A framework of attitudes towards technology in sustainability studies, applied to teachers of ecological economics

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Abstract

Technology can be a problematic issue for sustainability studies: rebound effects to technology-based efficiency improvements can imply absolute increases of resource use; technology helps to improve food security, but also erodes biodiversity, etc. When addressing such issues ecological economics may support some technological solutions and question others. Hence attitudes towards technology, within the discipline, cover a wide spectrum and can at times be contradictory and hidden. In order to facilitate the orientation of scholars and beneficiaries of research and teaching in ecological economics, within this spectrum, we propose a holistic framework for its conceptualisation. Such a framework allows the transparent articulation of differing technology-positions, which we believe is vital for teaching and research in ecological economics. Our framework stretches from technological scepticism, over romanticism and determinism, until technological optimism and is derived from social and philosophical studies of technology. In between we define our own categories such as plain pessimism, entropy pessimism, the post-normal-science-view of technology and entropy optimism.

Thereafter we apply our framework to teaching material of international researchers that taught PhD students in ecological economics. Specifically we ask what attitudes towards technology are found in this material and how these relate to each other. Subsequently we trace those attitudes to personal backgrounds and self-perceptions of the teachers. A qualitative content analysis of lecture texts and questionnaire answers by teachers revealed patterns of attitudes and their relations to researchers' backgrounds. Teachers express explicit and implicit attitudes towards technology that contradict to varying degrees within single presentations and among colleagues. Optimistic and critical attitudes towards technology exist alongside ambiguous positions. Often patterns of attitudes differ among teachers. Topics of presentations can explain attitudinal expressions to some extent. But expressions can also be mere rhetoric devises. Personal backgrounds and self-perceptions of teachers, however, offer only limited explanations of attitudes.

Overall this implies a risk of lacking transparency in arguments made by ecological economics teachers and scholars. It is often unclear to what extent statements about technology relate to research findings or to personal attitudes. Technology is an important aspect of sustainability research and teachers may not be seen credible by their audience, if positions on technology are not clearly stated. Ecological economics lacks a disciplinary canon on the role of technology. Considering the diversity and uncertainty of technologies discussed we should perhaps simply acknowledge the multitude of attitudes and backgrounds of ecological economists. But this requires transparency of personal positions.

Keywords: technology, attitudes, case study, education, ecological economics

1 Introduction

Throughout history technological change had significant effects on human society, which commonly are seen as advancements. In the twentieth century, however, attitudes

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towards technology gradually shifted to more differentiated perspectives that in parts are more sceptical of technology. Technological disasters like Tsernobyl or Bhopal are seen to have contributed to more critical attitudes (compare Mitcham 1994). One could even speculate that technological advances, with few exceptions, like information technology, have become less important for society over the last decade. Moreover, at the end of the twentieth century critical post-modern positions on objectivity in science gained importance (e.g. Funtowicz and Ravetz 1994). These emphasise that the presence and attitudes of the researcher influence the outcomes of research, which requires making personal and institutional assumptions and attitudes explicit to recipients of the research, because on this basis the audience can better qualify the results.

This paper focuses on researchers' individual perceptions of the role of technology in sustainability studies - an area where critical post-modern positions are particularly pronounced (Funtowicz and Ravetz 2008). Particularly, ecological economists and related researchers have long criticized and departed from the blanket technological optimism, which dominates orthodox economic literature (Costanza 1989). But even these researchers have significantly varying opinions on the role of technology for sustainability. For example, some warn that technologies, which use resources more efficiently, also encourage increased use of resources that are then no longer available for future purposes (e.g. Binswanger 2001; Alcott 2005). Others, in turn, suggest that "environmental innovations" (e.g. von Weizsäcker, Lovins et al. 1997; Ayres 2008) or "technological transfer" (Ockwell and Rydin 2006) will support sustainability.

Up to now such prepositions on technology articulated in literatures and oral presentations of researchers have not been thoroughly explored. The paper aims to address these questions. To bring positions on technology to the open we developed a general framework that guides our empirical analysis. We content that when differing attitudes towards technology enter sustainability research it may have significant implications for its conduct, content and outcomes. The paper rest on a case study of the 2009 THEMES summer school in Brighton, which was initiated by the European Society of Ecological Economics. The school addressed questions of sustainability and explicitly discussed innovations and technology from a diversity of angles. Specifically, we explore the explicit and implicit attitudes towards technology in the teaching material of that event.

This led us to extract conceptual backgrounds for "technology" from the literature that are used to build a framework of attitudes towards technology. Subsequently this framework is applied to the empirical case. The implications of our results are critically discussed. Most importantly we argue for a need to make stances on technology more explicit, if sustainability research is to be taken seriously.

2 Conceptual Background

A major challenge when studying individual attitudes towards technology is finding an adequate definition of the term "technology". Commonly, dominant perspectives on technology (Mitcham 1994) and science (Kuhn 1962) change over time, which may lead to differing interpretations of the term "technology".

Carl Mitcham for example defines technology as the *"making and using of artefacts"*, which he claims to be a largely unreflected activity as most engagements with technology happen by habit no matter whether in high-technology or less-technology societies (Mitcham 1994). In his widely cited book "Diffusion of Innovations" Everett Rogers defines technology with a more consequentialist connotation: *"…A technology is a design for instrumental action that reduces the cause-effect relationships involved in achieving a desired outcome."* (Rogers 2003; p. 13). He proposes to divide a technology in a) a "hardware aspect", which consists of the tool as a material or physical object embodied in the technology and b) a "software aspect" that consists of the information base for using the tool. These two attempts to define technology share in common that they point at the social aspects of technology – how we deal with technology habitually and purposely. While these reflections helped developing our framework, we realized that broad definitions of technology were detrimental to our goal of mapping attitudes. When defined broadly enough, almost any human (or even animal) action involves the use of technology, including language or cultural practices.

It is important to note that technology is not given or static. Most discussions are about technological innovation and the diffusion of technology. Invention of technology is commonly seen as something happening before innovation and diffusion, as it concerns the development of entirely new artefacts. The social process of making them usable in practice would then be *technological innovation*. These ideas derive to large extents from Joseph Schumpeter who emphasised the role of technology and entrepreneurial innovation in capitalist economies (Schumpeter 1952). *Technological advancement* also relates to innovation, but is mostly an expression for *technological change* at broader scales with connotations of progress. Both concepts are often seen as core drivers for *economic* change. Before the twentieth century technological change was not as rapid and encompassing as today – especially at a global scale (Cameron and Neal 2003). Accordingly, historical descriptions suggest that in medieval or biblical times technology was given and hence the resources available to an economy set the upper limit to its economic achievements (Cameron and Neal 2003). *Technological change* is held to expand those limits by discovering more resources and using them more efficiently, which then enables economies to be inhabited by larger populations with higher standards of living (Cameron and Neal 2003). Such arguments essentially boil down to a notion of economic growth based on technological progress and they immediately raise questions of sustainability. But there are more differentiated views on technology.

3 A framework for the evaluation of attitudes towards technology.

Our framework or continuum of categories draws heavily on Mitcham's (1994) "three ways of being with technology", which constitute different ideal types of (social) relationships of humans with technology: ancient scepticism, enlightenment optimism and romantic uneasiness. Mitcham's framework focuses at the "modes of the manifestation of technology" (Mitcham 1994; p. 160). Technology can thereby be distinguished according to types of objects (utilities, tools, machines), knowledge (maxims, rules, theories), activity (making, designing, maintaining, using) and volition (active will, receptive will) (Mitcham 1994; p. 268). These can be translated into categories of implicit and explicit approaches or attitudes towards technology. But this requires us to transform Mitcham's framework. Our four main "techno-attitude" categories are called: technological scepticism, romanticism, determinism and optimism. We depart from Mitcham's ordering, since we aim at a continuum of possible attitudes, for which we develop subcategories. Nevertheless establishing categories is problematic. They overlap, and their boundaries are debatable and to some extent arbitrary as also Mitcham points out (Mitcham 1994). But building categories helps to detect inconsistencies and incoherence and thus forces to reason and reflect on attitudes and approaches towards technology.

3.1 Technological Scepticism

Mitcham's "ancient scepticism", describes attitudes towards technology during ancient or premodern times (Mitcham 1994). Technology was seen with greatest suspicion and unease. It bore the danger of being turned away from God or the gods until it had been established that it was innocent or necessary. This conforms to the view that technologies of today tend to cause environmental and ecological problems. Consequently technology needs external guidance. But there will always be hidden dangers in technologies.

There is a wide array of scepticisms concerning technology. Some may argue it undermines social cohesion, fosters individualisation and isolation or that it eliminates jobs and/or erodes their meaning (e.g. Fromm 1956; Illich 1973). From an environmental perspective technologies enable quicker exploitation of natural resources (Daly und Cobb 1994) e.g. using chainsaws instead of axes (McNeill 2001), an argument closely related to the rebound effect. Røpke on the other hand criticises the unified attention on technology for solving environmental problems, as this is likely to imply that underlying social conditions are not accounted for. (Røpke 1996). Daly and Cobb also conclude that *"…The assumption that new technology will solve the problem, …, does not hold up."* (Daly und Cobb 1994)

More generally sceptics may argue that technology almost always involves the creation of a-natural substances and processes, which tend to damage or disrupt natural ecological cycles. It could thus be seen as a means used by man to exert power and control over other human beings and the environment.
Within the category of technological scepticism we identify three subgroups: (a) Simple Scepticism, (b) Technophobes (plain pessimists) and (c) entropy pessimists.

Simple scepticism (a) implies that technology has to proof that it does not have drawbacks that cannot (readily or fundamentally) be mitigated. Therefore, risk assessment is needed. However, this suggests that it is possible to assess technology, which gives some hope, but only over a certain time while there is still a chance of technological failure. Optimism is thus only articulated in terms of means for assessment, but potentially it may just be proven that all technologies finally fail. Daly and Cobb cite Victor Furkiss, who argued in 1974 that the current society is locked in a positive feedback loop, where *"…technological change feeds on itself, …"* and thus *"…ecological humanism must create an economy in which…, technology is controlled, …"* (Victor Furkiss 1974: 235 cited in (Daly und Cobb 1994). .

Plain pessimism or technophobia (b) (Drengson 1982) could be described as a luddite rejection of all new technology. Representatives may attribute all or most problems of human society to this factor (e.g. poverty, inequality, environmental distruction,etc.)

and they may be quite pessimistic about human's destiny. The only hope for a sustainable future may be in reverting to simpler "low-tech-no-tech" lifestyles, integrating the human economy with ecological cycles and applying traditional knowledge. The Amish may be regarded as a societal group practicing this philosophy. The Luddite's fear of technology reawakened after the WWII bombings of Hiroshima and Nagasaki and later in the opposition to nuclear power. Technology gone wrong is also a reoccurring theme in the arts from Mary Shelley's 'Frankenstein' to science fiction movies like the Wachowski Brothers' Matrix Trilogy.

Some academic support for this view is provided by the Jevons or Rebound Effect (see for example Binswanger 2001). A more radical version of this hypothesis has been suggested by (Schneider 2008), who postulates that technological improvements always serve to overcome limits (time, distance, speed, weight, etc.), which eventually will result directly or indirectly in negative environmental, social and economic impacts. Instead we should not intend to overcome, but to embrace these limits (Schneider, Nordmann et al. 2002; Schneider 2008). This position is also articulated by the emerging field of de-growth economics (e.g. Ariès 2004; Latouche 2004; Baykan 2007).

The term 'entropy pessimism' (c) has been used by Robert (Ayres 2007), who himself refers back to (Pezzey and Toman 2002) and he provides Nicolas Goergescu-Roegen (1971; 1975; 1976; 1977; 1993) and Herman Daly (1987; 1992; 1992a) as representatives thereof. It is the counterpart to the 'neoclassical economic technological optimism', which we will refer to later. This debate has its roots, in early classical economic concerns of limits of agricultural output (Malthus 1807 [1798]; Ricardo 1821 [1817]; 1826 [1798]) and non-renewable resources (Jevons 1866 [1865]) and re-emerged in the late 60ies and 70ies (e.g. Georgescu-Roegen 1971; Meadows, Meadows et al. 1972; Schumacher 1973). Its authors could also be regarded as one of the first supporters of "strong sustainability" (Ayres 2007), and many of their arguments are based on thermodynamics.

For Georgescu-Roegen (1975) there had only been two "viable technologies" in human history so far: fire and the steam engine, as these were the only discoveries that would produce more energy than they consumed. All other technology could be seen as mere attempts to use and employ (or waste?) the available stock of fossil energy at a faster rate. Without our enormous fossil fuel derived energy affluence, most technology, would simply not exist, which is true even for some so called renewable energy technologies. This position is supported by many peak oil theorists (e.g. Campbell and Laherrere 1998). Moreover no technology is able to reverse the arrow of entropic degradation of energy and materials (Georgescu-Roegen 1971, p. 60), a position, which has been challenged by followers of the "energy dogma" (Ayres and Nair 1984; Ayres and Kneese 1990; Ayres 1994; 1997; 1998; 1999). On the other hand, the claim that sink capacities of the planet's ecosystems are reaching its limits or have already been surpassed, remains mostly unchallenged (Ayres 1998). It is thus argued technological advances will not be enough or because of the rebound effect (Binswanger 2001) will even worsen the problem of scale as illustrated by the Ehrlich (1971) equation (I=P*A*T).

For Tainter, (2000; Allen, Tainter et al. 2002), technological advances are also not a sign of progress, but instead the result of an increasing societal complexity due to crises and scarcity and driven by population growth. Without this pressure people would still live the way indigenous tribes do, which tend to work much less than people in modern societies. Eventually, he argues, societies tend to become too complex to maintain and they collapse.

3.2 Technological Romanticism and Post-Normal-Science

Carl Mitcham claims an "an uneasiness" about the "modern technological project" that derives from philosophical reflection and experiences made with technology in the twentieth century such as nuclear weapons and environmental pollution (Mitcham 1994). Opinions emerged that critics of technology have to take its benefits into account and that proponents have not only to consider its complexity and fragility in the environment but also the moral arguments of technology critics (Mitcham 1994). Within such "romantic uneasiness" technology is seen as questionable and associated with feelings of unease, but these relations are ambivalent and hence, sublime aspects would essentially determine the viability of a technology (Mitcham 1994).

Technological romanticism is situated in the ambiguous middle between technological optimism and pessimism, within which it can tend more towards pessimism or optimism. Hence, we have divided this category into (a) an ambivalence about technology, that emphasizes the possibility of drawbacks and (b) an ambivalence that emphasizes the possibility of benefits. These perspectives are close to the Post-Normal-Science (PNS) views on technology (c), which focuses on many technological aspects of science, particularly complexity, risk and uncertainty of technology deployment (Ravetz, Funtowicz, und Costanza 2008). PNS is therefore a third subcategory.

Evolutionary concepts of technology that are non-deterministic may also fall into romantic uneasiness, because all kinds of outcomes are possible, but it remains unclear what could be desirable. The ethical underpinnings of evolution are not clear-cut. Exceptions are e.g. Huxley's dualistic argument of the fittest being not necessarily the ethically best (Huxley 1970), while Herbert Spencer suggests the fittest to be the best, and John Dewey conceives ethics part of cultural evolution and thus itself evolving (Nitecki 1994). The sociobiological ideas of Edward O. Wilson also met diverse ethical perspectives (Caplan 1976; Richards 1986). Therefore evolutionary stances on technology can be extremely ambiguous.

(a) Ambivalence about technology that emphasizes the possibility of drawbacks

Martin Heidegger argues that technology invites its questioning and also has to be questioned in order to experience it (to exist) (Heidegger 2009). Heidegger sees dangers in too much technology, but also a close relation of humans with technology (Mitcham 1994; p. 55). Similarly ambiguously Lewis Mumford argues that only human demands and aspirations are the reasons for making up the mind about technological means (Mitcham 1994; pp. 42-43). These can either be "polytechnics" that are life-oriented and work for the democratic realisation of the diversity of human potentials or "monotechnics" that work in authoritarian processes towards economic expansion, resource depletion and military power (Mitcham 1994). Technology may for example "weaken social bonds of affection" and "alienate from affective strength" to exercise technology (Mitcham 1994; p. 299). Thus, an ambiguous uneasiness about technology is being articulated and although it may be beneficial there is more pronounced speculation about negative aspects. Such equivocal attitudes imply indecisive opinions on how to treat technology.

(b) Ambivalence that emphasizes the possibility of benefits

Although it may have drawbacks, possible positive aspects of the technology that are made rather specific may be at the forefront. Such uneasiness concerning technology implies that hopes associated with technology are emphasised while it remains unclear how to treat technology. For example, Mumford's "polytechnics" could be the focus, because they are life-oriented and work for the realisation of the diversity of human potentials. At personal levels technology thus "engenders freedom" (Mitcham 1994). Further, the "will to technology is an aspect of creativity" and the "artefacts expand the process of life and reveal the sublime" (Mitcham 1994). But it is unsure how one actually can arrive at the conditions of such prospects.

(c) Post-Normal-Science (PNS) view on technology

The PNS view on technology relates to romantic uneasiness, as it calls for a new definition of *quality* in the management of complex science-related issues: If decisions have to be made about 'if', or 'how' to apply or support a new technology and if the system uncertainties are very high and so are the 'decision stakes', then a process of extended peer review should be initiated (Funtowicz and Ravetz 2008). Such a process acknowledges the plurality of legitimate perspectives, which PNS upholds, because the traditional reliance on the Descartian notion of scientists as the beholders of the "truth" and "sound science" ignores two important facts (Funtowicz and Ravetz 2008): First, the uncertainty and complexity of social and biophysical systems and second the bias and disagreement that exists among most experts (Wynne 1992; Yearley 1999; Maranta, Guggenheim et al. 2003; Lessard 2007).

This approach is claimed to be needed when choosing which technology should be support the achievement of sustainability goals e.g. nuclear power or renewable energy. Often this is addressed by unqualified pro science and technology statements, which portray all technological advancements as intrinsically good and synonymous of human progress (e.g. Broers 2005; cited by Stirling 2007). Even when public participation processes are deployed, these face a risk of being degraded to therapy or plain manipulation (Arnstein 1969) or to "technologies of legitimisation" in order to 'close down' a wider political discourse (Harrison and Mort 1998; cited by Stirling 2008). Stirling (2007) therefore calls for rigorous, complete and inclusive processes of transparent stakeholder deliberation (starting from the initial 'framing').

Such 'upstream engagement' (Wilsdon and Willis 2004; cited by Stirling 2007) should not obscure the essentially normative and political character of technological choices. Generally, within attitudes of romantic uneasiness, it is not clear whether PNS positions really maintain a middle ground regarding technology for sustainability. The future may be a "technological" one, which is certainly true if technology is defined widely enough (Stirling (2007). But, depending on the definition of technology, an impression remains that returning to less advanced technologies or to no technology at all is implicitly being ruled out.

3.3 Technological determinism

When it is held that technology is dynamically progressing, technological change is seen as automatic or at least "quasi-automatic" because the productivity of capital is partly a function of the embodied technology (Cameron and Neal 2003). Similarly deterministic Jaques Ellul defines as *"…the totality of methods rationally arrived at and aiming at absolute efficiency (for a given stage of development) in every field of human activity"* (Elull 1954, cited by Mitcham 1994; p. 57). Technology thereby replaced capital as the dominant force in the economic progress and thus the natural environment is being replaced with a technical environment (Mitcham 1994: 60). For constructivists, however, technologies are "social constructions" to a similar degree as they are technological constructions (Mitcham 1994). Determinism may thus be seen open at some point, though only from the social sphere. But even then, as Francis Fukuyama argues, some groups will always develop technology, no matter whether catastrophic events destroy its infrastructure, or people decide to abandon technology. This is simply because, if some humans survive, technological knowledge will do so as well and technology will be used, because it enables groups to defend themselves against others (Fukuyama 1993).

Evolutionary approaches towards technology can be deterministic, although it is widely held that evolution is an open process. Within evolutionary approaches it is not questioned whether technologies are good or bad. Rather it is focused at the mechanisms that drive and transmit technological change (e.g. Nelson und Winter 1982) and it is those mechanisms which can be portrayed as deterministic. This is common in evolutionary economics, where determinants are variation, inheritance, inevitability and selection of properties. These can only be relaxed by degrees of human intentionality (Hodgson 2004). For example, co-evolution of society and ecology suggests that more complex socio-technical systems evolve that cope with a decreasing diversity of natural ecosystems (Norgaard 1981; Norgaard 1994). While such arguments are rather deterministic, the emergence of random feed-backs can also be seen as non-deterministic, suggesting relativity and reflexive post-normal perceptions of technology. However, this category focuses on general technological determinism where outcomes have no specific value.

3.4 Technological Optimism

Although the term "technological optimism" is being used in the academic literature, we could not find a prober definition for it. Here we would describe it as the positivistic belief that all phenomena, which are detrimental to the goals followed by humans, can be effectively removed or overcome by humanly devised technology. Alternatively we could define it as an attitude towards technological advances, which assumes that at one point in the future humans will be able to understand and control all relevant variables of any given process on earth and beyond, if they wish to. This position therefore is related to the Descartien view of men's role in this world as "master and possessors of nature" (Funtowicz and Ravetz 2008). Hence it is a result or symptom of "normal science", which sees science as a puzzle solving activity within an unquestioned and unquestionable 'paradigm', as Kuhn (1962) defined it (Funtowicz and Ravetz 2008). These enthusiastic ideas about technology are based on modern Enlightenmentattitudes (Mitcham 1994). Technology therein is inherently good and its misuses are accidental. Hence, the burden of proof is with those who oppose new technologies. We have subdivided this group into the (a) technophiles, (b) technocrats and (c) entropy optimists.

The most extreme forms of 'technological optimism' are those of the technophile (a) and the technocrat (b). The technophile sees all or most technology as intrinsically good and beneficial for humans (especially high technology). This person would adopt technologies enthusiastically and expects them to improve life and solve social problems (Drengson 1982). A technocrat would go even further than this, as he/she believes in "rule by experts" or that decision-makers should be selected based on their specialized, technological knowledge, and/or rule according to technical processes. It is believed that this would greatly improve efficiency and reduce socio-economic irrationalities(Brunham 1941). In less radical forms, traces of technocratic attitudes can be found in all forms of 'technological optimism' and most prominently in the language of 'sound science' (Stirling 2007) of the common pro-technology political discourse. Therein technology is believed the main determinant of the future of the human society; where history can be reduced to a one way track "race to advance technology" (Broers 2005; cited by Stirling 2007). Another typical characteristic of this attitude is its apparent intolerance towards technological sceptics, even if moderate. those critical of technology, even if scepticism is moderate, which may be referred to as 'enemies of reason' (Taverne 2005; cited by Stirling 2007) or '...member(s) of the "flat earth society", opposed to ... modern life itself' (Malloch-Brown 2001; cited by Stirling 2007).

An optimistic attitude towards technology could be seen as an essential component of neoclassical economic theory, which we shall call entropy optimist (c). In summary, and according to our analysis technological optimism in neoclassical economic theory has the following rationale: Continuing unlimited economic-growth is an "*axiomatic necessity*" (Georgescu-Roegen 1977, p. 266) to rid society of most social evils like unintentional unemployment, poverty, overpopulation (the poor have less children) and pollution (the rich care more about their the environment as they can afford the "luxury") (compare World Bank 1992; Spence 2008; World Bank 2008). Technological progress justifies the assumption of perfect substitutability of the factors of production, which feed this unlimited economic growth (compare Solow 1956; Barnett and Morse 1963). Not only are scarce (or exhausted) materials substituted for new, more abundant ones (compare Dasgupta and Heal 1974; Stiglitz 1974; Solow 1974a; Solow 1974b; Stiglitz 1979) but also are material intensive products and processes substituted for others which need less material and energy e.g.: from torches, to candles, kerosene lamps, gaslight, incandescent light, fluorescent light to light emitting diodes (LED's). Prices and the market are the drivers behind this mechanism (Cameron and Neal 2003). Moreover more growth also means more resources for research and therefore more technological advances and more substitution.

Factor substitutability, or the substitutability between manmade and natural capital are moreover the basis for the "weak" interpretation of sustainable-development. This is because it implies mechanical reversibility of processes (Söllner 1997), which means that any unfavourable outcome of human activity can be reversed ('technological fix') e.g. ocean fertilization to sequester CO^2 (e.g. Beckerman 1995). Another key assumption of this attitude is the unlimited availability of energy in the future as promised by Nordhaus et al's (1973) 'backstop technology'.

In terms of governance of technology mainstream economists tend to argue that this should be left to market mechanisms, despite the fact, so the critics, that there are numerous examples, where markets chose inferior technological configurations.. Technological progress is in this way treated as a single, pre-ordained path; as a 'winner takes all' race along a pre-determined path (Stirling 2007). The rejection of this technological optimism in favour of "prude pessimism" could be seen as the mayor philosophical dividing lines between the mainstream, neoclassical economic theory and Ecological Economics (Costanza 1989)

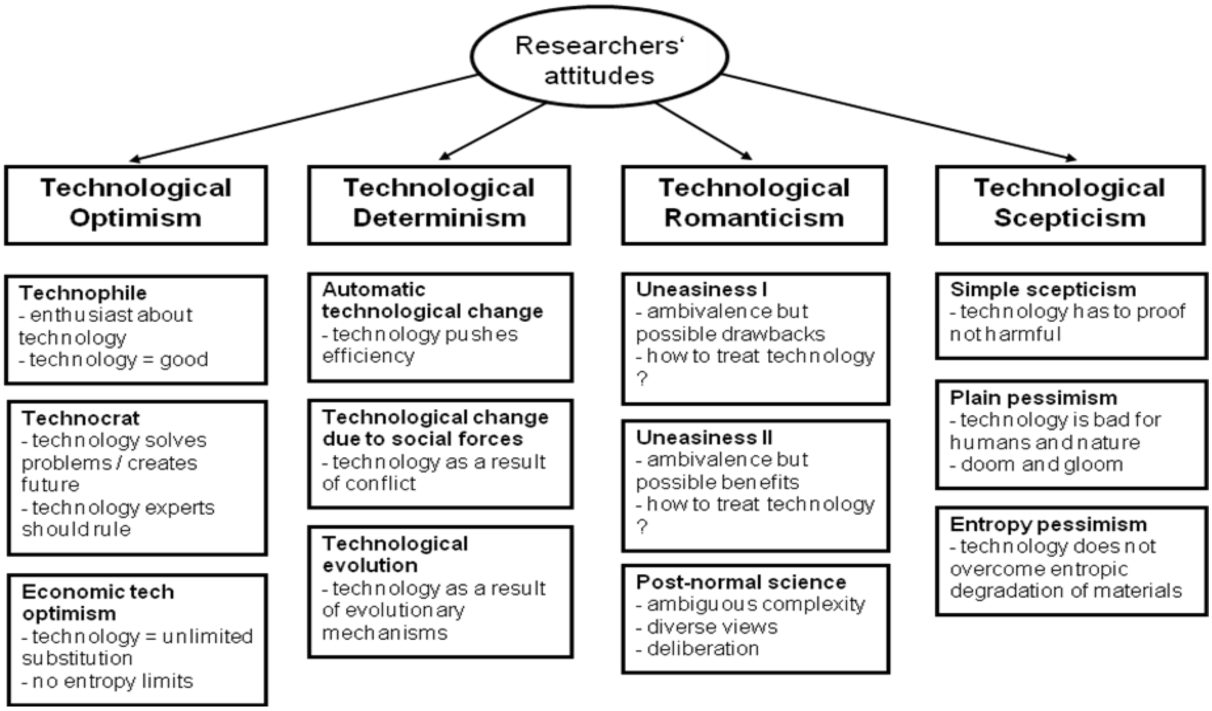

Figure 1: A conceptual frame of attitudes towards technology

4 <u>Material and Methods</u>

The empirical research rests on a case study (Yin 1994) of a two week Marie Curie Summer School in Brighton, which was carried out in June 2009 and focused on "integrated analysis of complex adaptive systems" in the area of ecological economics. Participants were international PhD students and post-docs from the natural and social sciences. Lecturers were international and came from a diversity of backgrounds, ranging from physics to social sciences. The study investigates manifestations of implicit and explicit attitudes towards technology in the teaching and presentation material that was made available to the students. It consists of slides from 17 presentations, which are related to 10 lecturers. The study aims to develop an empirically grounded view on explicit and implicit attitudes towards technology that are conveyed in the presentations. An email questionnaire, consisting of semi-structured and structured questions, has been answered by five lecturers in March 2010 as a complement. It elicits personal and professional backgrounds and aims of the lecturers and also gave them the opportunity to state their personal attitudes towards technology themselves within structured categories based on Figure 1. Answers to semi-structured questions have been condensed inductively to derive codes that enable comparison among individual responses. It was intended to use the resulting data to give reasons of why individual lecturers hold certain attitudes towards technology and convey them in particular ways. But the small sample size and a response rate of 50 per cent requires us to treat the data cautiously.

To conduct a qualitative content analysis of the lecture slides, initial analytical categories were derived from the literature as they are represented in Figure 1 (Mayring 2008). Each category was divided into explicit and implicit contents. Together they formed a basic guideline for finding quotes, statements, assumptions, representations, arguments, *etc.* in the material. The categories were filled up with relevant material from the presentations and the analysis continued with iterative re-elaboration in terms of refinement of contents and categories, adjustment of content-category relation and generalisation of contents with the help of codes derived inductively from the material and deductively from the literature (Miles and Huberman 1994; Mayring 2008). The coding integrated selective, meaningful parts of the material that are of particular significance to our research question (Miles and Huberman 1994). The analysis was conducted jointly. Going through the material yielded explicit definitions and articulation of attitudes, prototypical quotes and rules to distinct among categories, which were reworked and checked in subsequent steps until a more solid picture emerged that is being presented in the results section below.

5 <u>Results and discussion</u>

Within the 17 lectures that were analysed, 379 arguments related to technology were identified. All lectures did relate to technology in certain aspects and across lectures the whole range of attitudes described in the literature was covered. However, attitudes towards technology were not always explicitly articulated. Implicit manifestations of attitudes are widespread and also have implications for the general arguments conveyed with a lecture. Thus, the general arguments of a lecture often turn out to be contradictory when taking particular attitudes towards technology articulated within a lecture into account. Generally, individual lectures are skewed towards certain attitudes, although not necessarily intended by the lecturers. The numbers of “techno-arguments” identified in individual lectures differ significantly, partly because the lecture topics imply lesser or more coverage of technology. Another reason may be personal attitudes of lecturers themselves. These might also be reflected in lecture topics. Within individual lectures, though, one has to make a difference, between illustrative repetition of conflicting arguments made by others and those attitudes belonging to the case the lecture is arguing for.

When analysing the content of the lectures, it emerged that optimistic attitudes towards technology were most straightforwardly articulated, while sceptic and ambivalent romantic attitudes were more difficult to trace. Technological determinism can prevail in optimistic and sceptic attitudes, but may also itself be a view on technology. Cases in point are arguments based on concepts of evolution, which often involve technological determinism in ways that prevent direct criticism of underlying statements. Optimism mostly implies determinism, as certain logic is suggested to bring about the desired state of technology. Similar configurations are at work with scepticism, albeit in a different normative direction. In romantic and ambivalent positions, multiple perspectives that share ambiguous views from different, altogether incommensurate, ends prevail. Romantic and ambivalent positions are often unclear about futures and also suggest that views on technology might change in the future, similar as conceived by post-normal science. The boundaries between categories of attitudes are blurry, but optimism is clearly distinct from scepticism. In turn, ambivalent attitudes appeared often close to scepticism, but could not be identified as fully sceptic.

Table 1: Attitudes towards technology as stated by lecturers and aggregated statements containing explicit and implicit attitudes towards technology identified in corresponding lectures.

		Lecturer				
Self-stated attitudes towards technology (T)	Interpretation	H	A	J	I	D
a) T is always good	optimist					
b) benefits of T outweigh drawbacks	optimist					
c) T solves problems	optimist	x		x	x	x
d) T expands our limits	optimist	x		x	x	x
e) society always pursues T	determinist	x		x		x
f) T always results in new T	determinist	x		x		x
g) T evolves over time	determinist	x	x	x		x
h) unsure about T, but rather see benefits	romantic					x
i) unsure about T, but rather see drawbacks	romantic			x		
j) society has to deliberate on which T to deploy	PNS view		x	x	x	x
k) T has to prove not being harmful	skepticist		x	x	x	
l) harm caused by T outweighs its benefits	skepticist					
m) T can overcome entropic (physical) limits	entropic optimist	x				
n) T inevitably faces entropic (physical) limits	entropic pessimist		x	x	x	x
Number of statements with attitude towards technology in presentations						
Optimism		13	12	34	-	17
Determinism		2	-	3	1	4
Romanticism		13	5	18	9	1
Scepticism		4	37	5	1	2
Unclear		1	3	-	1	8
Total		33	57	60	12	32

The email interviews suggest diverse backgrounds and aims of lecturers, which overlap to varying degrees. It seems that their self-stated attitudes towards technology only relate in particular cases to these patterns. For example the two lecturers, who are not involved in environmental issues, claim not to be sceptic about technology. Matching self-stated attitudes towards technology to those found in related lectures seems almost impossible with the data at hand as can be seen in Table 1. Two lecturers, however, did not state clearly determinist attitudes towards technology. In their lectures no or only one determinist position on technology could be found. But these few examples should be treated with caution. Greater sample sizes or deeper interviews should suggest clearer relations. Nevertheless, this is not to say that backgrounds, aims and self-stated attitudes of lecturers should straightforwardly influence the attitudes towards technology conveyed in lectures. More research in this direction would be necessary.

In the lectures were also statements that relate to technology, but lack clarity to which attitudes specifically. A more thorough analysis departing from categorisation of single arguments and using more codes per argument may reveal more insight into both, these statements and the successfully categorised arguments. The categorised arguments, which all convey rather specific attitudes, however, require a more extensive description. Quotes indicate lecturers with a capital letter and lectures with a number starting from one (A1-I1).

5.1 Optimism

Optimistic attitudes towards technology were widespread in the lecture material and often clearly articulated. Thus, many arguments are explicit and most arguments can be related to distinctly specifiable subcategories. Optimistic attitudes rest on some sort of improvement by means of technology or a claim that novel and better or optimal technologies are possible. It is partly also emphasised that transfer and diffusion of technology is desirable and possible. The argument then is that technology should be used and that possible limits can be overcome. This assumes that technology can be steered towards desired ends or it is implied that technology will do so by itself or is desirable by any means.

A subcategory of technological optimism claims that technological change is always to the better and consists of improvements to a reference point. In one of the presentations the *“level of technology and innovativeness”* served as a measure of performance (B2). Another (D1) suggested *“niches for radical innovations”* that outperform former innovations. Similar attitudes prevail in graphical representations of technological change where utility derived from technology increases over time, though partly at different rates (B2, C1, D1). Likewise *“economic returns from the use of technology”* and *“incremental improvement”* of technology that are part of a notion of *“technological progress as optimisation”* are mentioned (H1).

A closely related subcategory suggests drawbacks of certain technological advancements, but optimistically it is insisted that there are always possibilities of alternative and better technology. The emphasis is on *“novelty”* (D1, B1) *“innovation”* (B2, D1, E1, J1) and *“alternatives”* (A2, C1, J1) of technology, but also *“learning”* to improve or use technology (D1). Without further specification it is claimed that *“there are many green niche innovations”* and *“windows of opportunity”* for technological novelties (D1).

The optimism that always technology can be found that solves the problems caused by a pre-existent technology rests on notions of repair and reversibility. This subcategory does not abound with arguments, but it contains positions that are straightforward: *“monitor impacts and adjust”* claims one lecture (D1), while another argues that technological diversity does *"mitigate lock-in"* through portfolios that prevent negative pressures to concentrate (J1).

Often attitudes conceive technologies as solving specific problems, without consideration of their wider impacts. Many relating arguments point at responses to climate change. One lecture optimistically suggested that renewable energies are *"good for the environment"*, create employment and are good for coping with peak oil (A2), while another pointed at developing countries' *"access to new technology for economic growth and poverty alleviation"* (F1). Less straightforwardly it was argued that diversity does *"promote resilience"* as it *"offers a 'response' tool for adaptive strategies"* and *"enables experimentation and adaptation to challenge"* (J1).

Cross-cutting through optimistic subcategories are vague and implicit notions of growth and no limits. Some arguments rest on general neo-classic economic optimism or entropy optimism, for example ignoring rebound effects. One lecture identified presumably *"low carbon technology"* such as *"hybrid vehicles"*, *"coal gasification"* and *"improved combustion efficiency"* (F1). Another argued that one needs to *"develop alternative energy sources"*, albeit *"including conservation"* to replace fossil fuels (A2). But further arguments are less explicit when it comes to their relation to entropy and growth, though issues of limits and entropy are actually implied.

5.2 Determinism

Three arguments can be associated with technological determinism: (i) technology determining technological change, (ii) technology determining social change, and (iii) society determining technological change. The latter two often come together. For example, a lecture argued that technology affects agents and agents' choices who in turn affect technology (I1). Relating to that, another lecture claimed that *"system evolution is path dependent in that choice at one moment in time affects the likelihood of subsequent choices"* (C1). Such evolutionary arguments often contain both deterministic and probabilistic arguments, while the emphasis is on non-random mechanisms. Consequently reinforcement mechanisms are a common theme. One lecturer claimed that *"innovations have historically been clustered in ways that are amplifying"* (H2), while another suggested that *"diffusion is a non-linear process of niche accumulation"* (D1). Similarly deterministic attitudes towards technology appear within technological optimism and scepticism, though these have a positive or negative view on technology.

5.3 Romantic uneasiness and post normal science

Attitudes towards technology can have a sense of uneasiness and ambivalence. Many of the arguments in the lecture material turn out multifaceted, because aspects of them could also fall under other attitudes. The ambiguous combination of aspects that also contain elements of uneasiness, however, could better be seen as a specific attitude towards technology. This comes along with notions of complexity, diverse views and possibilities, contingency, uncertainty and limits to settled knowledge, which can mix differently. Thus, decisive prescriptions to treat technology are missing. Tendencies of attitudes can, however, be summarised in subcategories of romantic uneasiness.

An ambivalent attitude towards technology may emphasise possible drawbacks, although no decisive recommendation on how to treat technology is formulated. For example *"winning technology may fail"* over longer terms (D1). Another lecture pointed at different aspects of technology ranging from unproblematic to problematic such as *"risk of engineering failure"*, *"unfamiliar toxins"*, *"hazards 'human factor'"*, *"ambiguity of interests, priorities and framings"*, *"new vectors"* or *"forms of harm"* (J1). Acknowledged difficulties with large-scale change of technology often imply similar uneasiness: a lecture saw *"importance of initial conditions, inability to see the whole map, problems of making the transition"* (H1), while a further claimed that there is no *"silver bullet; all niches have problems, e.g. social debates, resistance, NYMBY"* (D1). Thus, the role of human ambiguity is important and impacts on society are a crucial concern.

To a lesser extent attitudes showed ambivalence towards technology that emphasised a possibility of benefits. Within this subcategory of romantic uneasiness notions of hope coincide with lack of decisive ways to deal with technology. This is exemplified by arguments such as that *"on the whole faster innovation tends to win, but enough time is needed for 'co-evolution'"* (B2). Implicitly ambiguous notions of hope feature in ideas that *"...there is more to the world than human 'feeling' about commodities"* (A2). And, similarly, when claiming that *"rebound effects are significant, but they need not make energy policies ineffective"* (G2) a more materialist notion of hope is being conveyed that is ambiguously embedded.

Attributes of technology that are contingent to changing factors can be an important ingredient of ambiguous and uneasy attitudes towards technology. Within this subcategory of attitudes it remains open whether technology is positive or negative as it is argued explicitly in J1 or that *"resilience as positive or negative depends on object, context, perspective"* (J2). Similarly, due to a probability of being successful or lethal, it is claimed that *"evolution is messy"* (B1). Another lecture identified a *"technical incommensurability"* that relates to *"evolving complex systems, multidimensional nature of complexity"* as well as *"uncertainty, ambiguity and ignorance"* (G3). These examples show that nothing is settled and diverse views are conceivable, which all come with some degree of uneasiness.

Post-normal science (PNS) shares much in common with romantic uneasiness. Lectures did not explicitly suggest a clear boundary between science and technology. But there are many instances where attitudes towards technology would also fit to PNS, in particular when technologies imply problems of uncertainty and ignorance that come along with different views at those problems that nevertheless require evaluation. Attitudes may, thus, emphasise *"indeterminate realities"*, *"reflexive framing"* or *"plural frames"* (J1). Even when knowing an aim, there may be difficulties in achieving it. Accordingly, a lecture suggested an *"incomplete understanding of the technology transfer process"* (F1). Difficulties with objective decision-making are thus often implied.

5.4 Scepticism

Critical attitudes towards technology that assume technology causes harm or will be bad under certain circumstances can be summarised as scepticism. Technology thus has to prove not causing harm, while it is generally assumed that technology and its context are unstable. For example, there is a *"fragility of stocks of capital"* and a *"fragility of the entire socio-economic system"* (A1). Degrees of scepticism depend on the contents of arguments. These can be differentiated into specific subcategories. A simple sceptic attitude towards technology can be identified as a subcategory. It implies that unambiguous measurement is possible and risk assessments are needed. Despite partial success of certain technologies, these may fail later, nevertheless. One lecture points at fisheries, where *"the evolution of fleets leads to greater instability"* (B2), while a further lecture suggests a *"shortcoming of the evidence"* that other technologies will be successful (F1). Often, however, scepticism comes close to pessimistic attitudes or even is plain pessimism.

Plainly pessimistic attitudes conceive that technology, over a certain timescale, leads to 'doom'. Collapse is an inevitable outcome and there will be nothing positive afterwards. Use of technology and its effects are thus scary. For example, *"fossil fuel burning is required to stop"*, because of *"catastrophic climate change"*, but *"this is not going to happen"* (A1) and hence the catastrophe is inevitable. Another lecture showed a graph, where negative impacts of economic development are increasing, even if *"clean technology"* is deployed (F1). Such economic-growth criticism forms a special case of pessimistic attitudes, which often relates closely to pessimistic outlooks on entropy developments of the earth. For example, a lecture claims that *"less consumption, more leisure time, will put less stress on the environment"*, that *"we are growing by destroying"* natural capital and that *"people in the future will have fewer economic resources with which to deal with environmental change"* (A1). Correspondingly, *"economics does not provide a map for arriving at a steady state economy"* (H2) and there are notions of the *"economy as an evolving thermodynamic system"* (A1). Relating attitudes that emphasise the rebound effect suggest, even when technology improves efficiency and seemingly breaks thermodynamic limits, the rebound effect would be greater than the savings. It was thus pointed at *"resource efficiency and the rebound effect"*, which imply, directly and indirectly, but also at "economy wide" scales, that *"energy efficiency improvements"* increase demand and thus consumption, therefore drawing down stocks of energy and other resources (G2).

5.5 Scope and implications

The analysis of the lecture material yielded a structured account of attitudes towards technology that lecturers implicitly or explicitly conveyed to participants of a summer school. The categorization of attitudes was not always straightforward. Certain overlaps, e.g. between optimism and determinism, have been made clear, but there are at least four issues that require discussion. First, *“transfer and diffusion of technology”* were themes that emerged in various arguments related to different attitudes. One lecture (F1) often linked this to *“technological capacity building”*. Whether or not these terms are jargon, they easily have an optimistic connotation and suggest that technology transfer and diffusion is good. Why else would one care about facilitation of technology transfer and diffusion and why else would *“technological capacity building”* be important? Yet, single arguments were also sceptic on its feasibility. Possibly, therefore, one might construct hierarchies of attitudes towards technology. Second, *“technological transition”* had a similarly optimistic connotation. However, some applications of this term also suggested ambiguous attitudes towards technology and it may well be argued that an inevitability of transitions is deterministic. Third, *“learning”* in relation to technology could be equated with technological advancement. Learning is often about improving technology, being able to create technology or putting technology to optimal use. Rarely, learning seems to be about restricting technological advancement. But sometimes arguments suggested limits to successful learning and knowledge. It is thus unclear how to treat learning and knowledge of technology. The occasionally used term of *"understanding"* still comes with a notion of discovery. It commonly does, however, not presume particular attitudes towards technology. Fourth, the notion of *"technological diversity"* was part of diverse attitudes towards technology, but clearly not related to pessimism. Diversity often had a notion of portfolio optimization that suggests: the more different technologies, the better. Individual technologies may thus not be useful, but at later stages they might be. Hence, diversity often implies attitudes ranging from romantic to optimistic. The concept of technological diversity may also be used strategically and thus implying some sort of optimism, if it for example enlarges possibility spaces of technologies or erodes the control of established technological agendas, because it enables the establishment of an "agenda of alternatives".

Diversity is a concept that could also be applied to the results of the analysis. A diversity of possible attitudes towards technology is evident. Lectures were not clearly biased towards certain attitudes. Rarely, however, sceptic or pessimistic attitudes were critical for the general argument of a lecture. In parts, they might just be a rhetorical device to argue for alternative science, new projects and policy shifts. This would imply optimism, though not necessarily in technological terms and not as a personal value, as certain optimism is often part of applications for research funding. Only problems that can be solved are useful to be worked on. Technology is often suggested to provide such solutions.

Clearly defining technology may thus be important. But in theory this is simpler, as when applying it to the lecture material. Within the material it rather seems that individuals work with different, more or less clearly, defined concepts of technology. In addition, they may not be aware of what attitudes towards technology they exactly convey to others. One may argue for drawing a distinction between science and technology, not only because the lecture material has been produced by scientists. But some scientists may find it useful and others pointless. Possibly the difficulty to establish clear boundaries between applied science and technology boils down to an ethical question of what humans should do to themselves and the material world. Indeed, it is widely held that there is no possibility of value-free definitions of technology (Mitcham 1994). It is thus the "software" part of using and creating technology that needs attention (Rogers 2003: 13). Our data from email interviews, however, suggests that we have to be cautious when predicting attitudes towards technology conveyed in lectures on the basis of personal backgrounds and aims of researchers. Mismatches between self-stated attitudes towards technology and attitudes revealed in lectures do also prevail. Personal background and aims seem very uncertain predictors even of self-assigned attitudes towards technology, which compares to findings on PhD students in ecological economic reported in Ehlers *et al* (2009). But larger sample sizes may help to establish clearer patterns.

The patterns identified in the analysis imply that framings of technology can be diverse and ambiguous. Hence, the framing of attitudes towards technology in this analysis is debatable. Yet, individual attitudes of researchers towards technology might influence research outcomes. At least in parts, these are also embedded in larger paradigms such as unreflective technological optimism. For example, if a study sets out to explore what a future "car-system" might look like, it is implicitly assumed that a system based on individual transport using the automobile is sustainable in the long term, which may not be the case. Even the less optimistic attitudes relating to romantic uneasiness, may turn out as indifferent relations to technology in practice, where there may be a mismatch of attitudes and actual behaviour.

6 Conclusions

This study was not an attempt to identify a single correct way to view the role of technology for sustainability. Our goal, instead, was to develop a framework to categorize differing attitudes towards technology and to use it as a tool to make individual stances of researchers and teachers explicit. This is important as positions on technology will inevitably influence the outcomes of sustainability research and teaching. Testing this framework empirically, we conclude that even in a small sample of lecturers working in similar or related disciplines, attitudes towards technology are highly diverse, which is reinforced explicitly and implicitly by the attitudes conveyed in the lectures. Personal backgrounds and aims of researchers and their self-stated attitudes towards technology may not necessarily clearly relate to another and to attitudes conveyed in lectures. While this picture is still unclear, we suspect that such data may only provide limited contributions to transparency of attitudes. But, given the importance of technology in the sustainability discourse, more transparency about the stances on technology that scholars adopt in their research and teaching would be useful. We can only engage in constructive deliberation on the use of technologies, if we know on what attitudes towards technology the relevant research rests. To reflect and to transparently articulate their own attitudes towards technology would in post-normal science terms also be a public responsibility of scientists. Today, technology is increasingly not seen as good per se. Thus, it is argued, that technology should be subjected to some sort of public appraisal. Moreover, there are calls that scientists should be encouraged to clearly expose the limitations and dangers of the new technology they develop or propose. But, as our study shows, there are diverse perspectives on technology. Our framework helps to reveal them as explicit and implicit attitudes towards technology. When deciding on technology deployment it would be fair, if the whole spectrum was brought in and made explicit. There should not be positions or options that are systematically discriminated or ‘closed down’, as it may be suspected in the case of non-adoption of new technologies or a reversal to earlier less advanced practices. Hegemonic discourses on technology may still be at work as these manifest in structures that influence most decision makers. These may be ingrained in personal positions and even dispositions, but may not be made entirely transparent to individual researchers. All, individual attitudes towards technology, discourses and the languages used by researchers require attention when aiming for transparency.

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