
Weighty Knowledge: Hyper Expertise and the Vertical Integration of Expertise (HEVIE)

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Abstract

There has been significant interest in recent STS literature in describing changes to the nature of expertise in the context of shifts in the nature of technical and scientific practices and meanings (for a sample of the recent literature see: Collins & Evans 2002; Edmond & Mercer 2004b; Frickel & Moore 2005; Jasanoff 2005a; Novotny, Scott & Gibbons 2002). I will use the following brief discussion to provide a preliminary characterization of some of the important forms of expertise that would appear to exerting an increasingly influence in legal and regulatory settings (primarily but not exclusively) in the US. In particular, I will focus on the role played by various types of expertise and images of science in the scientific controversy surrounding the health risks of electric and magnetic fields and radio frequency radiation: the *EMF/RF* debate. This scientific controversy has dovetailed with, for a number of years, broader debates surrounding the determination of the appropriate role for science and expertise in public health and environmental regulation and (US) product liability litigation. I will also provide some working hypotheses to account for why such forms of expertise have appeared and outline some theoretical questions raised by the emergence of vertically integrated expertise.

Introduction: the EMF/RF debate

Public exposure to Electromagnetic Fields and Radiofrequency Radiation (EMF/RF) is a by-product of the operation of a number of familiar modern technologies. High voltage power lines, power transformers and even some household electrical appliances emit EMF. Mobile telephones, radio transmitters and radar emit RF (and microwaves). High levels of EMF exposure can create potentially harmful electrical ‘eddy currents’ within the body and high levels of RF have the potential to cause dangerous heating of tissue. The energy or heating mechanisms explaining these

scenarios are reasonably well understood and a number of scientists have assisted in developing regulations and standards to ensure that such high levels of exposure are rarely experienced. A number of other scientists have nevertheless expressed concern that much lower levels of EMF/RF exposure may also be dangerous. They have suggested that heating and energy mechanisms offer inadequate explanations to account for the biological effects of low level exposure to RF/EMF observed in various laboratory studies. They also point to a variety of epidemiological studies that have suggested links between low level EMF/RF exposure and health problems.

These contrasting scientific approaches to understanding EMF/RF have been at the heart of a controversy that has now been running for more than two decades (Miller 2003). In anticipation of possible social/economic/legal impacts (personal injury suits and costs of infrastructure redevelopment) the EMF/RF debate has had a rich legal/regulatory history being the subject of numerous government reviews and public inquiries and litigation (Geurjuoy 1994; Mercer 2002; Stilgoe 2005; Walsh, Wilson & Kauffman 1997). The debate has also become overtly political with regular accusations being made by consumer advocates, activists and 'dissenting scientists' that telecommunication and electrical industries have systematically exerted pressure on various scientists and scientific institutions to downplay the possible hazards of EMF/RF (Maisch 2005; Slesin 2005). Other critics, from the technocratic left, have promoted the diametrically opposed view, that the debate has been driven by regulators being too accommodating towards irrational public fears (Burgess 2004). Yet again, eminent physicists such as Robert Park (1990) and Richard Wilson have accused proponents of the thesis that low level EMF/RF exposure is harmful of engaging in 'junk' or 'voodoo' science (ALF 2002; Wilson 2005).

Aside from these more polarized views various scientific uncertainties still continue. For example, the reliability of assurances that mobile telephones are safe are compromised by the fact mobile telephones have not been in use long enough for epidemiological studies to realistically map possible long term effects (Graham-Rowe 2003). Longer standing epidemiological studies of health impacts of EMF exposure have consistently revealed worrying links to small increases in incidences of childhood Leukemia but have been beset by ongoing disagreement over causal

mechanisms, exposure models and statistical significance (Neutra, Delpizo & Lee 2002). Most regulators have taken these uncertainties as a warrant to avoid setting stricter EMF exposure levels. In the case of RF some government reports have more or less rejected the possibility of health risks (Health Council of the Netherlands 2002) whilst others have suggested precautionary principles be invoked to discourage the excessive use of mobile telephones by children, pending the need for further research (Stewart 2000).

Despite these ongoing uncertainties the intensity of debate appears to be abating: there has been an ongoing failure for a scientific consensus to be reached on physical causal mechanisms explaining how low level EMF/RF could be harmful; a number of government/scientific reports have not seen it appropriate to initiate major regulatory changes, recommended exposure limits in most regulatory standards only consider the potential problems of energy and heating and are steadily being internationally harmonized, and, a number of recent personal injury law suits involving mobile phones have been dismissed (Edmond & Mercer 2004; Grasso 1998). The widespread adoption and social acceptance of mobile telephones has also no doubt also played an important role in this 'process' (Agar 2002).

It is beyond the scope of this current discussion to describe a detailed account of the scientific micro-politics involved in the EMF/RF controversy so, rather than offer a theoretically holistic SSK controversy study (Mercer 1996) I will focus, rather, on one key aspect of the debate, that is: the important role played by what could be described by 'Hyper Experts' and the 'Vertical Integration of Expertise' (HEVIE). I will suggest that these experts and accompanying forms of expertise have exerted an important influence on the current 'condition' of the EMF/RF debate and the post *Daubert* culture of science, law and regulation in the US and elsewhere.

'Daubert'

Over the last decade there have been considerable concerns in the US (and elsewhere) with the quality of expertise and science being admitted into courts or being used for regulation. Repeated claims were made during

the 1980's–90's that science being used for litigation and regulation was frequently 'junk science': science purpose built for litigation and regulation that was biased and of an inferior quality to proper science (for a critique see Edmond & Mercer 1998). Though not alone in voicing concerns with the quality of science being used in courts various industry based lobby groups and politically conservative 'think tanks' such as the Manhattan Institute and Atlantic Legal Foundation (more on them below) played a dominant role in emphasizing the urgency for legal reform. This debate became crystallized in 1993 in the US Supreme Court Judgment of *Daubert*.

In simple terms, the court was called upon to review the rules for the admissibility of scientific evidence for US Federal courts. The case prompted considerable debate attracting numerous *amicus briefs* ('friend of the court' submissions) from key scientific, industrial and other relevant lobby groups. Most advised the court on what they believed were the key elements of scientific knowledge. The court determined that US Federal court judges should, from now on, consider a non-exhaustive check-list to determine whether or not scientific evidence should be admitted to court.

The check-list (which drew somewhat inconsistently from a variety of bodies of scholarship, including some science studies figures, most notably: Popper, Hempel, Jasanoff and Ziman, provided 4 main criteria for what made up admissible science: whether a claim could be tested (falsification), did it have a known error rate, was it peer reviewed, and, whether or not it was generally accepted by other relevant scientists. Judges were advised to become active scientific gatekeepers not only considering the conclusions of science but its method(s).

Initially the court attached some limitations to this role: judges should not be pressured into becoming amateur scientists; the check-list was a non-exhaustive guide only; and courts should not seek absolute truth or cosmic understandings. Despite these caveats, in a number of key cases which have followed (*Joiner* 1997; *Kuhmo* 1999), the *Daubert* 'criteria' appear to have, in fact, become a strict check-list which has been applied to 'assist' judges in actively interpreting the quality of various scientific claims and exclude expert evidence when they see fit (Edmond & Mercer 2004a).

In most legal and popular science commentary the *Daubert* check-list has been treated as a valuable and accurate description of science (Goodstein 2000; Saks & Faigman 2005). For evidence of the emergence of a recent contrary trend see: Michaels & Monforton (2005). Such a favourable view has not been shared in most science studies literature (Edmond & Mercer 2004b; Haack 2000; Yearley 2005).

Preliminary assessments suggest that *Daubert* has generally helped corporate defendants who are less likely to be dependent on novel science that has not yet been subject to expensive testing and had the opportunity to be open to significant review (Edmond & Mercer 2004a).

Hyper experts and the vertical integration of expertise (HEVIE)

I use the economic metaphor vertical integration to highlight the efforts of conspicuous multi-skilled experts and their institutional supporters to privilege certain types of knowledge/product and attempts to manipulate demand for this knowledge by reshaping the 'marketplace' (courts and jurisprudence) to be more amenable to a particular style 'product' (blended/hybrid law science knowledge). The metaphor of 'hyper-expertise' has some similarities with observations about the role of the so called 'heterogenous engineer' which have featured in studies on the emergence of large-scale socio-technical systems: 'heterogenous engineers' take on the roles of the multi-skilled builder of socio-technical networks: 'heterogenous' in that they shape all the features of a network, not simply 'technical' elements (Law 1987).

EMF/RF 'hyper experts'

I have chosen to focus on three influential figures in the EMF/RF debate who I believe can accurately be characterized as 'hyper-experts' (there also a number of others) these are Kenneth Foster, Michael Repacholi and Richard Wilson. Below I have provided a brief sketch of their respective biographies (at the time of writing) highlighting the diverse contexts across which their expertise has expanded.

Kenneth Foster is Professor of Bio-engineering at the University of Pennsylvania, immediate past president of the IEEE Society for the Social Implications of Technology, and immediate past president of IEEE Engineering in Medicine and Biology Committee on Man and Radiation (COMAR). Foster has published a number of scientific studies and policy reviews on the EMF/RF question this has included policy commentaries in generalist journals such as *IEEE Technology and Society* (Foster & Veccia 2002/2003) and *Science* on the inadequacy of precautionary principles and EMF/RF (Foster, Repacholi & Veccia 2000). His interests in policy have extended even further 'upstream' to legal matters co-authoring the book 'Judging Science' with Peter Huber of the conservative New York based 'think tank' the Manhattan Institute (Foster & Huber 1997). 'Judging science' provided a detailed analysis and commentary on the implications of the *Daubert* case on US Federal jurisprudence and has been an influential citation in a number of US Federal court judgments (see Edmond & Mercer 1999; 2002; 2004c). Foster has also been a signatory to an *amicus brief* (see more on this below) submitted in EMF litigation by the politically conservative tort reform lobby group, the Atlantic Legal Foundation (ALF). The ALF has submitted 'amicus briefs' to most of the leading US appeals cases which have taken place over the last decade arguing for industry friendly strict interpretation of rules for the admissibility of scientific evidence, especially in personal injury litigation (ALF 1999; 2002).

Michael Repacholi has made numerous appearances as expert witnesses in litigation, and public and government inquiries. Repacholi has been one of the central figures in attempts for more than a decade to establish uniform international health and safety guidelines in relation to RF and EMF. He has authored and co-authored dozens of EMF reports, scientific overviews and position papers on the EMF debate most of them as part of his leading role in the International Committee for Non-Ionising Radiation Protection (ICNIRP) of the World Health Organisation (WHO), he has also acted as a consultant for electricity authorities advised committees of the Australian National Health and Medical Research Council (NHMRC). Repacholi has also co-authored with Foster a commentary published in *Science* on problems with the application of the precautionary principle to EMF/RF (Foster, Repacholi & Veccia 2000) and coordinated scientific experiments that have stimulated ongoing scientific debate (Slesin 2002a).

Richard Wilson is Mallinckrodt Research Professor at Harvard University, past director of the Regional Centre for Global Environment Change, Harvard University, Founder of Society for Risk Analysis: Consultant on Nuclear Safety, Toxicology, Epidemiology, Public Health, Safety and Risk Assessment. He has also published on high-energy physics, environmental pollution, risk analysis and EMF/RF epidemiology. He convenes the 'sound science' web cite for the Atlantic Legal Foundation and has been a signatory to a number of 'amicus briefs' submitted to

US courts involved in EMF/Rf and other personal injury litigation. He is also outspoken in promoting the argument that problems in the relationship between science and society are primarily due to unnecessary social interference in science and technology (Wilson 2000; 2005).

As the short sketch above indicates, Foster, Repacholi and Wilson have been active participants in both 'upstream' and 'downstream' contexts (Gieryn 1998) where the EMF/Rf debate has taken place. All have produced scientific research papers, written reports designed for use in legal and regulatory settings, acted as expert witnesses or provided support to parties involved in litigation, published popular overviews of the debate and written commentaries hoping to influence the way courts and regulators interpret, not only the science of EMF/Rf, but science more generally. They are able to varying degrees assist in the articulation, transfer and translation of EMF/Rf knowledge, shaping not only knowledge claims which are temporally and spatially primary (but not necessarily epistemologically 'primary') but are able to exert influence upon the environments their claims are being received in and acted upon. Importantly all three 'hyper-experts' also have important linkages with influential scientific and regulatory and professional institutions, e.g. the WHO, the IEEE. Wilson and Foster's efforts have had the support of various pro-industry lobby groups such as the ALF.

A variety of forms of evidence can be provided to suggest that Foster, Repacholi and Wilson and the style of expertise that they have brought to bear on the EMF/Rf debate has become an important factor in delimiting EMF/Rf regulatory and legal actions, this in turn is likely to feedback into reducing research funding. This should not be taken to suggest that there are not other types of actors involved in the debate: various scientists continue to do specialized research and there are still a number of active critics, regulators and commentators. As I noted above the contours of the debate are also still being shaped in various ways by the ebb and flow and trends in scientific studies. I would suggest nevertheless that in a long standing controversy such as the EMF/Rf debate, key experts such as the ones I have identified, have had the most significant influence. Another interesting factor to consider is the way experts such as

Repacholi, Foster and Wilson, have so far displayed the apparent capacity to maintain legitimacy (at this point in time) for their engagements in these multiple contexts of knowledge production. Although it should be noted that Repacholi's ubiquitous role in EMF/RF regulation has been subject to critique from some activists and commentators (Slesin 2005).

Accounting for the emergence of HEVIE

A number of working hypotheses can be put forward to help account for emergence of *HEVIE* in debates such as EMF/RF over the last decade.

- *First*, there has been the capacity for such experts to participate over significant lengths of time in the same debate and take opportunities to participate in numerous different sites of knowledge construction. They are provided with the opportunity to shape and refine their knowledge claims in anticipation of legal and regulatory needs. For instance during the 1980's and 90's in response to ongoing demands of litigation and regulation many power authorities and electrical utilities retained legal and public relations firms to help them manage the EMF/RF 'problem'. In the context of litigation for instance, the Washington DC based firm Crowell and Moring managed the legal campaigns of many of the worlds electrical utilities, this meant that a 'stable' of largely the same experts could be repeatedly drawn upon and legal and scientific strategies refined. By the early 1990's some experts could boast more than 20 court appearances in EMF campaigns (Brodeur 1989). Activists and industry opponents engaged in similar but less refined and well funded exercises (Mercer 2002).
- *Second*, the regulatory and legal environment in the US in particular, has been shaped by an increasing sensitivity of judges and regulators to questions about the adequacy of scientific evidence. Various models for auditing the quality of scientific evidence have been proposed (see *Daubert* above; Edmond & Mercer 2004b; Jasanoff 2002; 2005a). There has been a tendency for these models to be unrealistic and lead to pressures being placed on participants and decision-makers to package

their claims according to artificial models of scientific method and certainty. Many have argued that such an environment heightens the tendency for specialist scientific, novel and uncertain scientific, claims to be dismissed or deconstructed. Vertically integrated expertise which has been packaged in a legally tractable form and carries the imprimatur of scientific associations, eminent scientists and other 'public' signifiers of authority is likely to exert more influence than 'isolated' specialized expert knowledge claims which are less likely to be packaged, simplified and blended to suit legal and administrative needs. It is to this issue of the production of knowledge packages that I will now turn my discussion.

Knowledge packages—a brief case study of vertically integrated expertise: 'Covalt v. San Diego Gas and Electric'

As noted above, hyper-experts not only participate in producing scientific papers but are active in the production of things such as: *amicus* briefs, submissions to public inquiries, scientific literature reviews, reports to government inquiries, and editorial commentaries. These types of products will often reflect the hybrid roles of the hyper-expert blending together different forms of legal and scientific authority. Unlike the traditional specialist scientific paper, these products are much more likely to indicate how scientific conclusions should be put to work and are more likely to engage in more explicit discussion of the nature of science in general and the way models of science may be applied to the question at hand (Mercer 2002). Bolstered by multi-dimensional models of scientific and legal authority the decision maker is 'told' what decision the science demands. An important example of a vertically integrated knowledge product in the EMF/RF debate is an *amicus* brief submitted by the Atlantic Legal Foundation to the EMF case of *Covalt v. San Diego Gas and Electric* (sections from the case study below have been taken from a more detailed discussion in Mercer 2004).

Covalt was an important test case heard in the Supreme Court of California (Park 1990). *Amicus* ('friend of the court') *briefs* can be submitted

to courts by parties who declare an interest in the outcome of the case but are not parties to the action itself: judges are free to consider or ignore them. The Atlantic Legal Foundation brief (brief of R. K. Adair et al. 1996) was signed by fourteen eminent scientists, six were Nobel Laureates. Many of these signatories were regular 'clients' of the ALF. Kenneth Foster, discussed above, is a 'client' of the ALF and became a signatory to a later Atlantic Legal Foundation EMF brief, basically a copy of the *Covalt* brief, filed in the later case of *Ford vs Pacific Gas and Electric Company* (brief of E. R. Adair et al. 1997). The ALF had filed *amicus* briefs in a number of important US appeal cases involving the admissibility of expert evidence. This has included landmark cases such as in *Daubert* (Bloembergen et al. 1993), *Joiner* (Ames et al. 1997) and *Kumho* (Bobo et al. 1999). These briefs were quite often similar in form, involving a summary of the key scientific issues before the court, a short summary of relevant evidence jurisprudence and models for how these things should be linked together. In this later context, the briefs play the role, to borrow a term from T. S. Kuhn (1962) of providing 'exemplars' or 'ideal problem solutions' to law/science problems. The ALF's *Covalt* brief opens by stating the interest of the *amici* and blends general statements of science with an endorsement of existing California EMF policy:

Amici are scientists who have studied the issue of the health effects of electromagnetic fields [EMF] and believe that the current concern that EMF causes disease, particularly cancer, is not supported by the weight of credible scientific evidence. *Amici* further believe that the 1993 policy statement by the California Public Utilities Commission (...) correctly evaluates and assimilates the current state of scientific knowledge regarding the health effects of EMF. *Amici* are concerned that any decision which even implicitly can be seen as support for the concerns about EMF would lend credibility to beliefs which are essentially without scientific foundation and based on irrational and speculative fear of injury (Adair et al. 1996, 6).

The brief offers a compressed review of EMF 'science'. Its main focus is on diminishing the scientific value of epidemiological studies of EMF and the failure for EMF studies to be able to be explained by physical causal mechanisms. The brief 'anchors' this discussion to the nine so called

Bradford Hill Criteria for assessing epidemiology. The criteria helped give the brief structure and generic authority. The authority of their interpretation of EMF science is further bolstered when not only is it linked to the Hill criteria but also to the scientific/legal authority of relevant jurisprudence. The influential earlier Supreme Court case of *Daubert* is cited as an authority for ‘ordinary scientific concept of repeatability’.

Hill also mentions, under this heading [attribute 7] coherence with laboratory experiments on animals and *in vitro*. Many experiments on the effect of electromagnetic fields have been quoted as evidence that low intensity magnetic fields cause effects in biological systems. It has been suggested that the experiments on calcium efflux on chicken brains substantiate the epidemiological results. There are two problems with such a statement. Firstly the results of these efflux experiments have not been closely similar when repeated, so that the ordinary scientific concept of repeatability, which can and should be applied to laboratory experiments and which is closely connected with factor (3) on the United States Supreme Court’s list of criteria in *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, (...) is not satisfied (Adair et al. 1996, 6).

The brief also reminds the reader that the failure for EMF science to satisfy ‘Hill’s principles’ can be confirmed by recourse to the opinion of ‘responsible public bodies and professional associations’ such as the WHO: the type of association that is the home of hyper-experts such as Foster and Repacholi.

It would be inappropriate for a court to allow the introduction of scientific evidence that satisfies few of Hill’s principles, without extensive evidence also being proffered on the principles themselves and the logic behind them. Of course opinions can differ on whether these principles are met, since there is a difference of opinion, one might refer to reviews by committees composed of distinguished and competent persons and set up by responsible public bodies and professional associations. We list some reviews below (Adair et al. 1996, 6). [The reviews cited include those of the *WHO*, chaired by Repacholi, and the *American Physical Society*]

The brief offers an excellent example of a hybrid blend of integrated law/science knowledge. It seamlessly links disparate scientific standards: such as Hill’s criteria for good epidemiology and the United States Supreme Court’s *Daubert* criteria for science, the authority of mainstream

scientific institutions: 'responsible scientific bodies' such as the WHO, appeals to common-sense: 'ordinary scientific concepts', and specific scientific studies: EMF epidemiology, and calcium efflux experiments on chicks brains. This streamlined package of general concepts of science, specialized scientific studies, medical standards, legal precedent, common sense and bureaucratic authority would appear to have been well received by its legal audience.

Justice Stanley Mosk rejected the *Covalt's* case and cited with approval the ALF brief (amongst other mainstream science views) as an important authority for his decision.

[The] AMA likewise adopted a policy statement declaring that the association 'will continue to monitor developments and issues relating to the effects of electric and magnetic fields, even though no scientifically documented health risk has been associated with the usually occurring levels of electromagnetic fields (...)' The same conclusion is expressed in an *amicus curiae* brief filed in this court by 17 prominent physicists, epidemiologists, biochemists and physicians including among their number six Nobel laureates (Slesin 1996).

Whilst it may represent bravado and hubris, hyper expert and signatory to the amicus brief Richard Wilson held no doubts as to the effectiveness of ALF efforts in *Covalt* and later cases.

In 1990 it was estimated that these claims [that EMF causes leukemia or brain cancer] had already cost the United States a billion dollars as utility companies buried and rerouted power lines, and fended off law suits. Many law suits were instituted. The Atlantic Legal Foundation, representing a number of distinguished amici in each case, filed briefs of amicus curiae in several key cases. The most crucial was before the supreme court of California where a Mr Covalt had sued San Diego Power and Light Company. The case was dismissed in this court. Mr Ford's case in a lower California Court was rejected on appeal. No legal case claiming an effect has ever survived appeal. ALF believes that was largely due to its activities (Wilson 2005, 3; for similar claims also see Park 2000).

Wilson accounts for the apparent success of these activities in straightforward rationalist terms of courts in a sense being guided by the self-apparent nature of the scientific truths being promoted in the briefs and

the activities of eminent scientists. This of course overlooks the continuing theoretical debates taking place in more specialized settings in the EMF/RF debate and conflicting interpretations of the best ways regulators should deal with scientific uncertainties, such as, for instance, the question of the relative status that should be given to animal studies vs. epidemiological studies, and what sorts of certainty are required to justify regulatory and or legal action. Such questions are far from straightforward scientifically, politically or legally. A straightforward rationalist account of the success of the briefs also overlooks the way groups like the ALF and Wilson and other 'hyper-experts' have also been active participants in forms of 'world making'. By helping to promote wider perceptions of a junk science crisis and by demanding greater judicial attentiveness to scientific gate-keeping (Edmond & Mercer 1998; 2004a; 2004c) groups such as the ALF have indirectly assisted in encouraging a legal and regulatory environment which is more amenable to the types of expertise they can provide.

Concluding comments

The emergence of *HEVIE* raises a number of theoretical questions of interest to STS scholars. I have space here to just touch on a three: How is this expertise legitimated? What sorts of critiques are likely to emerge? How applicable is my case study outside a US and common law context?

To address the first question it is interesting to briefly re-iterate by noting the way these emerging forms of expertise appear to draw authority from blending images of expertise as professional status and experience with more epistemologically nuanced images of expertise as 'objective' (Porter 1995). For example, the ALF continuously emphasize the high status of its stable of experts, yet they simultaneously promote the idea that 'sound science' is simply recognizable by good scientists (or appropriately informed judges and regulators) aside from and beyond specialized domains or experience. *HEVIE* appears to negotiate this potentially contradictory dichotomy by making claims for legitimacy which rely, in a sense, on not only having expertise in specific experiential terms but also having expertise in understanding and applying criteria such as *Daubert* and 'sound science'.

To answer my second question, it could be anticipated that broader forms of criticism more sensitive to the structure or form of such expertise will also emerge. For instance: relevant scientific specialists may start becoming more vocal suggesting *HEVIE* inadequately simplifies scientific work (Hilgartner 1990), or that *HEVIE* lacks transparency and offers too many opportunities for conflicts of interest to arise. In these contexts the 'strength' of *HEVIE* in facilitating the coordinated production assessment and implementation of knowledge may also be a weakness. Whilst not specifically directed at the EMF/RF debate these types of concerns have been recently voiced by variety of US public health lobbies and scientific associations in relation to the links between particular scientists/experts and industry and their promotion of images of science such as *Daubert*. These critics believe various industry groups are returning to variation of the models pioneered in earlier times with smoking and asbestos which promote unrealistic models of scientific certainty to limit regulation. The ALF's image of 'sound science' and the model of science embodied in most US courts following *Daubert*, for instance, may be having an important effect on helping to promote a culture of inertia in the US in relation to regulating against possible risks from technology to the environment and public health (Edmond & Mercer 2004a; Mercer et al. 2005; Michaels & Monforton 2005). Further problems could also arise through *HEVIE* being too 'Fordist' and prone to being 'tightly coupled' (Perrow 1986). Exposure of fraud, misconduct or error of one key expert or institution could potentially compromise the legitimacy of a whole package of knowledge claims.

To close, I will consider my third question: Is this form of expertise likely to be limited (to use Jasanoff's terminology 2005b) to operating within the political culture and civic epistemologies of the US: and in particular legal and regulatory settings. Without engaging in considerably more empirical study I would be cautious in suggesting that vertical integration in the exact form I have described above will occur in all settings. Nevertheless the on-going integration and hybridization of academia and industry (not only in the US) is likely to stimulate other new forms of expertise in different settings which will almost certainly offer important challenges to traditional understandings of the norms of science and the role of experts

(Kleinman & Vallas 2005). At the same time, I would suggest that the patterns I have noted in the EMF/RF debate are likely to emerge in other similar regulatory settings involving longer standing scientific controversies. Organizations such as the Atlantic Legal Foundation have spread their interests to other scientific debates and adopted similar lobbying strategies as developed in the EMF/RF debate (Edmond & Mercer 2004a; Wilson 2005). It is also worth noting the global character of many of the experts and organizations I referred to in my case study above. For instance, hyper-experts such as Repacholi and organizations such as the ICNRP of the WHO function in a variety of different national regulatory settings. It is interesting to speculate on their implicit promotion of *HEVIE* as part of their 'solution' to the 'problems' of harmonizing differing national regulatory cultures and civic epistemologies. It is also likely organizations such as the WTO and WHO will have affinity in the future with '*Daubert* like' initiatives, which may help them to benchmark, simplify and translate meanings of science and legitimate expertise in cases of international disagreements. A current example where such epistemological 'auditing tools' are likely to be applicable is in addressing differing interpretations between the EU and US of the role of science in informing the policy implications of the precautionary principle (Yearley 2005). It is interesting to note that both Foster and Repacholi have already published commentaries on this topic emphasising the disjunctures between their versions of 'sound science' and the precautionary principle (Foster, Repacholi & Veccia 2000; Foster & Veccia 2003).

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