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Environmentalism and Technology

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Abstract

The environment movement often targets technology. It switches between enthusiasm for some technologies (like wind energy) and resistance to others (like nuclear power). And yet theory regarding the way social movements engage with technology is little developed. Environment groups are simply assumed to contribute to the 'selection pressures' under which technologies evolve. This paper seeks to develop theory by bridging a gap between social movement research and the sociology of technology. It will move between the two literatures and use examples to illustrate how the environment movement's enthusiasm and resistance to technologies penetrate their networks of development.

1. Introduction

Technology is a key vehicle for unlocking wealth creation and development in all countries, rich and poor (UNDP, 2001). At the same time, technology plays a powerful mediating role in our relationships with one another and with nature, for good and ill. Technology distributes benefits to some and risks to others (Beck, 1992). In each of these ways, questions of technology development spill beyond the narrow remit of technology producers and market demand. They take on a vital public dimension (Winner, 1977). Nowhere has this been so apparent as in relation to the environment.

Modern environmentalism recognised technology's significance in the early stages of the movement's development. An early theme was the promotion of alternative technologies more appropriate for idealised ecological societies (Schumacher, 1973; Sandbach, 1980). Over the years, environmentalists have opposed and advocated different kinds of technology. Nuclear power; genetically modified crops; renewable energy; intermediate and appropriate technologies; pesticides; clean technology; organic farming; mining operations; recycling; sustainable forestry; fishing technologies; large dams; incineration; the list goes on. Some technologies have attained iconic status and helped consolidate movement identities. In this vein, attitudes towards technologies, can also divide environmentalists.[1] Today, some environmental campaigns continue to have an explicit technology focus, both positively, as in campaigns to promote wind energy, and negatively, as in the campaign against agricultural biotechnology. Environmentalism is both enthusiastic and resistant to technology.

Environmentalists seek to exert pressure for greener technology development through a variety of tactics, e.g. orchestrating consumer boycotts; high-profile direct action; exercising investor pressure; entering development partnerships; formal participation in technology assessment institutions; creating appropriate technology initiatives; and political lobbying. Whilst social movement research has noted such activity, it has stopped short of analysing how this activity actually engages with technology

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[1] The debate over the benefits of wind power against its landscape impacts is a current example.

development. Environment movement research has conventionally considered movement identities, dynamics, activities and impacts in relation to political systems (e.g. ideas, institutions, and interests) (Doherty, 2002; Rootes, 1999), and not technology systems (e.g. artefacts, actors, and practices). At the same time, environmentalism is largely absent from the social science literature on technology development. At best, it is considered an external pressure bearing upon technology systems (Geels, 2004; van de Poel, 2000). There is little elaboration - neither upon the nature nor the effect of such pressure. Understanding the ways environment movements engage with technology development and the influence they have is consequently underdeveloped. This paper aims to bridge that gap.

It must be stressed at the outset that what is *not* being attempted here is an account of the emergence of environmental technologies. Innovation is a multi-actor, networked process for which a single actor focus is an inappropriate unit of analysis (Sørensen and Williams, 2002; Rip and Kemp, 1998), especially relatively marginal actors like environmentalists. Rather, the unit of analysis here is environmentalist engagement with technology – which is but one factor in the many relationships that are involved in the development of technologies – and as such an environmentalist focus does appear appropriate.

The objective is to introduce an analytical framework for exploring environmentalist attempts to engage in technology development. Case studies into social movements targeting technology do exist, e.g. Luddism (Thompson, 1963), or the anti-nuclear movement (Rüdig, 1990). Bauer (1995) drew on a number of case studies to develop a frame for analysing resistance to technology, but not instances of enthusiasm. A few case studies exist into proactive attempts by environmentalists to shape technology, notably the alternative technology movement (Pursell, 1993). But less so for the way more recent 'solutions campaigning' engages with technology (Murphy and Bendall, 1997). The work of Ron Eyerman and Andrew Jamison (1991) attempts a general analysis. Their cognitive approach makes a case for how environmentalism has contributed to greener knowledge production (Jamison et al, 1990; Jamison, 2002). However, a concomitant affect is implied for technology without really analysing how that engagement operates. Whilst all these contributions are valuable, a general framework for understanding why environmentalists engage with

technology in the way that they do, and why that engagement operates differently, still seems lacking. This objective here is to contribute to the existing literature in that vein.

An analytical framework is suggested here by considering points of contact between two relevant literatures. The first literature is environment movement research. The second is the sociology of technology. At the most general level, it is social values and mutual interests which bind social movements together and which they seek to progress in society.[2] Meanwhile, the sociology of technology identifies technology development as a fundamentally social process. As such, social values and material interests pervade the construction of technology. If environment movements and technology meet, then it will be through interactions between the values and interests that each embodies.

The intent of the paper is conceptual. It is a first, tentative step into research territory that has hitherto been sketched but not mapped. Examples are used to illustrate the points being made. More systematic research will be needed to test and develop the hypotheses raised here.

2. Environmentalism and technology

'The aim of societal pressure groups is typically to change the social world in some way. Usually, they are not interested in technology as such, but more in the way technologies can be used for societal goals, or the kinds of effects technologies may have and which may be considered desirable.'
(van de Poel, 2000: 393)

Environmentalism typically engages with technology as a vehicle for its core social goals – though iconic technologies like wind power, organic farming and nuclear energy have informed and reinforced those goals. Before developing an analytical framework, it is worth pausing to consider environmentalist engagement with

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[2] Given earlier remarks about movements against classes of technologies, the social values and interests binding movements together can sometimes be quite narrow, like the anti-nuclear movement, and members could easily have quite divergent social values and interests in relation to other issues.

technology.[3] What are the phenomena that an analytical framework must capture?
Briefly, environmentalist enthusiasm for and resistance to technology is expressed in
at least three ways:

1. Reconfiguring the technological challenge, by widening the criteria for
   interpreting the performance and desirability of different technical qualities.
2. Attributing positive or negative meanings to technologies, such that the
   relative positions of different technology options are re-considered.
3. Enrolling others into an alternative technology vision and seeking constituents
   who could help in its development.

Environmentalism both opposes and advocates technologies. It can engage with
generic technologies (like nuclear power or renewable energy) or target specific
technologies (like certain chemicals in agriculture). Engagement involves a variety of
repertoires that fall under confrontational or partnership styles. It can engage both
directly and indirectly with technology. The latter includes those activities that,
whilst not focused upon a technology, can nevertheless end up influencing technology
choices made by others. Environmentalists can articulate concerns (e.g. climate
change and carbon emissions) that reflect positively or negatively upon technologies,
depending upon how they perform relative to the issue of concern (e.g. Sports Utility
Vehicles). More directly, but perhaps less often, environment organisations play a
direct role in the development of cleaner technologies, such as the encouragement and
motivation provided by Greenpeace to the manufacturers of the Greenfreeze
refirgerator (van de Poel, 2000). Consequently, we need an analytical framework
whose modes of engagement can capture and interrogate all these phenomena.

With these considerations in mind, environmentalism can be considered to engage
with technology in two conceptually distinct modes. First, it seeks to reframe
technological considerations. That is, activism opens up the (environmental)
performance of a technology to critical appraisal, such that the desirability of those

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[3] Outside the activities considered here is the use of technology by environment movements, such as
ICTs in the coordination of campaigns across different places (e.g. Mamadouh, 2004). Rather, the

technical practices is reconsidered. In this way it seeks to influence the frameworks through which different technology options are considered. In *framing technology* differently, the ambition is to insert new performance criteria and alter the relative position of different technology options – a cleaner technology, like wind power, is consequently appraised more positively than the incumbent (fossil fuel) technology. The second mode of engagement lies in the *negotiation of technology*. Environmentalists have to substantiate their framing. In negotiating technology they try and draw in the different actors and resources necessary for the development and diffusion of favoured technologies, or at least try and help those actors who are trying to develop them.

Each of these two modes of engagement is now considered a little further. Whilst conceptually distinct, in practice the two operate and inform one another recursively. Moreover, it is important to bear in mind that both framing and engagement are dynamic, unfolding processes situated in wider political contexts. With these caveats in mind, we begin by considering the framing of technology.

Framing technologies

Environmental activism can penetrate technology development by reframing established technologies. Attempts are made to reconfigure the technological challenge, by widening the criteria for interpreting the desirability of different technical qualities. Technologies are destabilised under environmentalism's criticism of hitherto satisfactory technologies. A technological 'success' story becomes a 'problem' technology. The food productivity gains delivered by innovations in agrochemicals, for example, become overshadowed by problems of contamination. The electrification and irrigation benefits sought from large hydroelectric dams come to appear less straightforward when considerations extend to include the impact on displaced peoples, land loss, redistribution of water rights and other issues.

focus here is how environment movements seek to shape the development of technologies for environmental ends.

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Environmental protests are a common attempt at bringing attention to wider performance considerations. Environment groups also seek to re-frame technologies by sending experts to the international and European committees that negotiate technology standardisation, where they try and insert environmental criteria into those standards (e.g. see http://www.ecostandard.org/index.php). Orchestrating consumer boycotts, or applying investor pressure are other activities that effectively seek to attribute environmental associations with certain technology practices. Across all these and other repertoires of activity, the effect of environmentalism is to press for new criteria against which technology options are appraised and under which technologies develop.

The accuracy of the environmentalist message and the resonance it has within business innovation processes can be limited, depending upon the precise form of the protest, and given that the message is often filtered indirectly by, for example, the media (Fillieule and Jiménez, 2003). Nevertheless, the occupation of a site for an infrastructure project, or a mass march on centres of government, or a demonstration outside the offices of a technology developer, certainly signifies a problem. Subsequent debate sparked by these attention-grabbing events can elaborate the contours of that problem and introduce the performance criteria that current or proposed technological activities fail to consider sufficiently.

Sometimes a technology falls directly and explicitly under the protest spotlight and is recognised as a central component in the overall problem (anti-nuclear protests being an obvious example). If the existing technological practice is deemed to be problematic, then what is the best way of rectifying the situation? Should modifications and incremental improvements be urged for the existing technology; or should a radical alternative be pressed? The initial emergence of modern environmentalism as a radical critique of industrialism, for example, implied a completely different frame for approaching technology. The decentralised, self-reliant ecological visions favoured by environmentalists at that time provided a different framework for judging different technology options (Smith, 2005). Small-scale technologies were favoured (Schumacher, 1973; McRobie, 1981). In offering a critique to, say, a government technology appraisal, an environment organisation may demand consideration of other factors. Criticism of cost-benefit analyses of

technology options, for example, or other narrow risk assessment procedures, can lead to an opening up of the process, and demand the institution of more participatory technology appraisals (Stirling, 1993; Wynne, 2002).

Framing need not be so direct as advocating a specific technology alternative or appraisal process. More usually, a specific technology or group of technologies is not the direct target. Rather it is the *effects* of technology use in society that is the concern. The way technology pervades modern society means it will often be implicated by environmental protest. Protests relating to an environmental problem (e.g. over climate change or groundwater contamination) implicate a number of culpable technologies. To the extent that protest keeps issues on public agendas, and these agendas attain policy and strategic significance, then environmental protest can destabilise those technologies implicated. Technology developers have either to defend the performance of their artefacts, or re-direct their innovation activities and better account for the (socially mediated) environmental pressure.

In raising the public saliency of an environmental issue, so protest can help that issue filter into the criteria against which technology performance is judged (van de Poel, 2000). Of course, such judgement is less likely to take place without environmentalist pressure subsequently coming to bear more directly upon the technology - such as being taken up by regulatory agencies, or through corporate social responsibility measures, or the greening of technology consumers and their market choices. In other words, environmentalist concerns have to enter the social institutions in which technologies develop and are influenced. It is these institutions that ultimately serve to frame decisions about technologies. As such, the more clearly political activities of environmentalism aimed at institutions can have knock-on consequences for technology.

Negotiating technology

In this mode of engagement, environment groups seek to help and bolster other actors with the resources and wherewithal to help in the development and diffusion of a favoured technology. The environment movement has always advocated the development of alternative technologies when discussing solutions to the

environmental problems it prioritises. Some of these alternatives have proven quite versatile in offering solutions to various environmental problems over the years. Renewable energy, for example, has had long-standing backing from environmentalists on grounds of local autonomy, oil depletion, acid emissions, climate change, an alternative to nuclear power, job creation. Similarly, locally produced organic food has been a favoured technique for reasons of soil health, wholesomeness, pesticides, biodiversity, non-GM, food miles, and local regeneration. Such versatility means favoured technologies appeal to a broader constituency whilst also adapting to shifting public and political agendas.

Negotiating examples include the way some NGOs are entering into partnerships with technology developers and users (Murphy and Bendell, 1997). Greenpeace, for example, has entered into partnerships over the manufacture of freezers free of CFCs and the development of offshore wind (van de Poel, 2002). The Forestry Stewardship Council is an NGO-initiated alliance with industry whose system of standards certification aims to promote more sustainable forestry techniques. Similarly, NGOs are involved in the World Commission on Dams, which is developing criteria, standards and guidelines for large dams. The World Wide Fund for Nature has endorsed favoured products over the years. Since 1966, the Intermediate Technology Development Group (ITDG) has encouraged the development of intermediate technologies designed to be accessible for the poor in developing countries. Environment groups' media campaigns might, for example, publicly shame poorly performing companies, whilst praising those who are innovating greener products and processes (e.g. ENDS, 2004). Mass membership NGOs can encourage their membership to switch to using favoured, more sustainable technologies. Through the promotion of green electricity tariffs, for example, or fair trade produce, NGOs try to nurture a green market for more sustainable production techniques. This is technology negotiation through marketing. Environmentalists also negotiate technology in the way they lobby for policy changes that have both direct and indirect benefits for favoured technologies. Campaigns for government subsidies for installing photovoltaics, for example, or inserting sustainability criteria into multilateral technology transfer programmes effectively contribute to a more favourable institutional setting for greener technology developers.

It would be naïve to claim environmental movements play a central role in technology development – they lack key technological resources and are rarely in the business of selling technologies. Nevertheless, the discussion above suggests they canplay an important conditioning role and can have a helpful influence for greener technology developers. Which is why research in this area is needed. The common assumption that environmentalism is simply an 'external' pressure is no longer sufficient. Environmentalism has very practical technological consequences: businesses find their technology strategies disrupted unexpectedly by environmental protest; government technology policies can be similarly derailed. This is particularly true when environmentalists are able to tap into wider public unease over technology. The experience of agricultural biotechnology is a salutary example here.

Recognising the need to better account for this external pressure, some governments, businesses and multi-lateral organisations (e.g. World Bank) are opening up technology appraisal to greater participation, including the participation of environment movement organisations. So whilst environmentalist influence over technology is not an unbridled success, its attempts at influence is considered sufficiently important for other actors to try and incorporate it in their technology development activities. Recent years have seen public and corporate policy-makers fathoming how best to reform regulatory institutions and strategic thinking such that environmentalist voices might be better accounted for in innovation processes. In the UK, as elsewhere, various government departments have acknowledged the importance of stakeholder participation in technology.[4] Some go so far as to call for new policy mechanisms to better understand and respond to 'increasing aspirations towards public accountability and democratic control of the direction of development of science and technology' (Defra, 2004: 16). These developments open and institutionalise a particular route for environmentalist engagement in technology.

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[4] E.g. HM Treasury, the Department of Trade and Industry, the Department for Education and Skills, and the Department for Environment, Food and Rural Affairs

Yet environmentalist engagement is likely to continue to spill beyond these new appraisal institutions. A wider politics of technology will persist in civil society. The objective in these participatory institutions is to build consensus and reach closure around a technology option. This may not always be possible. In situations where controversy prevails, technology appraisals can be marginalized if they fail to highlight different perspectives and seek to close-down on a consensus position too quickly (e.g. due to the pressures of business competition and investment cycles) (Cambrosio and Limoges, 1991; Stirling, 2005). Some NGOs have already become suspicious of new, participatory technology appraisals, arguing that such institutionalised engagement, by its very nature, tends to restrict agendas and seeks to circumscribe debate (Genewatch, 2003). 'Processes of engagement tend to be restricted to particular questions, posed at particular stages in the cycle of research, development and exploitation. Possible risks are endlessly debated, while deeper questions about the values, visions and vested interests that motivate scientific endeavour often remain unasked or unanswered' (Wilsdon and Willis, 2004: 18). Government and business are perceived to be using these exercises to dissipate controversy and surmount deadlock, rather than opening innovation to genuine alternatives.

Even when the new participatory institutions are used to open-up options and scope the issues more thoroughly (Stirling, 2005), they will do so within a wider context – a context that can trigger the application of a participatory technology appraisal in the first place. Non-institutionalised environmentalist engagement in technology will continue to seek influence in civil society and in the market. This section has illustrated the diversity of that engagement, and how it seeks to frame and negotiate technology through orchestrating consumer boycotts, high-profile direct action, exercising investor pressure, creating development partnerships, etc.

However, this description does not explain differences in engagement nor their technological consequences. In the next section we explore themes in the environment movement literature that provide clues for analysing engagement more systematically. The section following on from that introduces themes from the sociology of technology. On the one hand, we need an analytical framework which will help us understand the different action repertoires of environmentalists when

directed at technologies and, on the other hand, we need a framework which will help explain the way those activities feed into technology development.

3. Themes in environment movement research

No pretence is made at a comprehensive literature survey here. Instead, the intention is to draw out themes relevant for analysing environment movements and technology development. Environment movements are a challenging subject. Their dynamic and informal nature make them a messy unit for analysis. Defined broadly, they operate in civil society arenas, within which networks of people and organisations engage in collective actions towards common goals (Rootes, 1999; Edwards and Gaventa, 2001). In the discussion so far, the term environment movement has been used loosely to span different kinds of groups involved in activism, whether it is large membership organisations with a professional staff, such as international and national NGOs, or looser, informal networks of volunteer activists and organisations co-ordinating on a specific campaign.

Environment movements are generally studied in relation to political systems, since these offer the most obvious means towards movement goals (van der Heijden, 1999). As with work on social movements more generally, environment movement research can be divided between internal accounts and external accounts (Foweraker, 1995). Internal accounts seek understandings of movement identity, organisation and dynamics. External accounts analyse movement strategies and explain their impacts upon society.

Internal accounts can help identify why different movement organisations frame technology in the ways that they do. Why, for example, does one movement actor agitate for decentralised and small-scale forms of technology, operated under communal or cooperative relations, whilst another is happy to work in partnership with firms for the widespread commercialisation of quite large-scale technologies? The literature suggests answers will be found in the identity, organisation and resources available to different environment movement actors. As such, a number of factors in the environment movement research literature could help explain

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differences in the framing and negotiation of technology: the backgrounds of movement intellectuals; the social and historical context under which movement activism emerged; the worldview or ideology holding the movement together; key ideas or principles at the heart of the movement; the membership base; the resources that can be mobilized by the movement; favoured repertoires of action. Differences along these lines suggest avenues for understanding the variety of movement engagement in technology and sources of influence. A movement's identity, its key ideas, and dynamics will work to frame their approach to technology. The resources available to environmentalists, and their favoured repertoires of activism, will be important in the negotiation of technology.

Also important will be the structures of opportunity for engaging with technology presented by the context in which the movement operates. Research looking outside movements, and analysing their activity and influence in society needs to be considered carefully here. The literature tends to look at impacts that work through political systems, since these tend to be a common target for environment movements. Questions of access might prove to be as pertinent for environmentalist access to technology systems, provided transpositions are made carefully. In the context of political systems, movement access is tied to the characteristics of the system and the opportunity structure available (van der Heijden, 1999). How open are key political institutions to new agendas and issues? Are there many access points (e.g. through devolved governance or multi-party systems), or are they limited by a centralised system? How easily do policy processes accommodate new voices (e.g. invitation to policy consultation)? Do political élites seek to integrate and co-opt environment movement challenges, or exclude and repress?

Similar questions can be raised over access to technology systems and opportunity structures for engaging with technology development processes. What are the different routes for environmentalists to access technology decisions? How open are the innovation processes to new participants? Do technology producers integrate new demands or seek to exclude them? The technology system for energy, for example, was tightly closed in many countries in the 1970s. It was a state-run monopoly with a preference for large-scale, fossil-fuel and nuclear technologies operated through highly-centralised control. There were few points of access for the small-scale

renewable energy ideas of the environment movement at that time. In situations where energy systems were less established and entrenched, openings for activists were greater, such as developing off-grid renewable systems. Thus environmentalists keen to work on small-scale renewable energy found greater scope through aid programmes in developing countries rather than working in industrialised settings. Liberalisation of energy systems and a more favourable policy climate (the latter helped by environmentalist lobbying) opened up some opportunities in the 1990s, and some activists moved into wind energy development. The food system, in contrast, was less monopolistic in the 1970s. There was a slim opening for organic producers to develop niche markets, particularly amongst the alternative milieu of the 1970s.

In sum, the characteristics of different technology systems can structure environmentalist engagement. Some technology systems are relatively more open than others, and this characteristic is an important analytical consideration. Looking at things more dynamically, the extent to which a technology is already developed and embedded in societies can determine how open it is to environmentalist engagement, advocacy or destabilisation. However, this is not as straightforward as it seems, since even technologies at an early phase in their development have behind them significant business and government research commitments and expenditures, and whose trajectories can be difficult to deflect. This simply underscores the importance of understanding the technology opportunity structures associated with specific technologies and open to environmentalist engagement.

However, it is not just openness and opportunities that count in technology systems. The repertoires by which environmentalists seek to engage with those systems will also have a bearing. Welding shut an industrial discharge pipe is clearly a very different kind of action compared to sitting around the boardroom table discussing a partnership project. Yet they can be symbiotic – the 'reasonable' environmentalists negotiating with business derive some of their power from the potential to disrupt business yielded by other activists. In deciding whether and how to engage with technological opportunity structures environmentalists have to think of their constituencies and ultimate goals. Some environmentalists worry over the selective co-option of their ideas by government and big business and a concomitant loss for radical change. Others accept compromise as a pragmatic necessity in the gradual

diffusion of more sustainable technologies. This point reminds us that any split between internal and external environment movement processes is heuristic. The two interact. The openness of the target system (political or technology) will present opportunities. But the identity and dynamics of the movement itself will influence the desire and ability to take advantage of those opportunities.

In summary, the environment movement literature suggests a number of themes relevant for studying its engagement with technology development. The strategies pursued, the directness of that engagement, and impact on innovation will be explained by the identity and resources available to the movement, the way opportunity structures facilitate and constrain access, and the action repertoires favoured by movement organisations. Reading across from political impacts identified in the literature, environment movement impacts on technology might be *substantive* (e.g. accelerated diffusion of a renewable energy technology), *procedural* (e.g. incorporation of environmental criteria into innovation processes), *structural* (e.g. the creation of technology assessment institutions), or *sensitising* (e.g. raising awareness about the environmental significance of a technology) (ven der Heijden, 1999). Substantive and procedural impacts relate most closely to the negotiation of technology introduced in the preceding section. Structural and sensitising impacts are more likely to be found in the framing mode of technology engagement.

4. Themes in the sociology of technology

The sociology of technology, particularly the constructivist perspective, highlights the importance of social processes in the promotion, selection and development of technologies, over and above any technical logic inherent in the technology artefact (Pinch and Bijker, 1984). Technologies, prototypes, or prospective designs possess or promise certain qualities and performance (e.g. speed, efficiency, power, comfort). But these qualities, whilst important and necessary, are insufficient for guiding technology development. They *underdetermine* technology choice. It is social processes – and especially the material interests and social values expressed in those processes - that present criteria against which these qualities are judged, and whether

the technology represents a worthwhile means for satisfying a human need[5] (Yearley, 1988). It is the way the performative qualities of a technological solution are taken up, interpreted, invested in meaning, attributed a market value and exploited that clinch its development.[6] A sociological understanding of technology means its development cannot be a purely objective, technical exercise. It becomes inherently social, and even political (Bijker, 1995). Andrew Feenberg summarises how the values of different social actors become embodied in technology development:

> 'Businessmen, technicians, customers, politicians, bureaucrats are all involved to one degree or another. They meet in the design process where they wield their influence by proffering or withholding resources, assigning purposes to new devices, fitting them into prevailing technical arrangements to their own benefit, imposing new uses on existing technical means, and so on. The interests and worldview of the actors are expressed in the technologies they participate in designing.'
> (Feenberg, 1999: 11)

Environmental movements hold quite different criteria for promoting and interpreting technological solutions compared to many technology developers. Activists often confront businesses' narrow economic and technical criteria with broader criteria for social and environmental appropriateness. This suggests an important theme in the advocacy of technology is its framing by different groups. The literature identifies technological frames as being informed by (Bijker, 1995):

- a group's goals;
- the problems and challenges it considers imperative to address;
- the problem-solving strategies appropriate for this challenge;
- the criteria for judging solutions; the knowledge and material resources the group can draw upon;

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[5] Though human need is itself a complex objective (see Leiss, 1978).

[6] Judgements are often based upon a mix of impressions, informed by such things as values, prior experience, comparison with the qualities of incumbent technologies, expectations, knowledge, and institutions.

- and comparison against any existing technology practices that the group considers as exemplifying their frame of reference (either positively, as in 'this is the kind of technology we need more of', or negatively, as in 'this is the sort of problem technology we need to avoid').

Environmentalist framings of technology development will be informed by some of the themes introduced in the preceding section (i.e. prevalent in environment movement research): the backgrounds of movement intellectuals; the social and historical context under which movement activism emerged; the worldview or ideology holding the movement together; key ideas or principles at the heart of the movement; the membership base; the resources that can be mobilized by the movement; favoured repertoires of action.

Another key theme apparent in the sociology of technology is the processes of enrolment of different actors and resources (e.g. researchers, manufacturers, investors, regulators, machinery, infrastructures) into the 'socio-technical' networks needed for the development and diffusion of a particular technology (i.e. a network that provides resources, markets, technical know-how, manufacturing capabilities, infrastructures, legitimacy, and supportive institutions) (Rip and Kemp, 1998). Of course, different actors hold resources of more or less relevance for technological development (e.g. R&D laboratories, venture capital, manufacturing processes, marketing, testing and standards institutions). As these actors invest a technological solution with their own meanings, and join with its development, so they also modify the technology to fit their own frame of reference. Environmentalism tries to see that its frame of reference is present in such processes of enrolment and technological negotiation.

This theme suggests the impact of the environment movement can be analysed in relation to the success with which it enrols support for its technological demands. Activist pressure and persuasion is the device they have for enrolling support amongst others. However, a radical demand deliberately challenges the expectations held by industry and government about the future course of technology development. In instances when demands are radical, then a considerable gulf has to be negotiated if activists, whose primary resources are ideas and political pressure, are to enrol the support of groups with the resources to develop technologies. Some of the alternative

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technologies proposed by environmentalists struggled to enrol material support in the 1970s owing to the radical stance taken by activists (Smith, 2005).

As already suggested, important for processes of enrolment are the negotiation and evaluation of what a prospective technology's qualities mean for different actors (e.g. the effectiveness with which it solves a problem). Expectations about the technology's likely benefits must have a degree of flexibility in their interpretation, such that the viewpoints of different actors can be accommodated. If this happens, these actors are more likely to commit to the development of the technology (Bijker, 1995). In other words, technology development is a boundary object from which different groups will take their own meanings, informed by their frames of reference (Akrich, 1992). Enrolling others or becoming enrolled in the technology development of others provides a way of analysing environmentalism and technology.

It is rare for an environmental movement (or organisation) to be at the centre of technology development, i.e. pulling in the resources needed to develop a technology option which the movement themselves have initiated. A few exceptions do exist. ITDG develop intermediate technologies that they consider appropriate for some of the poorest communities of the world. More often, environmental groups can help a network of other actors who are developing more environmentally-benign technologies. Mass membership organisations, for example, can endorse products amongst their supporters, such as urging them to switch to renewable energy electricity suppliers. Greenpeace provided such support for the development if the 'greenfreeze' refigerator (and in Germany Greenpeace has also set up its own energy supply cooperative). Environment movements can bring some green legitimacy to a set of practices through their involvement in development partnerships. The Forestry Stewardship Council is an example of how environmentalist principles for sustainable forest use and access to resources – a technological frame of reference – have been negotiated into a certification standard for wood-based products through partnership with some members of the forestry industry.

Some scholars argue that the negotiation of technology through different frames, under various social processes, and across networks of resources, means no single actor is privileged. 'All relevant social groups contribute to the social construction of

technology; all relevant artefacts contribute to the construction of social relations'
(Bijker, 1995: 288). The key term here is 'relevant'. Bijker offers an implicitly
pluralist view: relevance is an open competition between different groups possessing
various, but always incomplete, levels of technological agency. A marxist view would
consider relevance as structured by the imperative of capital accumulation and
proximity to the means of production. An elitist theory of relevance would attach it to
elites acknowledged as having scientific and technological expertise.

The environment movement was, in part, predicated upon the question of relevance,
in so far as it was a reaction against technocracy (Pepper, 1990). In technocracies,
expert knowledge elites are the only relevant participant in technology, and non-
experts are excluded from direct participation in technology agendas.[7] One legacy of
environmentalism has been to challenge this exclusion. Indeed, some consider
activists' critical analysis of technocracy to have paved the way for the sociological
understandings of technology being discussed here, and opened technology
assessment to greater public participation (Bijker, 1997: 4-6; Darnovsky, 1991: 76;
Waks, 1993).

It is important to remember that interpretations of technological performance can be
flexible, but not completely pliable – some framings will derive more credibility and
traction from the existing, concrete situation than others. Technologies are embedded
in infrastructures and social institutions that have developed alongside them, and
which help them to function (including markets and lifestyle routines). As such,
structural influences bear down upon the technological frames of actors. Prospective
alternatives will be assessed in comparison with the incumbent technology that they
seek to displace, and with that will come all the structural constraints embodied by the
established technological practice (hardware, markets, practices, institutions).
Supermarkets, for example, are becoming a powerful force in the diffusion of organic
produce. This development is happening within a supermarket frame of reference
informed by their established conventional food system for standardised foodstuffs.
So the adoption and adaptation of organic food production has to fit supermarket

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[7] At best, non-expert interests might be represented as objects in 'intellectual technologies' like cost-
benefit analysis, social indicators, and systems analysis (Wynne, 1975).

systems and criteria for perennial availability, in sufficient quantities, at sufficient sizes and appearance, at the right price, with bar codes and requisite packaging, and so on. Large quantities of produce travel over great distances, non-standard produce is graded out (i.e. rejected), and large, specialist organic growers are encouraged. Key criteria developed in the 'original' organic movement are lost or overlooked: it is a long way from their vision for smaller, mixed-farms and local food economies.

As differently resourced actors are enrolled into the development of a technology, and technology diffuses, so it takes on a more solid and established form. The new technology becomes better known, its benefits and potential more clearly understood, and standard practices for using it develop. Indeed, lifestyles develop facilitated by the technology and can subsequently reinforce the direction of technology development. In the sociology of technology literature, this development from technology option to working artefact is known as closure. Current technology practices reflect the incorporation of the different material interests and social values influencing its earlier development. The technology embodies those interests and values. As meanings solidify in the development of the technological artefact, so it becomes more fixed and 'closure' is reached:

> 'The process of "closure" ultimately adapts a product to a socially recognized demand and thereby fixes its definition. Closure produces a "black box" - an artefact that is no longer called into question but is taken for granted. Before closure is achieved, it is obvious that social interests are at stake in the design process. But once the black box is closed, its social origins are quickly forgotten. Looking back from that later standpoint, the artefact appears purely technical, even inevitable.'
> (Feenberg, 1991: 11)

The technology becomes accepted, its qualities widely recognised, and social relations adapt to them. The relatively flexible technology option or idea has taken shape and becomes fixed and solid. People learn to live with the technology, identify scope for further, profitable improvements, and adapt the technology to other uses. Incremental innovations continue, but within a frame set by the closed technology.

Obviously, the framing effect of environmentalism often works against closure processes. Social values hitherto excluded from technology development begin to intrude through the profile raising and agenda setting attempts of activists. The sociology of technology introduces some themes by which environmentalists' influence (or lack of) in technology can be analysed. These are the way the technological problem is defined and the criteria and expectations by which different technology options are judged. Negotiating technology is seen to require a favoured technology to perform with sufficient interpretative flexibility for it to be seen in a positive light by other actors and *their* frames of reference at the same time. What is deemed attractive through the environmentalist frame must also appeal to those with the resources needed to develop the technology (e.g. a business frame and/or government frame). In other words, the extent to which environmentalists engage with technology at the level of negotiating development depends, according to the literature, upon the degree to which relevant, resourceful actors can be enrolled.

5. Analysing environment movements and technology development

The discussion so far suggests reasons why movement conceptualisations of environmental problems influence the kinds of technology solution promoted, and the strategies activists pursue in promoting those solutions. Environment movement analysis suggests answers will rest with movement identities, and the openness of the political and technology system. Themes in the sociology of technology emphasise the importance of how activists frame development criteria for technology and enrol support from other groups. Here we bring those themes together. Of analytical interest is why and how the articulation of environmentalist pressure frames technology options and negotiates technology development. Table 1 summarises the themes that can explain those articulation processes.

Table 1: Different themes in framing and negotiating technologies.

	Relevant themes from social movements	Relevant themes from sociology of technology
Framing Technology	Context in which the environment movement	Problem definition.

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	operates. Movement identity, ideas and dynamics.	Criteria and expectations for technology solutions.
Negotiating technology	Opportunity structures presented by political (and technology) systems. Activist strategies for exploiting these opportunities.	Interpretive flexibility over technology qualities. Enrolment of relevant, resourceful actors necessary for technology development.

The framework emphasises how distinctions must be drawn between different environment movements (or their member organisations, constituent networks and so on). It provides a starting point for analysing reasons why particular environmental movements engage with technology differently.

A concern for technology and the environment has been assumed to be common amongst all environmental movements, but the specifics are unlikely to be the same. Some environmentalists can be technologically optimistic. They believe the right kinds of technologies, developed under the right kind of conditions, can move us towards a more sustainable future. Other environmentalists are not so optimistic. They are sceptical about a technological logic ever being able to restrict the way it materially exploits natural environments. This simple philosophical classification between technocentrism and ecocentrism (O'Riordan, 1981 cited in Pepper, 1990) reminds us that distinctions must be drawn regarding identities and activist strategies.

Differences will emerge on a practical level. Activist networks may not have the time (and capacity/ability) to become involved in the detail of technology design – even the larger NGOS pool resources when sending experts to technical standards committees. Such detailed negotiation is not always the best use of limited resources. Broader, destabilising protests can make more strategic sense. Others do target specific technologies (e.g. the nanotechnology focus of the Action Group on Erosion, Technology and Concentration - ETC). They build up knowledge resources and find ways of engaging with the specific technology.

Environment movements and their organisations can be divided between urban and rural foci, middle-class and working-class; broad and narrow concerns; mass membership and direct activist; subscription funded and government funded; professional and non-professional; industrialised and developing country contexts; and so on. Each of these has implications for technology engagement, as the preceding sections and framework suggest. Here, by way of illustration, we look at how analysis through the framework could proceed for environmentalism in Southern (developing) and Northern (industrialised) situations respectively. This broad-brushed distinction, and somewhat speculative characterisation of environmentalisms in the North and South, is nevertheless seen to provide sufficient contrasts to illustrate each of the dimensions of the analytical framework developed. This quite a crude way of distinguishing between environmentalisms, whilst serving the illustrative purposes here, will need much more thorough analysis in the future. Technology has a habit of crossing the jurisdictions of political systems. That is, the networks of actors and artefacts that constitute the production and use of a technology can span the globe, and spill beyond the control of individual political systems. It is important, therefore, to consider northern and southern difference in engagement and, indeed, the way different environmentalisms may engage around the same technologies.

Framing technology in the South

Environment groups in developing countries generally mobilise local people in the defence of natural resources from outside exploitation (Haynes, 1999). In relation to the analytical framework, we can see that the resource-based concerns of southern environment groups holds important implications for their engagement with technology. It provides an important context in two respects. First, their environmental problem actually provides raw material for the reproduction of technology systems elsewhere (such as oil reserves or mineral exports). Second, technology brought in from elsewhere is extracting the natural resource and threatening local access to resources (such as industrial fishing). These two positions are not exclusive of others. But in so far as environment movement organisations in the South are concerned with conservation and socially just access to natural resources, then they will come into contact with technologies in these two ways.

This has implications for how their activism is experienced by technology developers. Environmentalists in Southern NGOs seek to destabilise technologies and present a technological frame that has an alternative local perspective at its core. It is the way technology both demands the products of resource extraction and enables that extraction that is the concern: logging, mineral and oil operations, plantation cropping, large-scale irrigation farming, industrial fishing, hydro-electric dams, patenting of natural materials for industrial use. The movement's identity and dynamics put the problem of unjust, over-exploitation at the heart of the problem and technology is framed accordingly. Activists wish to stop the encroachment of the technology and preserve existing uses of the resource base – such as the contest between traditional, small-scale fishing and the large-scale mechanised techniques on industrial fishing trawlers.

The criteria framing the technology issue involve questions of type of technology, ownership of the technology, and beneficiaries from the use of the technology. A large hydro-electric dam and irrigation scheme, for example, not only presents massive disruption, but it represents one vision for how the power and water resources of a nation can be developed. Protesters counter-pose this with a vision for smaller-scale, distributed alternatives for local needs, and resource efficiency measures designed to bring power and water to those affected by the dam proposal.

It would be mistaken to classify all southern environment movement concerns as centred locally on resource extraction. Rapid urbanization, and an emerging middle-class in these urban centres, spawn environment groups campaigning on local amenity and pollution issues (van der Heijden, 1999). Their campaigns for the improvement of local environments effectively frame technology as a call for sustainable urban technologies (such as water infrastructures, cleaner factory processes and lower traffic emissions).

Negotiating technology in the South

Typically, protest is against specific projects rather than technology per se. However, persistent local protest whenever and wherever a trans-national corporation seeks to set up resource-based operations can, over time, prompt HQ to undertake a strategic

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review of how those operations are practised. The technologies and techniques are reformed such that, for example, local pollution is controlled (e.g. in mining), even if the fundamentals of the disputes remain unresolved (e.g. local distribution of benefits).

The economic development imperative attached to resource extraction in developing country settings, particularly by national governments and multilateral financial organisations, is an important contextual factor. Agricultural biotechnology in the southern cone of Latin America, for example, is debated on the grounds of its pros and cons as a development strategy compared to the health or environmental grounds that dominate debates in Europe. Opportunities for negotiating technological alternatives will be fewer in a context where pressing priorities are traded off in terms of economy or environment (compared to the win-win rhetoric of ecological modernisation in the industrialised countries). When local environmentalism is rooted in questions of social justice, and opposition to the negative local consequences of economic development, the specifics of technology development are hard to advance.

In so far as industrialisation in developing countries is built upon resource-based factor endowments (Bell and Pavitt, 1993), this can serve to reinforce national government commitment to a path of development opposed by local environment movements. Pulp and paper industry is built upon forestry operations. Food processing becomes an extension of large agri-business operations. Such paths attain a momentum such that they appear an essential developmental commitment against which any alternative technology proposals from environmentalists struggle to compete and enrol support and resources.

Given this kind of government and business frame, it is little wonder that some of the alternative environmentalist frames for intermediate technologies are looked upon with less favour by key technological constituents (Yearley, 1988). There is insufficient interpretative flexibility to accommodate the frames of these actors and enrol them into intermediate technology development. Earlier enthusiasm for appropriate technology from multilateral agencies in the past (Jéquier, 1979) appears to have diffused into concern for more participatory development appraisals.

However, the benefit of alternative technological pathways, more in tune with local capabilities and concerns, continues to be argued by Southern NGOs, and attracts support from some Northern NGOs.

Framing technology in the North

Northern environment movements have access to technology regulatory institutions and information exceeding those in developing countries. In this way campaigns can be far more informed about the environmental effects of existing technologies or enter into debates about prospective technologies. Moreover, Northern environment movement organisations have the benefit of being much closer to centres of technology development. Opportunities to make the case for additional criteria in considering different options in technology development are therefore greater. This can be done by lobbying for the modification of regulatory institutions influencing technology development as well as engaging directly with technology developers through either campaigns or partnerships. Professionalised NGOs have been able to negotiate access to boardrooms and policy consultations.

Whilst the general picture for environment movements in the North has been its professionalisation and institutionalisation, the emergence of a more radical counter-current must also be noted (Rootes, 2003; van de Heijden, 1999). Direct action demonstrations and a more explicitly fundamental critique is characteristic of this counter-trend. It can generate very physical confrontations with technology. As such, the destabilising critique and the framing criteria brought to technological considerations from this strand of the movement is highly radical. Where alternative technology is advocated then, unsurprisingly, it echoes some of the radical visions of the earlier environmental movement: small-scale technology; local autonomy; renewable resources. A large NGO like the Soil Association displays a high degree of pragmatism, for example, over organic food diffusing through the global distribution networks of the supermarkets. More radical environment groups remain critical and argue for organic food to develop in local food economies – a view much closer to the original vision of the organic movement.

It is the more moderate framing of technology along ecological modernisation lines that has enabled the larger, professional NGOs to engage in negotiations with key technology developers (Mol, 1995). Sufficient common ground has been marked out or, at least, these NGOs have learnt to talk a business-like language on technology.

Negotiating technology in the North

The sociology of technology emphasises the importance of enrolling resources in technology development, and how there has to be flexibility between the different technology frames held by actors in order for such enrolment to be possible. This implies the technology frames of those actors with resources key to technology development must be negotiated (business and government). Environment movement organisations holding radically different technology frames will have to negotiate a considerable gulf with technology developers (Smith, 2005). Given the balance of technological resource dependency, this can be another pressure to become more institutionalised and adopt a less threatening, more business-like position. Organising conferences for business organisations and policy-makers. Presenting concerns within the more business-friendly framework of ecological modernisation. Arguing the economic case for more sustainable technologies. These are the action repertoires for negotiating technology, and they are most amenable to the professionalised and institutionalised NGOs in the North. However, there is much research to be done into how and why such access has been obtained and sustained. The threat of a more confrontational framing by activists elsewhere can encourage business to keep negotiating with more pragmatic ecological modernizers. Such relationships need much more research.

A partnership kind of negotiation will require the acquisition of necessary technical, market and policy expertise. The larger body of professional staff in some northern environment movement organisations permits such activity. The development of participatory processes for technology appraisal was mentioned earlier, and this provides a route for environment group involvement. However, the resources for this are not without limits. Nor will participation, negotiation and compromise in obscure technical committees lead to gratifyingly spectacular outcomes.

Even professionalised NGOs need to decide how to deploy their limited, technologically-relevant resources carefully. It makes strategic sense to negotiate those technologies whose development has positive ramifications for wider campaign goals. If the technology can be stopped (or promoted) then it carries with it a host of positive environmental implications for wider social and economic practices. The way agricultural biotechnology and organic farming both hold implications for perspectives and policies on farming and food more generally is an illustrative example of this selective and strategic technology negotiation. Does a development with pervasive consequences, like nanotechnology, provide a better technological pressure point compared, say, to a specific technology application, like a Sports Utility Vehicle? And yet, nanotechnology, because of its diffuse and prospective nature may be too abstract a target for some environment groups, who prefer more direct, visible, and provocative technologies as targets. The analytical framework suggests answers will derive from the way the two technologies resonate with the ideas and identity of the environment movements or groups, the opportunity structures for engaging with these technologies, the ability to reframe the technological problem, and enrol others into developing an alternative technological frame.

The above discussion of technology engagement by environmentalism in developing and industrialised contexts has shown some marked differences in terms of identities, opportunity structures, problem definition, technological criteria, interpretive flexibility and enrolment of actors. Table 2 summarises those differences.

Table 2: Technology engagement in Southern and Northern environmentalism: a summary of comparative hypotheses.

	Relevant themes from environment movement research	**Relevant themes from sociology of technology**
Southern environmentalism		
Framing technology in the South	Context: local campaigns on access to local resources. Identity, ideas and dynamics: livelihoods and access to resources; critical of neo-liberal development model; some amplification of plight by international NGOs.	Problem definition: exploitation of resources with little local benefit and considerable local problems (e.g. pollution, loss of traditional access). Criteria and expectations for technology solutions: appropriately-scaled technology amenable to local control and providing community benefits.
Negotiating technology in the South	Opportunity structures: few - national governments committed to resource-based development strategies; weak regulatory institutions. Activist strategies: direct action; petitions to local government officials; publicising of plight through national and international umbrella networks.	Interpretative flexibility over technology qualities: technology of secondary concern; persistent protest prompts technology holders to review and reform their extractive operations. Enrolment of technological resourceful actors: distance from centres of technology development makes negotiation difficult; few technology appraisal regulatory institutions; some help from intermediate technology developers.
Northern environmentalism		
Framing technology in the North	Context: professional and institutionalised NGOs and some radical, direct action networks. Identity, ideas and dynamics: global environmental problems; ecological modernisation; participation in business and government technology debates; undercurrent of alternative technology claims.	Problem definition: clean technology. Criteria and expectations for technology solutions: promote greener innovation processes; business develops more sustainable production and consumption systems; no fundamental economic restructuring.
Negotiating technology in the North	Opportunity structures: technology regulatory institutions provide information and access points; participation in policy processes that shape technology development. Activist strategies: advocacy of sustainable technologies; consumer awareness; partnerships; direct actions; pressure for policy change.	Interpretative flexibility over technology qualities: attain technical expertise to engage in dialogue; adapt message to business audience. Enrolment of technologically resourceful actors: promote green consumerism; appeal on green business grounds.

However, technological protest can, at times, be a basis for making connections between northern and southern environmentalism. Technology development operates over a variety of scales, such that drivers and impacts are distributed (Bunnell and Coe, 2001). Environmentalist networks can bridge those scales (Arts, 2004).

North-South connections

As a campaign target, technology can bring environment movements together as they seek alliances in order to: a) overcome a foe whose threatening presence derives from a web of different developmental sites (R&D labs, technology transfer programmes, multinational corporations, national government regulations, multiple markets, multilateral agreements); and / or b) create alliances for the promotion of alternative technologies whose development can be similarly distributed across space, across time and across social groups.

The negative impacts of technologies far away can, for example, be brought back to the home settings of the technology developers by trans-national NGO networks. Technology campaigns like agricultural biotechnology, large dams, and industrial fishing are illustrative. Trans-national campaign networks ensure awareness of the environmental and social consequences is raised far from the site of the specific dam project or crop – the message is heard in countries that host the firms providing and developing the technology. Pressure is put on their investors. Governments are lobbied to reconsider the technologies they underwrite with export credit guarantees or through aid spending. North-South environmentalist ties help reconnect technological issues and impacts that are displaced by business and technology systems. Connections forged by trans-national activism reframe technological deliberations.

Connections also help articulate demands for alternative technologies. Initiatives like the Forestry Stewardship Council have helped facilitate the development of more sustainable production techniques. The Fair Trade movement has helped link resource extraction and agricultural issues in the South to markets in the North. The challenge for environmentalists is to ensure this trans-national articulation of needs penetrates more deeply into technology negotiation processes. Here Northern

environmentalism appears to be at a greater advantage owing to its closer proximity and ability to engage in key technology negotiation sites (e.g. regulatory institutions, standard setting bodies, technology development firms).

Some qualifying remarks

Northern environmentalism has been positioned as much closer to centres and processes of technology development than many of its Southern counterparts. North-South inter-linkages were seen as bringing Southern considerations closer to those centres. However, this view should be treated with care. Not all centres of technology development are located in the North. Amongst the technologically significant Triad regions is South East Asia where environmentalism is distinct from the Northern environmentalism characterised here. Moreover, local modification of transferred technologies, and the creation of indigenous technological capabilities and innovations do occur (Bell and Pavitt, 1993). As such, sites for influencing technology development are more numerous and proliferating much more than is suggested in this paper, with concomitant influences on the way Northern, Southern and trans-national environmental movements engage with technology. In addition, environmentalist success in one region can merely deflect technology development to centres of lower resistance. GM in India and nuclear energy in China suggest campaign activities have to follow technology developments wherever they migrate. One bridge between northern and southern environmentalism is the sharing of campaign experience on technology.

6. Summary and Conclusions

This paper has discussed environmentalist engagement in technology development. It has argued that this realm of activism is an important and pervasive feature of modern societies. Yet it is also under-researched. As a first research step, two modes of engagement have been conceptualised: framing technology; and negotiating technology. A framework for analysing these modes of engagement was developed by seeking connections and parallels between two literatures: environment movement research; and the sociology of technology. The way an environment movement or

organisation frames a technology issue can be explained by the context in which the movement emerges, its identity and dynamics, the way it defines the technology as being problematic, and the criteria it argues for judging between technologies. When negotiating technology, the position of environmentalists can be explained by the opportunity structures available to them, the strategies they favour in exploiting such opportunities, the flexibility with which the technological framework can be interpreted by others, and their ability to enrol the support of other actors.

An argument for the technology-focused environment movement research method developed in this paper is that technology can be a common focus for environmentalists (e.g. in the North and the South), albeit under different circumstances, and as such offers a basis for exploring the similarities, differences and alliances between Northern and Southern environmentalism. Differences and points of contact between Northern and Southern environmentalism were used to illustrate how the analytical framework could be put to work. However, this suggestive and illustrative nature of the material presented was by no means definitive.

The conceptual nature of this paper means the considerations discussed here are tentative hypotheses, rather than robust generalisations backed up by a large body of evidence. Future research could test and strengthen the theoretical discussion in this paper in a number of different ways. First, a survey is required to map the variety of ways environmentalist activities connect with technology development under the two broad modes of engagement. This would correlate environment movement organisational types with the variety of repertoires targeted at technology engagement. It should also include the arenas in which this engagement happens. Second, analysis needs to understand how environmentalists themselves view technology both as a target and its role in promoting or retarding sustainable development. Here discourse analysis is the most fruitful method for research. Finally, and perhaps the greatest challenge, is to research the actual influence all this engagement has in technology development. Case study research would be a useful first step in that direction.

The essence of sustainability lies in the recognition of agency in social choices about technological futures. Environmentalism is an important attempt at such agency. One that merits further research and consideration.

Acknowledgments

References

Akrich, M. (1992) 'The de-scription of technical objects' in Bijker, W. E. and J. Law (eds) *Shaping Technology / Building Society* MIT Press, Cambridge, Mass.

Arts, B. (2004) 'The global-local nexus: NGOs and the articulation of scale' *Tijdschrift voor Economische en Sociale Geografie*, 95, 5: 498-510.
Bauer, M. (1995) *Resistance to New Technology* Cambridge University Press, Cambridge.

Beck, U. (1992) *Risk Society* Sage, London.

Bell, M. and K. Pavitt (1993) 'Technology accumulation and industrial growth: contrasts between developed and developing countries' *Industrial and Corporate Change*, 2, 2: 157-210.

Bijker, W. E. (1995) *Of Bicycles, Bakelites and Bulbs* MIT Press, Cambridge, Mass.

Bunnell, T .G. and N. M. Coe (2001) 'Spaces and scales of innovation' *Progress in Human Geography* 25, 4: 569-589.

Cambrosio, A. and C. Limoges (1991) 'Controversies as governing processes in technology assessment' *Technology Analysis & Strategic Management* 3, 4: 377-396.

Defra, Department for Environment, Food and Rural Affairs (2004) *Evidence and Innovation: Defra's needs from the science over the next 10 years* Defra, London.

Doherty, B. (2002) *Ideas and Actions in the Green Movement* Routledge, London.

ENDS, Environmental Data Services (2004) 'Greenpeace praises firms over chemicals' *ENDS Report* 359: 36.

Eyerman, R. and A. Jamison (1991) *Social Movements. A Cognitive Approach* Polity Press, Cambridge.

Fillieule, O. and M. Jiménez (2003) 'The methodology of protest event analysis and media politics of reporting environmental events' in Rootes, C. (ed) *Environmental Protest in Western Europe* Oxford University Press, Oxford.

Genewatch (2003) *GM Nation? Engaging People in Real Debate?* Genwatch, October.

Geels, F. W. (2004) 'Understanding system innovations: a critical literature review and a conceptual synthesis' in Elzen, B., Geels, F.W. and K. Green (eds) *System Innovation and the Transition to Sustainability: Theory, Evidence and Policy* Edward Elgar, Cheltenham.

Haynes, J. (1999) 'Power, politics and environmental movements in the Third World' *Environmental Politics* 8, 1: 222-242.

Jéquier, N (1979) *Appropriate Technology Directory*, OECD, Paris.

Mamadouh, V. (2004) 'Internet, scale and the global grassroots: Geographies of the Indymedia network of independent media centres' *Tijdschrift voor Economische en Sociale Geografie*, 95, 5: 482-497.

McRobie, G. (1981) *Small is Possible* Abacus, London.

Mol, A.P.J. (1995) *The Refinement of Production* CIP Data Koninklijke Bibliotheek, den Haag.

Murphy, D.F. and J. Bendell (1997) *In the Company of Partners* Policy Press, Bristol.

O'Riordan, T. (1981) *Environmentalism* Pion, London.

Pepper, D. (1990) *The Roots of Modern Environmentalism* Routledge, London.

Pinch. T. S. and W. E. Bijker (1984) 'The social construction of facts and artefacts: or how the sociology of science and the sociology of technology might benefit each other' *Social Studies of Science* 14: 399-441.

Pursell, C. (1993) 'The rise and fall of the appropriate technology movement in the United States, 1965-1985' *Technology and Culture* 34, 3: 629-637.

Rip, A. and R. Kemp (1998) 'Technological change' in Rayner, S. and E.L. Malone (eds) *Human Choice and Climate Change Volume 2I* Battelle Press, Columbus: 327-399.

Rootes, C. (2003) (ed) *Environmental Protest in Western Europe* Oxford University Press, Oxford.

Rootes, C. (1999) (ed) *Environmental Movements: Local, National and Global* Special Issue of Environmental Politics, 8, 1.
Rüdig, W. (1990) *Anti-Nuclear Movements: A World Survey of Opposition to Nuclear Energy* Routledge, London.

Sandbach, F. (1980) *Environment, Ideology and Policy* Basil Blackwell, Oxford.

Schumacher, E.F. (1973) *Small is Beautiful*, Blond and Briggs, London.

Smith, A. (2005) 'The alternative technology movement in the UK, 1970 - 1985: an analysis of its framing, negotiation and influence upon technology development' *Human Ecology Review*, forthcoming.

Smith, A., Stirling, A. and F. Berkhout (2005) 'The governance of sustainable socio-technical transitions' *Research Policy* 34: 1491-1510.

Sørensen, K.H. and R. Williams (eds) (2002) *Shaping Technology, Guiding Policy: Concepts, Spaces and Tools* Edward Elgar, Cheltenham.

Stirling, A. (1993) 'Environmental valuation: how much is the Emperor wearing?' *The Ecologist* 23, 3 (May/June).

Stirling, A. (2005) 'Opening up or closing down? Analysis, participation and power in the social appraisal of technology' in Leach, M., Scoones, I. and B. Wynne (eds) *Science and Citizens* Zed Books, London.
Thompson, E.P. (1963) *The Making of the English Working Class* Victor Gollancz, London.

UNHDP, United Nations Human Development Programme (2001) *Human Development Report 2001* Oxford University Press, Oxford.

Stirling, A. (2004) 'Opening up or closing down: analysis, participation and power in the social appraisal of technology' in Leach, M., Scoones, I. And B. Wynne (eds) *Science, Citizenship and Globalisation* Zed, London.

van der Heijden, H. (1999) 'Environmental movements, ecological modernisation and political opportunity structures' *Environmental Politics* 8, 1: 199-221.

van de Poel, I. (2002) 'The transformation of technological regimes' *Research Policy* 32, 1: 49-68.

van de Poel, I. (2000) 'On the role of outsiders in technical development' *Technology Analysis & Strategic Management* 12, 3: 383-397.

Wilsdon, J. and R. Willis (2004) *See-through Science: why public engagement needs to move upstream* Demos, London.

Winner, L. (1977) *Autonomous Technology* MIT Press, Cambridge, Massachusetts.

Wynne, B. (2002) 'Risk and environment as legitimatory discourses of technology: reflexivity inside out?' *Current Sociology* 50, 3: 459-477.

Yearley, S. (1988) *Science, Technology & Social Change* Unwin Hyman, London.