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The regulation of risk: Mobile phones and the siting of phone masts - the UK experience

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There are often scientific uncertainties and ambiguities surrounding novel industrial technologies. This makes regulatory processes problematic. An examination of the literature on mobile phone technology in the UK shows that whilst government and the telecommunications industry research has not found any clear evidence of ill effects on human health, other studies conducted more or less independently show a more mixed picture. The aim of this paper is to advocate a more open-ended regulatory process when investigating issues that exhibit scientific uncertainty. This process encompasses the views of a wider body of experts and lay persons. In the presence of uncertainty and ambiguity we believe that the precautionary principle is a useful tool with which to examine issues such as mobile phone technology.

Keywords: mobile phone technology; phone masts; public health.

1. Introduction

Mobile phone masts have been springing up around the UK over the past decade or so, and, with the constant innovation of mobile phone technology, there are likely to be many more over the coming years. This is causing anxiety for some people living near these masts. This anxiety is not new. For example, an ICM/Guardian poll in 2001 revealed that while nearly two-thirds of people in the UK used mobile phones, half of the population was worried that they might be a health hazard (*The Guardian* 2001). Many more recent surveys show high levels of enthusiasm for mobile phone technology, with some research suggesting that women think more of their mobiles than their boyfriends (*Daily Mail* 2009). Nevertheless, there are many groups that campaign against mobile phone masts, arguing that masts, and the phones themselves, cause cancers such as leukaemia, Hodgkin's, breast cancer, and may be linked to the incidence of autism (further details can be found at the Mast Sanity (2010) website). At the same time there are a number of individual scientists who have suggested a correlation between masts, phones and ill health (Carlo and Schram 2001; Goldsworthy 2007; Henshaw 2009; Sage and Carpenter 2009).

There has been considerable international research on the subject of risks from phone masts and the safety of phone use, most researchers not finding any causal link between mobile phone use and health problems, yet campaigns against the technology continue. The UK government has issued guidelines to local authorities on the placing of masts but these guidelines state that:

> The planning system is not the place for determining health safeguards...

believing that:

> ...if a proposed mobile phone base station meets the ICNIRP [International Commission on Non-Ionising Radiation Protection] guidelines for public exposure it should not be necessary for a local planning authority, in processing an application for planning permission or prior approval, to consider further the health aspects and concerns about them. (Department for Communities and Local Government (DCLG) 2001: 8)

The UK government and the ICNIRP classify microwaves as electromagnetic waves from 300 MHz to 300 GHz. (National Radiological Protection Board (NRPB) 2004). One study of phone mast protesters concluded that the protesters thought that:

> ... government policy seems to prioritize national economic performance over their quality of life. (Drake 2006: 405)

The phone mast industry is quite adamant that there is no scientific basis to restrict the use of mobile phones and the Mobile Operators Association (MOA) website states that:

> ... the balance of evidence from research indicates mobile phone technology does not pose a health risk... (MOA 2010)

But, as one independent scientist puts it:

> ... negative findings (frequently published in work financed by telecoms and power companies) have no meaning. (Goldsworthy 2007: 1)

And, it is likely that bad news about mobile phones and masts will be damaging to business.

This story is not a new one. Attempts to regulate genetically modified (GM) crops when they were introduced into the UK during the 1990s show the same differences of opinion between science produced by the industries concerned, and independent scientists and pressure groups. The BSE (Bovine Encephalopathy) crisis between 1985 and 1998 likewise shows a similar story. The UK government's attempts to protect the beef and processed food industries from the effects of the disease, was, according to one environmental organisation, misguided. The government's actions demonstrated how the misuse of scientific evidence is 'extremely problematic' and:

> ... all too easily, conditional, contingent scientific conclusions became assertions of 'fact' creating a false sense of certainty, that may later be overturned. (Willis 2001: 12)

This policy fiasco, as one study termed it (Bovens and t'Hart 1996: 15), also showed how independent scientific opinion was often ridiculed when it differed from official scientific opinion (Patterson 2008: 181).

In the regulation of new technologies such as mobile phones and masts there are always going to be scientific uncertainties. As a European Environment Agency study noted:

> The growing innovative power of science seems to be outstripping its ability to predict the consequences of its application, whilst the scale of human interventions in nature increases the chances that any hazardous impacts may be serious and global. (Harremoës et al. 2002: xiii)

It is therefore important that decision-making on the products of technology and science acknowledge the presence of scientific uncertainty and here the precautionary principle is relevant. The scientific uncertainty over the issue of electromagnetic fields (EMFs) from mobile phone technology, and the suspicion and anxiety generated among the public affected by this technology has seen some considerable debate over whether the precautionary principle should be invoked in research into the issue (Wiedemann and Schütz 2005; Short 2007: 25; Dolan and Rowley 2009; Kundi et al. 2009; Zinelis 2010).

This paper intends to examine the claims of government, the telecommunications industry and the scientific community to see whether or not the research into mobile phone technology is being skewed by the industries concerned. The paper also examines the government's part in the regulation, or absence of regulation, on the issue. We argue that in the presence of scientific uncertainty the precautionary principle is a useful tool with which to examine these issues, and that, as Stirling (2007: 312) has noted, the precautionary principle:

> ... provides a general normative guide to the effect that policy-making under uncertainty, ambiguity and ignorance should give the benefit of the doubt to the protection of human health and the environment, rather than to competing organisational or economic interests.

Therefore, this examination of the issues will be carried out using the precautionary principle as the theoretical framework. We argue that in the debates surrounding the regulation of new technologies, as we can see from the above examples, the regulatory process is often skewed in favour of corporate interests, rather than collective democratic choices. The paper will begin with an explication of the precautionary principle and how the UK government has given a commitment to its implementation in health and environmental decision-making. This will be followed by an outline of the perceived problem for human health that mobile masts and phones bring. Thereafter, we will examine the government's stance on mobile phones and the siting of phone masts and the telecommunications industry's defence of its technology.

2. The precautionary principle and risk regulation

The precautionary principle is often seen as an alternative to the more common science-based, or sound science approach to risk regulation, whereby the balance of risks is sought in positivist methods. These methods are designed to collect data that is quantitative and verifiable and results in the reduction of what are often complex issues into smaller parts. This practice is based on the idea:

> ... that if you understand how the small parts work that will in principle tell you how the big thing works. (Barrett and Raffensperger 1999: 117)

However, the precautionary principle, while also requiring science-based evidence:

> ...demands in cases of uncertainty, the evidence should be weighted to err in the direction that leads to the higher margin of safety. (International Commission for Electromagnetic Safety (ICEMS) 2003)

The precautionary approach requires:

> ...going beyond reductionism to a full understanding of the whole as well as the parts and suggests that the whole is more than the parts. (Barrett and Raffensperger 1999: 117)

This means it is a more open-ended process with a more multi-disciplinary approach, a more inclusive peer review process of problem solving, that results in a more open-ended dialogue.

The distinction between these concepts is that one view of policy-making (sound science), involves the use of science and scientists with particular expertise to develop risk assessment procedures based on conventional scientific method. This focuses on finding causal links between hazards allegedly found in new products and processes being introduced commercially, while ignoring social, political and ethical issues. In this approach to dealing with risk resort is often made to statistical methods. A hypothesis is formulated and statistical tests conducted in order to falsify it. This is the null hypothesis. For example, an experiment attempts to find a link between a toxic substance and symptoms of illness, the statistical exercise may suggest there is no link, when in fact there is a link. This is known as a false negative and is a feature of scientific method whereby it is considered better to erroneously claim that there is no link, than to erroneously claim that there is a link:

> ...science errs on the side of 'no effect' and requires stringent standards of experimentation and replication to prove there is an effect. (Barrett and Raffensperger 1999: 112)

This approach of following false negatives can lead to a scientific dead end with no link being proven. This approach is helpful to regulatory policies because it allows government to say there is no proven harm, which then enables the government or industry to proceed to develop what may, in fact, be a questionable technology.

On the other hand, an approach that utilizes the precautionary principle, which, while still accepting conventional scientific method, is also aware of the conditional nature of scientific knowledge, finds ways to encompass the views of a wider body of experts and in some cases, the general public. Moreover, in this approach, any hypothesis takes the very opposite view to that of sound science. For, if a false negative occurs when experimentation finds there is a link when there is no link, the experimenter may conclude that because of fundamental statistical problems, such as the sample size being inadequate, or the result being due to chance or statistical fluke, the null hypothesis is rejected. Under a precautionary approach this may raise doubts about the certainty of the result and may generate more research.

Of course, this approach to risk regulation is problematic as it implies:

> ...a proactive interventionist action by domestic and international governments and regulatory authorities. (Feintuck 2005: 373)

And also implies that this:

> ...sits uncomfortably alongside the deregulatory agenda which has dominated Anglo-American politics since the 1980s. (Feintuck 2005: 373)

One academic in the field of environmental research observed that precaution used to be a dirty word:

> It was treated with great suspicion by the UK government, because it was regarded as a cost-raising, time-delaying and benefits-reducing measure. (O'Riordan 2002: xi)

However, the precautionary principle can:

> ...counterbalance scientific conservatism and pressure to maintain the status quo in the face of uncertain information, and ensure that decision-making processes are transparent, legitimate and accountable. (Tickner and Wright 2003: 213)

The UK government's past record on environmental policy has shown ample evidence of the science-based, or sound science approach, but in more recent times the government does appear to have moved to a more precautionary approach and there are signs that the culture of advice to government is changing. The government's Chief Scientific Advisor's review of the regulatory framework, and the resulting Guidelines for Scientific Advice (Office of Science and Technology (OST) 2000) lays down new definitions of what is meant by the term 'expert', and what constitutes 'relevant' advice to government. The Guidelines define:

> ...scientific advice as including not only the natural and applied sciences but also the social sciences and humanities. (OST 2000: 3)

Expert sources are taken to include not only:

> ...eminent individuals, and learned societies, advisory committees, or consultants, but also professional bodies, public sector research establishments, lay members of advisory groups, consumer groups and other stakeholder bodies. (OST 2000: para 12)

This shows a more collective or inclusionary way of approaching environmental risk assessment, which has modified the sound science-based approach. This can be seen in several reports over the past few years, such as the House of Lords Select Committee on Science and Technology report (House of Lords 2000); the House of Commons Select Committee report (House of Commons

2001); and more specialized reports, such as the Phillips Report on BSE (Phillips et al. 2000) and the Stewart Report on Mobile Phones (Independent Expert Group on Mobile Phones (IEGMP) 2000), demonstrating a more deliberative and inclusive approach which addresses problems of risk by including the judgments of a broader range of affected parties. The Phillips Report on BSE, in particular, stressed the need for government departments to ensure that recruitment to membership of expert committees should be based on an expanded definition of who is an expert, and urged:

> ...members of committees themselves to identify clearly and precisely their remit, and for the advice itself to be honest about uncertainties. (Frewer and Salter 2002: 141)

This approach to environmental decision-making is owed to the government's commitment to precaution: as far back as 1990, the government acknowledged precaution, as one of five principles, to guide policies on the environment (Department of Energy (DoE) 1990: 34), and the government's Inter-departmental Liaison Group on Risk Assessment (ILGRA) paper on the application of the precautionary principle made the point that the UK:

> ...government is committed to using the precautionary principle...

whilst stating that:

> The government is committed to using the precautionary principle, which is included in the 1992 Rio Declaration on Environment and Development. (ILGRA 2002: 2)

Moreover, the UK government accepts the EU position on the precautionary principle as laid out in a European Commission document (European Commission 2000).

3. Mobile phones and health: The perceived risks

Radio frequency (RF) is part of the electromagnetic spectrum as are television emissions, light, X-rays and gamma rays, but they operate at much lower frequencies. Of the higher frequencies, X-rays and gamma rays can break chemical bonds, damaging the material of cells in the body (ionization). Radio frequencies are a form of non-ionizing radiation and suspicion about health concerns surrounding them are not new—such concerns precede modern mobile phone technology. The anxiety and resistance to phone masts and in some cases mobile phones themselves has resulted in considerable research into possible health effects surrounding the technology. Microwave or radiowave sickness was first reported in August 1932 with the symptoms of severe tiredness, fatigue, fitful sleep, headaches, intolerability and high susceptibility to infection (Hecht and Savoley 2007). By 1971, the US Naval Medical Research Institute (NMRI) had referenced 2,300 research articles listing in excess of 120 illnesses attributed to RF and non-ionizing microwave radiation (Defense Intelligence Agency (DIA) 1976). Much recent research suggests that children and women exhibit more vulnerability to illnesses from irradiation than adult males. Children have less dense bones, immature immune systems and, by virtue of their size, they can act as aerials. Females have more complex hormone-based systems to be disrupted than do males. Furthermore, within half a mile of the Saintfield (Northern Ireland) mobile masts, it has been reported that there were some:

> ...eleven children under eleven with leukaemia and seven adults with cancer. (Hansard 2004: 1248)

And in a report by the NRPB (2004), the Executive Summary admits that:

> ...there are data which suggests that RF fields can interfere with biological systems. (Meyer 2007: 1)

One independent scientist blames pulsed microwaves for various biological reactions within human cellular structures which may cause illnesses. The problem seems to be that reproducing these effects in experiments does not always provide firm answers. This is:

> ...because of differences in the genetic and physiological condition of the biological material and its ability to defend itself against electromagnetic insults. (Goldsworthy 2007: 1)

Some research in this area suggests that low frequency electromagnetic fields and radio frequencies that have been modulated with low frequencies can remove calcium ions from cell membranes. (Goldsworthy 2010: 2; Hyland 2008)

One review of 101 studies of the genotoxicity of radiofrequency-electromagnetic fields (RF-EMFs) found that there is ample evidence that RF-EMFs can alter the genetic material of exposed cells, *in vivo* and *in vitrio* (Ruediger 2009). And, according to Powerwatch, although cancer has not been the most reported health effect from exposure to microwave sources, there are two studies that have:

> ...found that people living near a mobile phone mast were three times (Eger et al. 2004) or over four times (Wolf and Wolf 2004) more likely to develop cancer than those living in an area away from the mast...(Phillips and Phillips 2010: 2)

Emerging evidence of health hazards associated with mobile phones and their masts has so concerned scientists that a number of international scientists who participated in a workshop organized by the International Commission for Electromagnetic Safety, and sponsored by the Brazilian Health Ministry, agreed upon the Porto Alegre Resolution which recommended the adoption of the precautionary principle in the regulation of mobile phone technology

(Kelley 2010). Some research even challenges the methodology and adequacy of international safety guidelines. The ICNIRP's methodology, for example, has been challenged by one researcher who believes that the ICNIRP's:

> ... methodology for assessing the RF epidemiological literature is inconsistent and does not measure up to accepted standards for a 'meta-analysis'. (Maisch undated: 1)

According to Maisch, an Australian researcher in EMFs, the ICNIRP research references six studies on which it bases its assurance of safety because they failed to find any ill effects. Maisch takes a critical look at the ICNIRP's case studies and concludes:

> To include the... six studies in a cancer risk assessment as negative findings is highly misleading and deceptive. This level of bias and error is inexcusable for an international group charged with the role of conducting 'best practice' risk assessments of the highest calibre. (Maisch undated: 5)

These doubts can also be found elsewhere. A study published in *Paraphysiology* suggests that existing safety guidelines are not adequate. The authors believe that:

> ... existing safety standards are obsolete because they are based solely on thermal effects from acute exposures. (Sage and Carpenter 2009: 233)

They note that:

> Existing standard-setting bodies that regulate wireless technologies, assume that there are no bio-effects of concern at exposure levels that do not cause measurable heating. However, it has been established beyond any reasonable doubt that bioeffects and some adverse health effects occur at far lower levels of RF and ELF exposure where no heating (or induced current) occurs; some effects are shown to occur a thousand times or more below the existing public safety limits. (Sage and Carpenter 2009: 238)

These researchers conclude that:

> ... at present, the most persuasive evidence for cancer resulting from RF exposure is that there is a significantly increased risk of malignant glioma in individuals that have used a mobile phone for 10 or more years, with the risk being elevated only on the side of the head on which the phone is used regularly... (Sage and Carpenter 2009: 234)

This issue is clouded further by a study in *Science of the Total Environment*, where a group of researchers who undertook a literature review of studies conducted between 2000 and 2004 concluded that:

> ... the results are contradictory and the greater part of these studies is not able to address the issue of causality between exposure and outcome. Therefore, an effect of exposure to electromagnetic fields from mobile communication on well-being cannot be derived based on these limited studies. (Seitz et al. 2005: 54)

4. The UK government's policy and guidance

4.1 Planning policy

We are now into a third generation of mobile phones which use higher radio frequencies and a reduction in battery size, allowing phones to become smaller. This meant an increase in base stations was necessary to cope with the rapidly increasing data transfer. In 1991 the UK government demanded £16 million per annum from each of the main mobile telecommunications networks. This licence fee would confer on them a right to a proportion of the microwave band spectrum. Nine years later, auctions have realized a combined value of £22.5 billion (Wray 2007). The licence arrangement also regulates the quality of service, charging and the minimum level of geographical cover (Drake 2006: 392). The geographical cover is an important factor in deciding how many masts are required. Because it was anticipated that operators might have difficulties negotiating the siting of masts with local planning authorities, they were:

> ... granted permitted development rights which allowed them to erect masts up to 15 meters in height without planning permission or reference to the local population... (Drake 2006: 392)

Telecommunications companies may install radio equipment anywhere in the UK in accordance with their Wireless Telegraphy Act licences, issued by the Office of Communications (OFCOM). Obtaining planning permission for the siting of masts or other structures that host the radio equipment is a separate matter, because OFCOM does not have statutory responsibility for planning. That responsibility falls to the DCLG and their guidelines are outlined in a guidance note (DCLG 2001).

4.2 Government research into health concerns

The provision of scientific advice to the UK government on electromagnetic fields is provided by the NRPB—now part of the Health Protection Agency (HPA)—and its guidelines were thought sufficient for the new mobile phone technology. But as one study found:

> The NRPB represented scientific uncertainty about non-thermal effects as a solely expert concern. And these uncertainties were given no representation in the numerical standards that emerged from the processes of review, meta-analysis and risk assessment. (Stilgoe 2007: 51)

As mentioned above, guidance issued to local authorities on siting of masts states that:

> The planning system is not the place for determining health safeguards.

The guidance accepts the ICNIRP guidelines for public exposure:

> These guidelines cover the man-made frequencies between 0 and 300 GHz and apply to both the extremely low frequency

> powerline emissions and the radiofrequency/microwave sections of the electromagnetic spectrum. (Maisch undated: 1).

Government advice on this issue is at times contradictory. For example, the NRPB (2004: 6) document states that:

> We recommend that a precautionary approach to the use of mobile phone technologies be adopted until much more detailed and scientifically robust information on any health effects becomes available.

Yet in this same document it is stated that:

> ... it's important to ensure that the exposure of people from all new and existing systems complies with ICNIRP guidelines. (NRPB 2004: 11)

In response to campaigners' concerns about suspected affects of mobile phones and masts on health, the government initiated an inquiry by setting up the Independent Expert Group on Mobile Phones (IEGMP), commonly referred to as the Stewart Inquiry. The remit of the IEGMP went beyond that of the NRPB. Its aim was to look at the issues once more, independently of government (which the NRPB was clearly not) and the telecommunications industry. It was permitted to:

> ... consider present concerns about the possible health effect from the use of mobile phones, base stations and transmitters. (IEGMP 2000: 11)

But at the same time it was to review the current science. The IEGMP included two lay members, held public meetings, and invited interested parties, such as scientists and activists to give evidence. This group of experts emphasized the need for a precautionary approach because of public concerns about the possibility of health problems from mobile phones.

Following the publication of the Stewart Report, which recommended further research by an independent panel, a major programme for research was indeed set up. This was the Mobile Telecommunications and Health Research (MTHR) programme. This programme was to investigate health aspects of mobile phones and related technologies, and was to complement other national research programmes also in addition to work sponsored by the European Commission. The Stewart Report:

> ... also recommended that the research should be financed jointly by the mobile phone companies and the public sector. (MTHR 2007: 5)

An initial funding of £7.36 million was made, but the intention was that the funding be made by government and industry on a 50:50 basis. To ensure that none of the funding organizations could influence outcomes of the research:

> ... an independent programme management committee was set up to decide on research priorities, select projects and manage the research. (MTHR 2007: 5)

The committee has members from a broad scientific background that includes physics, neurobiology, cell biochemistry, electrical engineering, occupational and environmental medicine, and applied psychology.

5. Telecommunications industry research versus independent research

The mobile phone industry has funded scientific research into the health effects of their products but their public pronouncements reveal a rather negative attitude towards any suggestion of a problem. Industry websites and industry spokesmen quite often proclaim 'mobile phones are safe' or 'it can't be proven that there is no risk' (Willis 2001: 13). The Mobile Manufacturers Forum (MMF) website is clear about this:

> National and international independent expert panels have reviewed the literature every year or so for last twelve years. These reviews have been consistent in concluding that scientific research has demonstrated no public health risks from living near mobile phone base stations or from the phones themselves or indeed any other radio products operating within internationally accepted exposure guidelines. (MMF 2010)

The MOA website also clearly states that:

> 'RF signals are non-ionizing, causing no known damage to the body's cell structures. (MOA 2010)

But as noted above, scientists such as Andrew Goldsworthy believe that non-ionizing radiation is a problem.

However, there is a large body of independent research, i.e. not funded by either government or the telecommunications industry, that show doubts about possible health effects of the technology. One study from the University of Berne (Switzerland), published a data synthesis of 59 research studies involving possible ill health from low-level microwave irradiation. It concluded that:

> Studies *funded exclusively by industry* reported the largest number of outcomes, but were least likely to report a statistically significant result. The interpretation of results... should take sponsorship into account. (Huss 2006, italics added)

Other academics also have doubts. Dr George Carlo, a professor of epidemiology at the Science and Public Policy Institute in Virginia, was commissioned by the US cellular phone industry to do research into possible ill-health effects of mobile phones and for many years had been comfortable issuing public assurances that scientific research has found no health risks in radiation from mobile phones. But in 1999 he found new evidence that showed that earlier scientific studies were flawed. He publically called for new industry safety standards, which the industry refused to accept. The response from the mobile telecommunications industry was to discontinue his research funding, and attempts were made to discredit

him (Carlo and Schram 2001). While in the UK, Dennis Henshaw, a professor of physics at Bristol University and head of the Human Radiation Effects Group at the charity Children with Leukaemia, observed that there had been:

> So much research, yet so little notice taken.

He concluded that:

> In my estimation, official review bodies have cited less than 10% of the available scientific evidence relating to ELF-EMF effects. In some areas, none of the literature has been cited. (Henshaw 2009)

And furthermore, a UK environmental organization, Green Alliance, has noticed a tendency within the industry:

> ... to privilege scientific information, and give it too great a prominence. (Willis 2001: 13)

It points out that British Telecom (BT) in its response to the Stewart Report wrote:

> ... we recognize that public concern is not purely related to scientific fact but arises also from emotive elements which may impact on well-being. However, the language used, and in particular, the contrast of 'scientific fact' with 'emotive elements', implies a dichotomy between science and other views, and tends to privilege the scientific perspective, which is not helpful. (Willis 2001: 13)

As Goldsworthy notes, there are many thousands of papers written on the non-thermal effects of weak non-ionizing radiation such as that from cell phones and well over half of them show some sort of biological effect on health. However, because there is 'a lack of consistency', the:

> ... cell phone industry uses this to imply that there are really no ill effects and that it is all due to experimental error. This argument is, however, flawed because it does not take into account biological variability. (Goldsworthy 2010: 1)

For all of the above reasons some scientists have recommended a precautionary approach to the technology.

6. The precautionary principle and mobile phone technology: The debate

There is a debate in the literature between scientists employed in the telecommunications industry, other scientists, and non-scientists, on the subject of whether the precautionary principle should apply to decision-making on mobile phones and masts.

A sociological study on scientific advice on this issue (Stilgoe 2007) looks at how scientific advice changed from an approach based on compliance with guidelines to a style where:

> ... issues such as trust and democracy were intertwined with scientific risk assessment. (Stilgoe 2007: 45)

Stilgoe's study argues that:

> ... rather than focusing on questions of public ignorance or the public's perceptions of scientists, we should examine the extent to which experts construct 'The Public' (Wynne 1993: 322). This is the 'deficit model' whereby the public is thought to be unable to understand risk or the science surrounding it. It is only the 'expert' who understands risk and its implications:
>
> ... while the public are seen as having a'deficit' of information or understanding. (Willis 2001: 6)

Also:

> Wynne has explained on many occasions, the deficit model of public understanding of science can be seen as nothing more than an expert attempt to explain away public concerns with recourse to an image of an unqualified and ignorant public. (Stilgoe 2007: 47)

Stilgoe notices the differences between the NRPB scientists' finding on thermal consensus (NRPB 1992, 2004), and the Stewart Report (IEGMP 2000). The NRPB considered that microwaves to be safe once thermal effects had been accounted for. As Stilgoe puts it:

> ... the NRPB saw its authority resting with its basis in scientific evidence, with its advice being in no way 'political', and that the NRPB's failure to understand the many public concerns severely dented its credibility. (Stilgoe 2007: 50)

The IEGMP, on the other hand, broadened its remit to allow it to look at concerns about the possible health effects, 'while conducting a review of the available science' (Stilgoe 2007: 52). The resulting Stewart Report focused on the 'uncertainties that the NRPB saw as unproblematic', while recommending a precautionary approach to mobile phone use and network expansion (Stilgoe 2007: 52). Stilgoe concluded that:

> The pattern of experts telling non-experts what 'correct' areas of concern are is an extension of a deficit model of science and society, and is no longer sufficient. Public participation is now recognized as a necessary part of the process of scientific decision-making. (Stilgoe 2007: 55)

Another sociologist reminds us that:

> ... state responses themselves play an active, even determining, role in the social construction of health risks. This raises questions about the application of the precautionary approaches *on principle*. Balanced risk assessments need to consider the likely, often longer term, impact of politicising every possible hazard. (Burgess 2002: 186, italics in original)

Nevertheless, in an article in an environmental health journal two members of the MOA believe the precautionary principle is not an appropriate guide to policy formulation on mobile phones and masts when there is an:

> ... absence of a scientific plausible hazard from exposure to low-level RF. (Dolan and Rowley 2009: 1331)

Zinelis (2010) does not agree, arguing that some of the examples given by Dolan and Rowley, such as the risks from having hot showers or using transport are inappropriate. Zinelis points out that:

> ... these risks result from the individual's choices and are not comparable to exposures to electromagnetic radiation from base stations, which... occur without the individual's knowledge. (Zinelis 2010: 1)

In addition, Kundi et al. (2009: 484) do not agree and argue that:

> ... the precautionary principle is not intended as a response to unfounded fears of the public or to aim at zero risk, but as a risk management strategy in case of scientific uncertainty about the existence or magnitude of a risk.

They also argue that:

> ... ethical considerations, value judgments, and consensus play an important role when giving guidance to public health policy. This is because:
> ... it is impossible to derive a proposal for a policy from a sentence stating a fact. (Popper 1945)

Use of subjective terms such as 'sufficient evidence' (let alone 'convincing evidence' – convincing whom?) or 'adverse effect' is unavoidable. (Kundi et al. 2009: 484)

7. Discussion

So, the question remains: how safe is mobile phone technology? Despite all of the literature reviewed above, we appear to be no wiser about the risks. So much so that journalist Matthew Wall raised concerns in an article in *The Times* over the lack of a clear message about safety (Wall 2004). This brings us back to our earlier discussion about the way novel technologies are regulated—or at least, the way governments go about using scientific advice to justify regulation. In fact, the above review of the way science has been used with regard to the question of the safety of mobile phone masts is very reminiscent of many past examples of attempts to regulate environmental risks, for example, those discussed in Section 2: BSE and GM crops. In the early years of the BSE problem, lack of evidence of causes of the disease and the lack of any causal link between BSE and vCJD was used as justification for lack of action by the government of the day (Patterson 2008: 177). As two academics argued at the time:

> ... the government's policy was not precautionary. Its primary objective was rather one of trying to diminish, as far as possible, the short-term adverse impacts of BSE on the profitability of the food industry and the level of public expenditure. (van Zwanenberg and Millstone 2002: 1174)

Similarly, in the attempts to regulate the novel GM crops technology, when the long-term effects of genetic engineering on the environment could not be known, the biotechnology industry provided 'studies' to 'prove' the low risk to health and these were usually accepted by government. As one student of science and government policy argued, in regulatory control of these technologies:

> ... the corporations favour decreased oversight, arguing that stakeholders are the best arbitrators of safety, and regulation is too expensive or hampering to economic growth and competitiveness. (Nowotny 2003: 154)

In this present case of mobile phone technology we can see similar processes at work. In the papers produced by independent researchers and university academic research, discussed above, there is evidence that industry-sponsored research produces a high incidence of negative results, allowing industry to declare that the technology is safe.

It is clear that when regulating authorities intervene to limit risk, they find that this approach does not fit into the current deregulatory agenda of modern governments. The idea of choice through markets to allow strong economic growth conflicts with ideas of protecting the environment, and works against democratically determined collective values (Feintuck 2005: 373). The UK government, while professing to make decisions on the basis of the precautionary principle, tends to be very accepting of corporate reassurances of safety. It is also important to note that the precautionary principle does not claim to be a complete decision rule:

> ... instead, it provides a general normative guide to the effect that policy-making under uncertainty, ambiguity and ignorance should give the benefit of the doubt to the protection of human health and the environment, rather than to competing organisational or economic interests. (Stirling 2007: 312)

8. Conclusions

This paper has reviewed much of the research into the possible health effects of mobile phones technology and the results are mixed. The conclusions, overall, are that mobile phones and their masts do not affect the health of either the users of the phones or people resident near the masts. It is evident, however, that much of the research was either carried out by or funded by the telecommunications industry, and this research shows all the hallmarks of the sound science approach rather than an approach that could be said to be in any way precautionary. This approach to the problems of human health is based on the norms of scientific method involving peer review and publishing papers in scientific journals: or sound science.

However, governments have to make decisions through the political process utilizing this scientific research. Therefore, the science that politicians rely on needs to be convincing enough to allow them to justify their policy decisions to the public. This leads politicians to idealise science as something unchallengeable and allows them to argue that their decisions are rational and based on

independent science. But this is not necessarily an accurate portrayal of science, which is not entirely value-free as there is always a subjective element in scientific investigations. Moreover, there is also the problem of error in scientific practice: false positives and false negatives. One work on the subject of precautionary science sums this up neatly. This idealised view of science is used by politicians:

> ...as a 'protective shield' that may be used to justify policy decisions. (Barrett and Raffensperger 1999: 108)

We can see this in the research detailed above. In our current case where research has been conducted by independent scientists, the results often indicate a suspicion concerning the methodology used by industry. Yet the UK government has tended to overlook this body of work. On the other hand, work carried out by the IEGMP and MTHR, whose remit permits them to take note of public concerns and to listen to evidence from a wider body of expertise, tends to follow the precautionary principle. In this approach, the assessment of potential risks is based on existing knowledge and any indications of harmful effects will alert the authorities to the need to avoid or regulate for these potential risks until further knowledge has been produced.

An examination of this issue shows that it follows a similar pattern to that of other issues where government has sought scientific advice. As suggested above, it shows the same differences of opinion between science produced by the industries concerned, and independent scientists and pressure groups. The historical record shows that all recent UK governments have pledged their commitment to the precautionary principle in public, but in practice they have often paid little more than lip service to it. This may lead to the conclusion that UK governments take an opportunistic approach to the precautionary principle. On the other hand, it could also be said that they in fact respond to environmental and health risks on a case-by-case basis.

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