to develop the readiness of pupils to understand and use technology" and "it is particularly important to evaluate the impacts of technology on interaction between nature and human beings, make use of the chances it offers and understand the consequences of the impacts". Both statements, which are contradictory, include understanding and ethical evaluation of the effects of using technology. It is not possible to analyze or discuss the "good" and "bad" or "usefulness and harmfulness", as required by the curriculum framework, in a general manner. To be able to perform this type of analysis one has to define accurately the context to be analyzed. In other words the concept of technology has to be defined from a general and educational point of view in such a manner that the phenomenon in hand is as comprehensive and concrete as possible. The most recent National Framework Curriculum (2004) also introduces the ethical viewpoint but leaves the pedagogical solutions to the teacher.

In discussions about the development of local industry one often hears comments that there is no point in developing technology in remote villages. In this context technology is obviously understood only as high technology. The Finnish Innovation Fund (SITRA) has proposed that technological know-how should be divided into two viewpoints, one being high tech, based on knowledge, and the other one skill tech, based on skills. High tech includes information and communication technology (ICT) and automation using integrated electronics. Skill tech includes skilful use of technological devices and machines; i.e., combining skilful activities and technology in an innovative manner. In this context we would like to extend the concept of skill tech to include technology for welfare, experience, free time activities and entertainment. Then it would include, for instance, the food industry based on functional and organic production as well as tourism, fitness, hobby and entertainment services. The division proposed by the SITRA gives hope for the development of areas outside big cities at least in the field of skill tech. Our interpretation of the ideas presented by the Finnish Innovation Fund will be discussed in the following section.

If technology is interpreted broadly, it includes a host of different aspects. It is not a marginal phenomenon, although by studying the Finnish national framework curricula for comprehensive schools as well as for senior secondary schools one may get this view. In countries which have adopted a technological way of life, technology is involved in industry and production. The majority of gross national product (GNP) is produced by practical applications of technology. Nowadays, therefore, all citizens must be able at least to use technology (Parikka, 1997).

From an etymological point of view technology means, for instance, the "logos" of "tekno". This means technique supplemented with "logos", in other words, the

information, understanding and rational reasoning underlying the application of the chosen technique (von Wright, 1995). *This possibility of either applying or not applying the technique in a conscious manner offers a basis for the ethical consideration of the technology concept.*

TECHNOLOGY EDUCATION

Technology can be defined in general terms to include all humanity's artifacts and accomplishments. However, when defining development, research, and the related discussion of technology education in comprehensive schools, it should be defined by emphasizing the educational viewpoint. It means that the definition should include emphasis on the technology user's and developer's interest and understanding. Based on this, Parikka and Rasinen (1994) and Rasinen (2000) defined technology as follows: "Technology means understanding the structures and operational principles of technical equipment, machines, and devices, as well as their skilful and controlled use for developing new products and services".

In technology education on one hand machines and equipment (equipment technology) and on the other hand use of tools (manufacturing technology) are studied. Knowledge of the quality of production materials connects these technologies to knowledge of technology. This definition is related to both material and mental aspects. Figure 1 illustrates these aspects in the form of a comprehensive conceptual schema. It divides technological know-how into high tech (based on scientific knowledge) and skill tech (based on everyday experiences). High tech includes information technology, and automation that is based on computer systems. Skill tech is related to technical skills where technical equipment is utilized in an innovative manner. It can be argued that the nature of technology is based on humanity's inventions and production; it is future oriented and innovative, practical, and based on commercial needs. However, it is not usually environmentally friendly and might even have a negative impact on nature.

Until recently the relationship of human beings to different variations of technology has been *reactive*. This has meant adapting to technological innovations. Nowadays people are more critical and do not accept the idea of technology developing in the direction determined by itself. There is a demand for technology which is more human, user friendly and has fewer negative effects on the development of culture, society and nature. We expect a *proactive* approach when developing technology. In technology education, the central educational objective is to impart those technological skills that help students when they make ethical choices related to technical commodities, use technical commodities, and further develop technological solutions (Parikka, 2001). The basis for this is that the designing of technology, technological products, and also their effects are not value-free but in practice they include value choices at different levels - whether we recognize it or not.

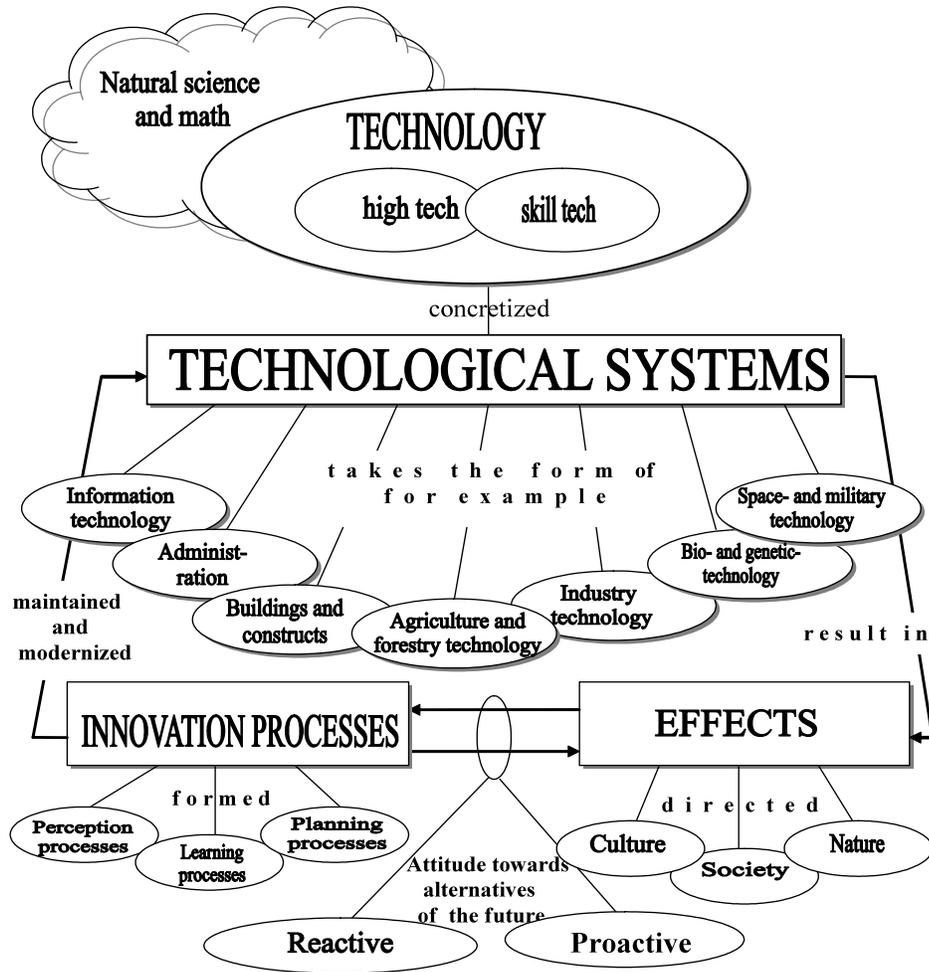


Figure 1. The concept of technology from the pedagogic viewpoint (adapted from Parikka (2001)).

Technology education offers many possibilities for ethical consideration

In traditional craft education the emphasis has often been on planning and producing different concrete products which are derived from our everyday life, and on following the curriculum planned by the teacher. During technology classes

understanding of the relation between technology and culture, technology and society, technology and nature and the effects of technology on these should be discussed and understood. This means a conscious, critical and reflective attitude towards technology. Education becomes more meaningful and diverse when an open analysis is conducted about the values and lifestyles - the concept of humanity and the world - that the technological way of life is based on, and where the choices will lead to. This type of consideration should take place during lessons in different subjects. This in turn will challenge the pupils to consider the development trends offered by future technology and to take more responsibility for their own curriculum and work.

In schools technology should be considered from various viewpoints (science - technology - society) (Solomon, 1993). The following points of view, for instance, could be considered (Parikka, 1998):

1. Integration of craft and technology introduces aspects of getting along in everyday life, experimentation, discovery and innovation (see more in Rasinen, Virtanen & Miyakawa, 2009).
2. Integration of mathematics, science and technology introduces aspects of applying mathematical and scientific know-how to technology, exploration and discovery.
3. Integration of entrepreneurship education and technology introduces aspects of commercial manufacture, national economy and material welfare. Without commerce technology will not advance.
4. The aspect of environmental education introduces the minimization of the negative effects of technology on nature, the repairing of damage already caused and awareness of an ecological way of life; in other words, the ethical aspect of technology.
5. The aspect of design and forming emphasizes creativity and innovativeness and is closely related to the aesthetic aspect of artefacts and human-made constructions.
6. The international aspect introduces studies of foreign languages and history as well as the importance of knowing different cultures and their significance; in other words, the humanistic aspect.
7. Professional and gender equality introduces the aspect of equal opportunities for choosing one's profession.

Ethical considerations in technology education can challenge school pupils to take a stand, at least at the attitudinal level, on what they, as active citizens, regard as meaningful aspects and what means they have of affecting these aspects. The aim is to understand technology and science as cultural phenomena that have an effect both on our society and bio-physical environment (Kantola, 1997).

The present world of experience and its values guide the interests and the future dreams of our children and youngsters. The ethical consideration of our environment is based on the fundamental values of an individual. Therefore, it is important for the teacher to familiarize her or himself with the preconceptions, intellectual world and values of the pupils.

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The values, idols, hopes and dreams of today's children, as well as the environment they are growing in, has more or less completely changed compared to the times of agrarian culture. Since their birth the environment has been technological and dominated by television, computer, the Internet, and social media (Parikka & Ojala, 2008). This era is often called an information and communication era. In the case of many youngsters the situation is such that ICT devices may estrange her or him from nature and reality. In other words, there is a danger of not understanding the difference between fact and fiction. Overuse of the computer for games and the Internet may also prevent the social development of the child.

These facts should be considered when organizing teaching. All human solutions are based on value judgments. For this reason, a discussion on everyday values should take place with pupils from time to time. Sometimes the lame and tame discussion of values may be the fault of the present, hesitant educational culture. For this reason, it is important to become conscious and to clarify the basis for values. For instance, if we want to develop self-directive and intrinsic entrepreneurship among pupils, they should be encouraged to plan and decide about their own studies.

One important aspect of educational basic values is gender equality. This has been emphasized in all Finnish national framework curricula since 1970 (1970, 1985, 1994 and 2004) when Finland moved to a comprehensive school system. It means that girls and boys should acquire readiness already at school to be able to take up different professions in working life. Hopefully technology education has better chances of destroying the myths about women's and men's jobs than, for instance, craft education, which still seems to separate pupils according to their sex (Rasinen, Ikonen & Rissanen, 2008).

THE IMPERATIVES OF TECHNOLOGY

The values we ourselves have adopted from technology are connected to our opinions about the opportunities for affecting the direction in which technology develops. For instance, Niiniluoto (1986) argues that the various opportunities for solving the problem of directing technological development can be divided into two opposing views.

According to "*technological determinism*" the development of technique (technical methods, as in a craft or in scientific research) is determined by "*technical laws*" which are not dependent on the will of human beings. The deterministic viewpoint can be expressed, for instance, by stating that the development of technique (technical methods, as in a craft or in scientific research) gives humankind, via technological inventions, "orders", technological imperatives, which we cannot refuse to obey (Niiniluoto, 1986). It is simply believed that technique is developed through innovations and inventions in a direction determined by itself or by market forces. That direction cannot be predicted. Societies that trust in the potential of technology have to adopt it in as multifaceted a manner as possible to avoid lagging behind development (Manninen, 1993). According to this view the problems caused by technology can

best be solved by technology. On the other hand, "*technological voluntarism*" represents a view that the development of technology does not follow any internal laws but that humanity can, according to its consideration, make decisions on the development and use of technology.

The two lines of thought are further divided by Niiniluoto (1986) into two different viewpoints on the basis of how the negative effects of technology can be avoided or minimized, and what type of attitude should be taken to the present state of development of technology. If it is believed (under determinism) that the negative effects can be eliminated only by improving technology and by increasing new technology, it becomes a question of "*technocratic determinism*", in other words of the power of technique (technical methods, as in a craft or in scientific research) and engineering. The idea of technology being value-free and its development being able to take place without considerations of values and choices is often connected to technocratic determinism. If technology is understood to produce evil things, and correcting the situation necessitates opposing technology, then we are dealing with "*romantic antitechnology*".

By "*technological voluntarism*" we are generally referring to a choice between the so-called hard or soft direction for technological development. The choice is always based either on conscious or unconscious values. When the values are based on the subjective value choices of the decision maker, it is a matter of "*voluntary decisionism*". If in turn we believe that we or a certain group of experts are sure of the "correct" values or choices, we are talking about "*value objective voluntarism*" (Niiniluoto, 1986). Many international industrial trusts are examples of bodies that have a positive attitude to hard technology. Their aim is to support development projects that are commercially and economically profitable. The soft model of thinking is represented, for instance, by the green movement and the World Wildlife Fund (WWF). They believe that the direction of development can be controlled by changing values and lifestyle (e.g., Malaska, 1992; Tammilehto, 1982).

In the following figure (Figure 2), the above described viewpoints are presented in graphical form. This aims to outline the choices from amongst future technologies and the means of achieving them.

THE IMPERATIVES OF TECHNOLOGY

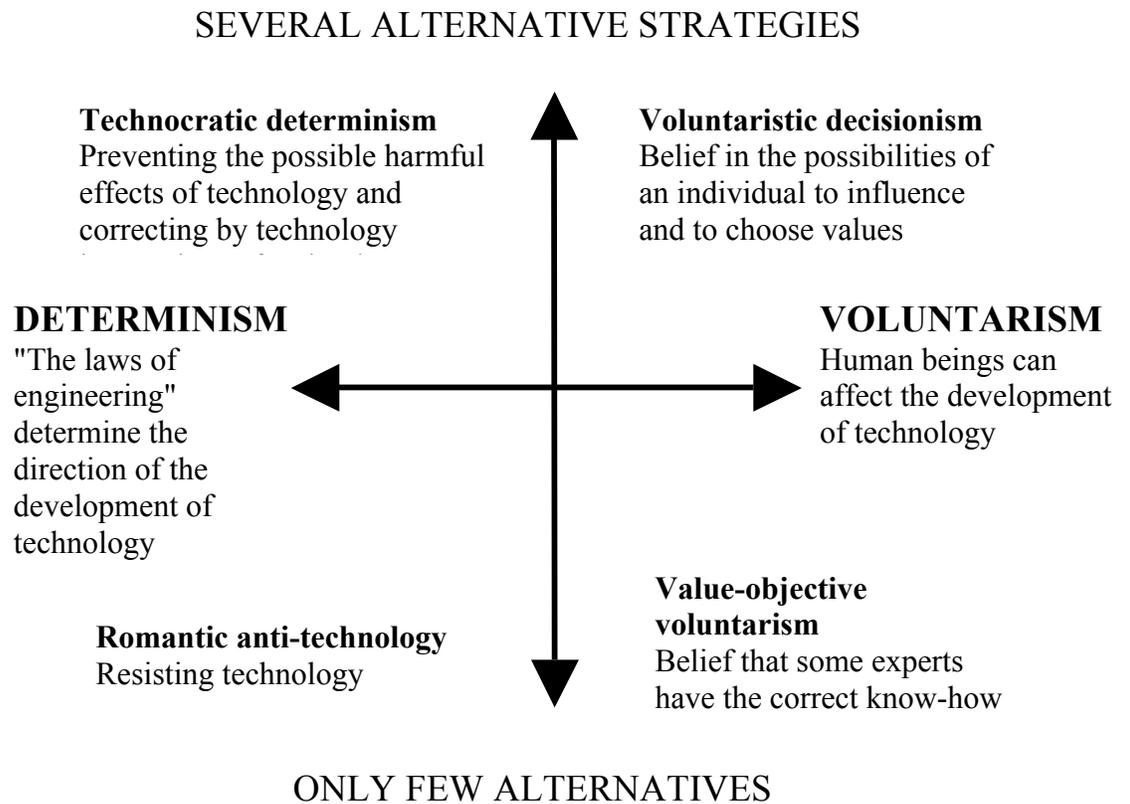


Figure 2. The imperatives of technology

THE INTERACTION OF TECHNOLOGY, CULTURE AND SOCIETY

When speaking about culture one seldom thinks that technology is connected to it, or what the effect of technological inventions on culture is. After a moment's reflection, however, it is easy to list many technological inventions that have been important for culture. The invention of the printing machine started the era of media culture. Telephone and radio made real-time communication possible. Television and video brought the picture to the media. The microprocessor, and the computer based on this, with its various programs and the world wide web, started the development of the information (computer) society, introduced the concept of virtual reality and made possible the publication of electronic newspapers, magazines and books (see more detail in Parikka (2008)). Important inventions from the point of view of society are the steam engine, the spinning machine, electricity and its use, using the combustion engine as a power source, developing car manufacture to mass production and using the computer (microprocessor) to control automation (robotics).

The effects of technology on culture and society are interconnected and can be understood only through one another. There, is, therefore, no point in trying to study them separately. The above mentioned technological applications are regarded as positive and desirable. This is why, for instance, school textbooks do not question, let alone critically analyze the effects and the ethical considerations of these applications for culture and society. All applications of inventions also have their dark side and negative effects, which should be studied as part of learning tasks and discussions (e.g., Parikka, 1998). For instance, since human beings started using the combustion engine about 100 years ago, known oil resources have diminished to half and the amount of carbon dioxide has significantly increased. As a consequence of this the car industry must concentrate on reducing fuel consumption and developing new power sources, if it wants to maintain its position.

MOORE OUT OF LESS

The views and decisions about technology have direct connections, for example, to how the interaction between nature and human beings is understood and how human beings should act to support sustainable development technology or green technology. It seems that environmental awareness, awareness of the value of nature and ecological awareness, in short the idea of a sustainable lifestyle, have become life values for many, at least young, people. However, technological development can be controlled and responsibility taken for it, only if people have a deep understanding of the negative and positive sides of technology. During school environment education lessons the negative effects of technology can be studied, for instance, under the theme of nature protection. If we think about this concept of protecting nature in an analytical manner, we can regard it as misleading. It gives, at least in an implicit way, the image that human beings are not part of nature, but above it and can justifiably control - destroy or protect - it. It is essential to

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understand that the concept of nature changes into the concept of environment as a result of the activities of human being.

At least the following three considerations have to be thought about in order to change the direction of developing technology towards saving nature: What is the basis of the development of present technology and what is really directing it? Will the excessive and unconsidered use of technology upset the balance of nature and will non-renewable natural resources be enough for the future generations (e.g., Mexpert, 1985)? Can the welfare of a society be based, also in the long run, only on the continuous growth of production and consumption?

The present way of production was not originally planned on the basis of minimizing the consumption of energy or material. Nowadays researchers, innovators, planners and industry are jointly developing such production methods in order to save natural resources as much as possible. When referring to environmental management of companies and ecological effectiveness of production, it is a question of producing better products and services with less energy and fewer materials (Pantzar, 1996).

To measure the consumption of raw materials and energy various measures have been developed, such as life circle analysis, material input per service unit (MIPS) and ecological footprint. With these the aim is to find out the consumption of material against the service or product produced. In life circle analysis the objective is to count the effect of the product on nature during its whole life-span. The MIPS measure is often called the "ecological rucksack". It describes how many kilograms or tons of natural resources are used in all production phases to produce a certain product or service. It is important to note that disposable products or products with a short life-span (like fashion clothes, mobile phones, computers...) increase the weight of the rucksack, while durable, long-lived and recyclable goods make it lighter (see also Chapter 12 by Elshof in this book). The ecological footprint describes how large an area of Earth is needed in producing products and services including treatment of waste and pollution as well as how big an area of forest is needed to capture the carbon dioxide.

CONSIDERING THE FUTURE

Various conscious visions of the future offer starting points both for pupils and teachers to clarify their thinking and views by doubting and questioning previous self-evident truths. It is important to arouse the awareness of pupils towards technological phenomena, entrepreneurship and industry and their value and meaning; to consider the development of technology and its options in a diverse manner; and to give them opportunities to influence in many ways and in a practical manner.

It is essential in the learning process to understand how a grasp of the essence of technology affects the pupils' thinking about the future, how understanding of its functions develops their self-esteem and how understanding its effects shapes their values and outlook on life and on the world. A revolution for future awareness and future thinking is needed now. There should be a change of direction towards a

more consumer oriented, culturally enriching and less environmentally exploitative (nature oriented and human technology) approach.

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