Evaluating the 'Ethical Matrix' as a Radioactive Waste Management Deliberative Decision-Support Tool

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ABSTRACT

UK radioactive waste management policy making is currently taking place within a participatory and analytic-deliberative decision-making framework; one that seeks to integrate public and stakeholder values and perspectives with scientific and technical expertise. One important aspect of this socio-technical reframing of the radioactive waste problem is an explicit recognition that legitimate and defensible policy making must take into account important ethical issues if it is to be a success. Thus, there is a need for tools to incorporate adequate assessment of ethical issues in a way that is compatible with this approach. The 'ethical matrix' is one such tool used recently to address a range of agricultural and natural resource issues that shows promise for this field. This paper assesses the strengths and limitations of the matrix and outlines a framework for the development of alternative tools to better satisfy the needs of ethical assessment in radioactive waste management decision-making processes.

KEYWORDS

Radioactive waste management, analytic-deliberative methods, public and stakeholder engagement, ethical tools, ethical matrix

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INTRODUCTION: RADIOACTIVE WASTE MANAGEMENT DECISION MAKING IN THE UK

In the UK, long-term radioactive waste management (hereafter referred to as RWM) has become a significant policy-making priority in recent years. The UK has accumulated a substantial legacy of radioactive wastes from civilian and defence related nuclear programmes, some of which will remain potentially dangerous for tens of thousands of years. In 2001 the UK Government and Devolved Administrations initiated the Managing Radioactive Waste Safely (MRWS) programme in response to previous failures to site radioactive waste facilities. The goals of MRWS were to achieve a RWM strategy providing long-term protection of people and the environment, transparency and publicly legitimacy, based upon sound science and ensuring the effective use of public monies (DEFRA 2001, 2007; NDA 2007).

One significant feature of the MRWS programme has been a shift away from techno-centric long-term RWM processes motivated solely by scientific and technical concerns, towards a more participatory decision-making structure that incorporates the less tangible political, psychological, social and ethical factors involved (Carter 1989; Kemp 1992; Slovic et al. 2000; Atherton and Poole 2001). This shifting policy focus involves an explicit political commitment to sustained and inclusive public and stakeholder engagement on the issues and the incorporation of diverse values into the decision-making process (Chilvers et al. 2003; Flüeler 2005; Sundqvist 2005).

The shift towards public and stakeholder involvement in decision making necessitates new deliberative and inclusionary processes (DIPS) (O'Riordan and Burgess 1999) designed to elicit, evaluate and integrate values, issues and concerns into an overarching framework of technical and scientific RWM. Consequently the problem of radioactive waste has been reframed as a 'socio-technical' one (Flüeler and Scholz 2004; Flüeler 2006) requiring specific tools and methodologies to facilitate an integrative participatory-deliberative approach.

In addition to the need for inclusive participatory decision making is a need to assess the ethical issues involved in the siting of RWM facilities. Ethical concerns are key aspects of both the public acceptability and legitimacy of RWM facility siting (Shrader-Frechette 1991; Brook 1997; Hadjilambrinos 1999; Sjöberg and Drottz-Sjoberg 2001). The UK Committee on Radioactive Waste Management (CoRWM), engaged with ethical issues explicitly as part of their option assessment phase and the subsequent recommendations to Government were based upon the input of public and stakeholder engagement on ethical issues and the input of ethical specialists during an expert

workshop (Blowers 2006). Hunt and Simmons (2001), Rawles (2002) and Cotton (in press), however, recommend that further 'bottom-up' engagement with members of potential RWM facility 'host' communities is necessary in order to provide ethically legitimate local decision making on facility siting. One such existing ethical tool termed 'the ethical matrix', may prove useful for this type of bottom-up, community-led assessment of ethical issues, and thus, the matrix is examined here to judge its suitability for this task. Following on from this analysis, the groundwork for an alternative model is proposed, one that builds upon the strengths of the ethical matrix in a manner adapted for the context of RWM decision making.

ARGUING IN SUPPORT OF PARTICIPATORY-DELIBERATIVE DECISION MAKING

The assessment of the ethical matrix as an analytic-deliberative tool is prefaced by an underlying argument for an inclusive and pluralistic decision-making approach, crucial to establishing political and ethical legitimacy. The arguments are threefold.

Firstly, inclusive participation by actors including the public is necessary as it expands the range of perspectives involved in the decision-making process and diversifies the pool of information available, increasing the likelihood that important social and ethical issues will be addressed. Secondly, facilitated deliberation around RWM issues exposes decision makers to diverse ideas and perspectives (including those that they are inclined to reject) serving an important moderating function by helping to build a culture of pluralism. Pluralistic decision making helps to avoid the extremism that occurs when decision makers only listen to people who see the world as they do (Florini 1999; Sunstein 2003). Pluralism should extend to consideration of the broad range of ethical positions presented by affected groups in RWM facility siting, although decision makers are also committed to finding some metric or standard against which to judge the validity of such (often conflicting) ethical positions in order to make informed choices (Fabre and Miller 2003; Forsberg 2007).

Thirdly, there is a normative argument to be made for inclusive participation; namely that the type of implicit consent involved in either implementing a technical solution (based primarily upon techno-scientific information and assessment) or decision making based upon aggregative voting (through representative electoral politics) is insufficient to legitimately expose individuals to additional or elevated risks resulting from living in proximity to RWM

facilities (Rawles 2002). Inclusive participation is therefore required so that consent can be obtained explicitly and transparently from those affected, improving the ethical legitimacy of the decision-making process.

Satisfactory engagement is necessary to foster support amongst stakeholder groups and potential 'host' communities – encouraging legitimate and defensible political decisions to be made (Hunt and Simmons 2001). It must be made clear however, that political legitimacy and ethical acceptability are not synonymous (Rawles 2000). Popular support in political decision making does not automatically equate with ethical justification. Thus, in parallel to the continued development of new participatory methods for the incorporation of diverse viewpoints is a need to develop practical tools to facilitate deliberation and moral judgement upon ethical issues. As Kaiser (2004) suggests, what one requires is a 'toolbox' for practical ethics, consisting of deliberative techniques and practices that '… makes ethical advice amenable to quality assurance and democratic transparency' (ibid.).

ETHICAL TOOLS – THE ETHICAL MATRIX

Kaiser et al (2004) highlight that although a number of emergent 'frameworks' for structuring ethical deliberation have arisen in policy-making circles (specifically in relation to bio-technology assessment), few have been adequately studied and developed to determine their applicability as public policy decision-support tools; see also (Beekman and Brom 2007). In recent years, new frameworks have emerged primarily from the fields of agricultural and bio-ethics. Evaluation of these frameworks for RWM could prove fruitful.

One such framework or tool termed the 'ethical matrix' (hereafter referred to as 'the matrix'), has gained a degree of popular support in recent years. Its creator Mepham intended the matrix as a means to assist people in making ethical decisions, particularly those around the introduction of new technologies into society. The matrix proposes ethical analysis from the perspectives of different groups affected by its employment. (Mepham 1996; Mepham 1999). The underlying rationale is that science and ethics are interconnected. Mepham and Tomkins (2003) argue that ethics is primarily a science of 'how we should live'; consequently all technical and scientific issues impact upon this. Mepham's tool therefore appears promising for the analysis of ethics in a socio-technical RWM decision-making context.

Mepham (2005b) argues that there are two ingredients necessary for the evaluation of the ethical impacts of technologies. The first is a set of

prima facie principles and the second a list of agents 'that have interests', emphasising that ethical analysis requires a compromise between competing requirements (ibid.). Analysis therefore needs to:

1. be based in established ethical theory to give it authenticity;
2. be sufficiently comprehensive to capture the main ethical concerns; and
3. employ user friendly language as far as possible (Mepham 2005b).

Mepham establishes the matrix in normative theory by adopting Beauchamp and Childress's 'principlist' approach. Principlism is an extension of Rawls's 'common sense rule' (Rawls 1951; Schroeder and Palmer 2003), applying four (in this case) *prima facie* 'common sense' ethical principles, broadly accepted within their original field of medical ethics (Beauchamp and Childress 2001):

1. *Autonomy* – (respecting the decision-making capacities of autonomous persons)
2. *Non-maleficence* – (avoiding the causation of harm)
3. *Beneficence* – (a group of norms for providing net benefits)
4. *Justice* – (distributing benefits, risks and costs fairly)

What characterises 'common sense principlism' is its derivation not from specific normative ethical theories, but from a selection of principles that (it is argued) are *commonly understood* within society and thus have a broad degree of support from both ethical theories and cultural beliefs (Beauchamp and Childress 2001; Howard et al. 2002; Schmidt-Felzmann 2003). The matrix applies principles to the deliberative consideration of specific practical questions. The supposed strength of principlism lies in the allowance of a stronger case based on one principle to outweigh a weaker case based on another in particular circumstances. This presents an alternative to monistic normative ethical theory approaches that tend to assert a single principle (or set of related principles) over others.

Mepham applied specific principles according to the field of analysis (i.e. dairy farming) and chose stakeholders affected by the decisions in that sector (Mepham 1996). Recent revisions allow, however, for the substitution of different ethical principles to different cases (Mepham 2005b). Applying the matrix to alternative fields, changes the moral context and consequently both principles and stakeholders can be amended based upon their relevance to the case.

The matrix substitutes the four Beauchamp and Childress principles for three, conflating beneficence and non-maleficence into 'wellbeing' – for simplification and because of the inter-relationship between preventing harm and enhancing quality of life. 'Autonomy' is kept, as is 'justice', although this was later re-labelled as 'fairness', in reference to the Rawlsian concept of 'justice as fairness' (Rawls 1999). The three principles are intended to represent three dominant philosophical perspectives in modern normative ethics: Kantian deontology, Benthamite utilitarianism, and Rawlsian social contract theory (Mepham 2005b).

Mepham argues that principlism doesn't constitute an 'ethical theory' in the strictest sense, nor does it use ethical theories, but is in fact a set of *moral premises* intended to clarify and assist deliberation (Mepham 1999; Mepham 2005a). The matrix avoids 'expert ethicist' reasoning by placing evaluation in the hands of 'non-experts'. Indeed the matrix was originally designed as a teaching tool (Mepham and Tomkins 2003), so simplicity and clarity are two of its primary aims. Simplicity is achieved by replacing complex terminology with commonly understood principles, while their grounding in established theory provides the basis for philosophically valid assessment.

In the matrix, principles are shown in columns and interested groups (or 'stakeholders') in rows. Figure1 shows a hypothetical example of an ethical matrix when applied to RWM. Similar ethical matrices have been used in a variety of contexts, such as the assessment of the food industry (Mepham 2000; FEC 2005); novel foods (Mepham 1999; Mepham 2001; Chadwick et al. 2003); bioremediation (Millar 2002); fisheries (Kaiser and Forsberg 2001; Kaiser et al. 2007); forest management (Gamborg 2002); animal farming (Mepham and Tomkins 2003; Whiting 2004); xeno-transplantation (Moore 1996) and environmental remediation (Forsberg and Kaiser 2002; Howard et al. 2002; Oughton et al. 2003a; Oughton et al. 2003b).

This last case is arguably the most relevant to RWM. The Sustainable Restoration and Long-Term Management of Contaminated Rural, Urban and Industrial Ecosystems (STRATEGY) project, examined the management of accident situations, such as a Chernobyl style nuclear fallout and used the matrix to assess the ethics of radiation protection and human welfare in emergency planning (Forsberg and Kaiser 2002; Howard, Forsberg et al. 2002; Oughton, Bay et al. 2003a). The project used the matrix to facilitate consideration of social and ethical issues related to countermeasures and establish a decision-framework for the selection of remediation strategies (ibid.). Oughton et al (2004) assert that various countermeasures affect different groups in different ways and the matrix could be used to help identify

	Autonomy	Justice	Wellbeing
Governmental institutions	• Respecting the authority of democratically elected institutions and officials • Political decision-making legitimacy	• Building partnerships, sharing decision-making authority with stakeholders	• Implementing RWM strategies that lower the risk to the aggregate UK population
Nuclear industry	• Freedom to generate and trade in (nuclear powered) electricity	• Ensuring benefits of continued electricity production outweigh risks/costs to the public	• Reducing risks to communities, future generations, workers and the environment
'Host community'	• Self-determination in local land-use decision making • Volunteerism for eligible communities • Veto power	• Receiving compensation or community benefits package • Avoiding 'bribery' i.e. not allowing development capital to be used to encourage economically dependent communities to volunteer	• Having protection from risks • Long-term socio-economic stability • Freedom from social stigma
'Future Generations'	• Freedom to adopt alternative RWM strategies if better technological solutions arise	• Better living conditions than current generations.	• Continued, unhindered access to resources
'The environment'	• Representing non-human interests by proxy in a decision-making process	• Ensuring that non-humans are valued equally to humans in decision making	• Maintaining biodiversity • Protecting individual organisms or aggregate ecosystems from environmental degradation and resources depletion

FIGURE 1. An example ethical matrix assessing radioactive waste management facility siting

the relevant information required for decision making (i.e., the facts, values and stakeholders affected), helping to avoid bias towards specific moral values and addressing conflicts between them in a systematic way (ibid.). However, even with all relevant information and systematic representation of different values, they recognised that *moral judgement* must be exercised, while also questioning who this moral judge should be. The study concluded that stakeholder involvement is a key element for ensuring a justified and publicly acceptable conclusion (Forsberg and Kaiser 2002) and the same could equally apply to RWM decision making. It must also be stated however, that the legitimacy of non-elected stakeholder representatives acting as 'moral judges' is itself a meta-ethical issue that requires justification within the decision-making process.

The prerequisite pluralism is shown to some extent within the matrix itself. There are several 'stakeholders' (by broadly conceptualising the term to include abstract elements such as 'biota' or 'future generations'), so the needs and values of multiple groups can be represented. Similarly, the three ethical principles allow for some breadth of ethical debate and the production of an easily understandable tool for use by ethical non-experts.

The matrix is intended as a tool for mapping out the issues *underpinning* a decision, rather than determining an ethical decision using some supposed metric of evaluation. By refraining from rule making or adhering to ethical doctrine, Mepham argues it is ethically neutral in its intent (Mepham 2000). Such neutrality is a requirement for pluralistic deliberation on ethical norms, moral values and their application to RWM policy. The matrix therefore alludes to Habermassian discourse or procedural ethics, whereby the argumentation of moral principles by (communicatively rational) individuals ascribes ethical value to a decision (Habermas 1980; Johnson 1991). By considering a range of normative principles, the matrix seeks to remove philosophical bias in influencing the decision outcome.

COMPATIBILITY BETWEEN THE ETHICAL MATRIX AND ANALYTIC-DELIBERATIVE DECISION-SUPPORT

Gamborg (2002) suggests using the matrix in an expert-led consultation process involving a panel of scientific experts, members of local government, administrative agencies, private industry and members of the public. During consultation, a spokesperson from each group would 'present their "client's cases" (so to speak), in doing so outlining the pros and cons for each group' (ibid.). Each panel member and each member of the 'lay' audience

is given a copy of the matrix. After the presentation of the case and ensuing discussion, participants indicate in each cell of the matrix, whether they feel that the ethical principle is likely to be upheld, violated or unaffected by the proposal. By collating these responses it is possible to obtain a verdict (ibid.), i.e. a measurement of the prevailing ethical mood among the participants (Mepham et al. 1997). In some respects this scenario is pluralistic, in the sense that it incorporates lay public responses in the matrix. However in this model, public-controlled ethical deliberation does not occur – only lay participant 'voting' or 'weighting' of a 'top-down' matrix.

This proposal also highlights additional problems for radioactive waste deliberations, namely that many of the potentially affected stakeholders lack a mechanism for representation as many of the matrix's potential 'groups' have no physical form and cannot take part in decision making. Although not specifically a criticism of the matrix; two of the key affected groups identified are 'future generations' and 'the environment'. The meta-ethical problem is that neither is a collective, physical (and thus rationally interested) stakeholder group and so each lacks a 'voice' of their own. Others like 'the general public' or 'NGOs' do have a physical form (of sorts) but their interests may be so diverse that they cannot be adequately represented by an individual spokesperson. Also, although it is plausible that some categories such as 'the environment' can be represented by specific advocacy organisations, NGOs or interest groups (Greenpeace or the Friends of the Earth for example); a meta-ethical issue remains around the extent to which proxy representatives can speak on the behalf of others, especially those that lack physical presence (see Latour 1998; Luque 2005).

Schroeder and Palmer (2003) assert however, that future generations and the environment (especially) must be included as default stakeholder positions in an ethical matrix because these groups cannot intervene in the decision-making process and yet are deeply affected by the outcome. It is therefore necessary to identify and interpret the best means for assessing their needs and always include these 'groups' in deliberative decision making. Although it is impossible for individuals to encapsulate the views and concerns of an entire (sometimes abstract) group, the most important factor is inclusive deliberation. The meta-ethical validity of the matrix could thus potentially be improved through the use of 'visioning' (Walzer 1996), scenario development, role-play or 'future search' type methods (Weisbord and Janoff 1996), whereby the interests of these groups can at the very least be *imagined* and reflected upon, thus strengthening the contextual validity (and hence meta-ethical legitimacy) of the matrix.

PRACTICAL SIMPLICITY AND ETHICAL VALIDITY

The design of the matrix highlights the importance of practical simplicity in assessing ethical concerns. With each additional stakeholder group, a new row is added, until it becomes too large and unwieldy for use as group discussion tool. Therefore key stakeholders are identified in universal groups such as 'local community'. This is however problematic. Treating diverse groups as homogenous entities (alongside others such as 'the general public', 'future generations' or 'the environment'), firstly assumes that a potentially diverse group of matrix-using participants will all understand these monolithic categories to mean the same thing, and secondly, fails to express the diversity of values and interests *within* these labelled groups. By representing the stakeholder groups as isolated and homogenous categories, this may cause participants to 'bracket off' the effect of group interaction. The problem being, that stakeholder groups tend to operate in a synergistic manner (O'Mahony 2004); i.e. the ethical 'effect' of one group's actions strongly influences and affects the consequences for and behaviour of other related stakeholder groups.

Although some principles (particularly 'Justice' or 'Fairness') allow for discussion of the relationships within and between different actors, the matrix's design lacks a mechanism to illustrate and record such inter-relationships – it only records the relationship between a technology and each separate stakeholder in isolation. A new design of matrix showing the intricate latticework of relationships between affected groups would increase the complexity of the model and again may lose the element of transparent simplicity. However, the notion of 'breaking out' of the confines of a 3x4 (or 3x5) matrix is worthy of consideration. The development of tools for ethical assessment in analytic-deliberative contexts may therefore benefit from being based around more detailed 'conceptual mapping' (see (Novak 1990)) of the synergistic relationships between ethical values both within and among stakeholder groups – showing the interactive elements of stakeholder relationships and how these shape moral judgements.

THE CHOICE OF PRINCIPLES

Similarly questions have been raised over the choices of the principles used and justifying the choice of any three principles over others. Again, the answer is grounded in part by the practical simplicity of the matrix. Having too many ethical principles makes the matrix cumbersome to use. If we

were to justify three specific principles for the RWM case, we must question how to choose those which will provide the most informative exploration of the issues. Transposition from agricultural practice to radioactive waste facility siting requires a re-assessment of the ethical premises from which the analysis can take place. In some cases where the matrix has been used in decision making, users have selected different principles for the matrix. Alternatives such as 'dignity', 'rights', 'equality', 'fairness' and 'solidarity' etc. have all been utilised (Schroeder and Palmer 2003). However, if this process of principle selection is driven by experts or facilitators then this raises a meta-ethical problem due to a 'framing effect' (Frisch 1992), whereby ethical principle selection is predetermined by experts and hence 'top-down'. In RWM decision-making contexts this is untenable. The function of a participatory decision-making process is to lead the analysis from the bottom up, i.e. from those (potentially) affected by the implementation of the technology.

In reference to this, Kaiser et al. (2007) developed a testing framework to compare a top-down ethical matrix (with facilitator or specialist defined principles) against a bottom-up (participant negotiated principles) matrix with 'lay' participants. In the top-down workshop nine experts applied the matrix to discuss key issues raised by the use of GM technologies. Broadly speaking, the experts concluded that the main problems with matrix were based upon the time constraints for discussion, the limitations of the knowledge of the participants and the requirement for a broader range of stakeholders to be involved in discussion particularly those with 'complementary backgrounds'. In written feedback however, "all participants believed the use of the Ethical Matrix helped the process" (Kaiser et al. 2007). The researchers also concluded that the workshop findings reinforced the perception that expert groups prefer to work with a top-down approach to implementing the matrix (ibid.). In contrast, their bottom-up approach involved less explicit facilitator guidance; deferring where appropriate to the majority views of the (usually) lay participants in specifying the principles and conducting ethical deliberation. The matrix was initially applied with the standard four principles (with 'Well-being' specified separately as 'Increased Benefits' and 'Reduced Harm', 'Autonomy', and 'Fairness'). Participants then translated these principles into specifications for the specified interest groups and following group discussion, 'Autonomy' was modified and 'Dignity' was subsequently used in the matrix (ibid.). The participants also added additional stakeholders to the original list. Some argued for the inclusion of 'future generations' as a stakeholder group, although it was agreed that these considerations could be included under a 'Consumer' group. Others perceived 'Research and

Knowledge Production' to be an important issue. As a result of this discussion, an additional stakeholder group, 'Research Community', was added to the matrix making a total of five (all from ibid. 76).

The framing of the ethical debate through the predefined choice of principles by specialists or expert ethicists and their subsequent deliberation in the top-down (classical) ethical matrix is controversial for participatory RWM decision-making processes, as this could potentially lead to further criticisms of 'techno-centrism'; albeit due to ethical rather than techno-scientific framing of the decision-problem. The bottom-up matrix would therefore be preferable for the RWM context, although considerable ambiguity remains around how the principles themselves are chosen and how one set of principles is preferred to others. The justification of the choice of principles in the matrix is an important meta-ethical concern. Unfortunately, the matrix lacks a specific mechanism for justification of principle selection and thus another tool is required for this purpose.

The matrix's standard set of ethical principles are grounded in the dominant 'Western' themes of moral philosophy, originally designed to maximise the breadth of ethical debate. However, the terminology used to categorise these philosophical traditions as principles is itself open to question and the difficulty in translating this into meaningful deliberative discourse lies in the interpretation of the principles themselves. For example, 'Autonomy' could conceivably refer to rights, duties, self-determination, liberty, freedom from coercion and personal responsibility. It could also refer to the decision-making capacities of individuals, or the relationship between intentional agents and the constraints of societal institutions.

In the example of the 'local community', they would conceivably have rights to freedom from harm, moral (and legal) rights to compensation or benefits packages, veto of the implementation process, as well as (if selected as a repository site) responsibilities to monitor and maintain the facility. Similarly, wellbeing can be interpreted on a variety of different levels, from the individual, communitarian, societal, or state levels. Justice could refer to legal processes of compensation, legal rights or political enforcement as well as Rawlsian, Hobbesian, Socratic or Aristotelian philosophical traditions. Although the matrix could be used as the means to *elicit* such discussions, it still lacks a mechanism for visually (and conceptually) clarifying different meanings – potentially causing confusion for both matrix users, and third parties evaluating the matrix-centred discussions.

One solution may be to stipulate precise principle definitions. Without this, the interpretation of each word as representing a broader theoretical category creates internal inconsistencies and potential conflict among stakeholder-

participants using the matrix, rendering a 'one-size fits all' ethical issue per stakeholder/ principle a rather limited analysis. The ethical matrix expressed in such a way, results in participants expressing the ethical impacts of different stakeholder groups in a single universal issue, so much information and ethical tension is lost (at the very least in the recording process) in the name of simplicity and keeping the matrix small enough to be a useful tool.

BUILDING UPON THE CRITIQUE

The ethical matrix has been used to address the challenge of ethical deliberation in a variety of technological decision-making contexts. Despite its popularity however, some significant problems remain for its implementation as a deliberative decision-support tool. The first significant critique stems from the inherent constraint of the 3x4 (or 4x4) design. This feature aids simplification and structuring of ethical discussions (Kaiser et al. 2007), but also limits opportunities for creative problem solving outside of the matrix's pre-defined principle and stakeholder categories. The trade-off between free-flowing discussion and idea generation and structure and transparency is a persistent challenge for deliberative and inclusionary processes. To borrow Stirling's (2004) terminology, the creative problem-solving and idea generation aspects of participatory methods ('opening up') requires reining in at some point in order to 'close down' deliberation and reach conclusions.

Mepham argues that basically, the matrix represents a checklist of concerns structured around ethical theory, and at best, allows for the stimulation of structured ethical debate from a range of perspectives (Mepham 1999; Mepham 2005a). To open up decision making, effective bottom-up deliberation is necessary, participant control and 'ownership' of the process, without the 'technocratic monopoly of information' (Jacobs 1997; Owens 2000) that expert-ethicist centred analysis brings. A top-down matrix cannot support deliberation in this capacity. If the supposedly 'correct' values are prescribed prior to the engagement process (including the inherent 'Western' philosophical bias of the pre-defined principles) then the 'bottom-up' nature of deliberation is removed. With this in mind, bottom-up deliberation with participant ascribed principles is required. In spite of this, four problems remain however.

Firstly, although it is argued here that bottom-up principle and stakeholder selection is appropriate, a further tool is necessary in order to achieve this in a transparent and meta-ethically justified manner.

Secondly, the range of principles and stakeholders offered by the matrix is comparatively small. A far greater range of stakeholders and principles would be needed to alleviate the inherent bias in the model generated by such a small selection. The identification and display of such a narrow set of principled perspectives and stakeholder groups could have two outcomes. It may lead to participant conflict over those groups that were chosen to be included in the matrix and those that weren't – a problem that may simply lead to a redrawing of a larger matrix with more representative groups. More significantly, important stakeholder groups absent from the matrix may be overlooked because they were not on the deliberative agenda, thus precluding them from informed discussion.

Thirdly, the matrix structure frames the deliberative agenda through inclusion and exclusion of certain groups. Thus, a meta-ethically justified process for the selection of stakeholders is necessary – a mapping device for identifying actors and the relationships between them. This process may take longer than simply making the matrix much bigger and spending the extra time filling in all the cells, although the selection of these inputs to the matrix is itself a deliberative process that requires structure, and hence deserves a facilitation tool in its own right.

Fourthly, the matrix in its current form also lacks suitable deliberative mechanisms for closing-down ethical decision-support processes. In a closing-down phase the aim is to instrumentally assist policy making by, 'cutting through the messy, intractable and conflict-prone diversity of interests and perspectives to develop a clear, authoritative, prescriptive recommendation to inform decisions' (Stirling 2004). In a revision of the matrix, Mepham includes a weighting mechanism for ethical evaluation, separating positive and negative 'ethical impacts' where a score is applied according to whether the principle is respected or infringed (Mepham 1999); weighted by scoring along a Likert-type scale, i.e. -2 (strongly infringe a principle) to +2 (strongly respect a principle) (Mepham and Tomkins 2003). Mepham (1999) argues that "scoring" perceived ethical impacts on a numerical scale may serve as a means of establishing relative perceptions, but the framework should not be viewed as a decision model. Indeed as Whiting (2004) argues, '…depending on the weighting given to various cells in the matrix almost any ethical evaluation can be supported'. Schroeder and Palmer highlight that simply counting the numbers of infringed and upheld principles has in itself an inherent utilitarian bias (thus procedures like the one Gamborg (2002) suggests, inherently prioritise the ethical values of the many over the few). Also weighting criteria based upon a hierarchy of principles are equally problematic as they contradict pluralistic ethical deliberation by arbitrarily

prioritising certain ethical principles over others. In the absence of reliable weighting criteria and hence a closing down mechanism for evaluation, summary and prescription, ethical decision making remains reliant upon the competency of the users' moral judgement, so greater clarification and structured deliberation around conflicting moral judgements is necessary.

THE FRAMEWORK FOR AN ALTERNATIVE DELIBERATIVE ETHICAL PROCEDURE

In light of the foregoing discussion it is necessary to sketch out what an alternative framework for ethical assessment could look like, in order to compensate for some of the limitations of the matrix in its current format. The ethical matrix has been framed in the literature as an 'ethical tool' which could operate as part of a 'toolbox' of techniques for application in different contexts of ethical problem solving. What is proposed here for the ethical technology assessment of RWM is a model that expands upon the matrix by opening it out to more effective bottom-up deliberation. Given the aforementioned lack of sufficient opening-up and closing-down mechanisms, it is proposed that multiple ethical tools are necessary, not simply in the format of a 'toolbox' (implying different tools brought out for different purposes) but arranged as a sequential ethical assessment procedure, to better satisfy the needs of an analytic-deliberative decision-support process.

Generally speaking, decision-support processes are multi-staged, commonly involving a search process to discover goals, the formulation of objectives following this search, the selection of alternatives and strategies to accomplish the objectives and the evaluation of outcomes (Scott 1971). In reference to this various established analytic-deliberative methods such as multi-criteria mapping (Stirling and Mayer 2001), stakeholder-decision analysis (Burgess 2006) and the hybrid deliberative mapping (Burgess et al. 2004; Burgess et al. 2007) are structured around a four-part model:

1. Problem framing
2. Option scoping
3. Criteria elicitation
4. Option appraisal

It is proposed here that the matrix could benefit from adaptation to a similar structure in the RWM context; separating into individual tools for each of the sequential stages. It is necessary to first establish bottom-up problem framing by grounding deliberation on ethical issues within the

practical techno-scientific and socio-political decision context. The first task is therefore effective information provision to community or stakeholder participants, this involves two aspects. The first is a balanced range of information resources, including materials from industry, Governmental and NGO perspectives regarding both social and technical aspects of the RWM problem. It also involves giving participants the opportunity and resources to assess their own information needs, question experts and thus prepare for informed deliberative engagement.

Secondly, the subsequent deliberation around such aspects of RWM should involve techniques to elicit and record a (long) list of identified stakeholder actors and also identify the relationships between them. Existing tools such as stakeholder analysis (SA) (Goodpaster 1991; Grimble and Wellard 1997) and stakeholder mapping (SM) (McElroy and Mills 2000; Elmendorf and Luloff 2001) have been used successfully to draw out the interests of stakeholder actors, identify conflicting and collaborating interests and assess the roles of stakeholders at different stages in a decision-making process. Effective SA and SM could prove beneficial to ethical assessment in that they allow participants an opportunity to examine the synergistic stakeholder relationships, potentially including future generational and environmental interests and even the technologies themselves. Such methods could be simply adapted to ethical deliberation, by framing the analysis and mapping processes in terms of how the behaviours of one group can be both ethically motivated and ethically consequential to other groups. Due to the complexity of the stakeholder categorisations that result from SA and SM, it may be necessary to then cluster the results into conceptually contiguous groups for simplification and further ethical deliberation. Although this process is comparatively time consuming and complex, it is meta-ethically preferable to the simplistic, arbitrarily selected and monolithic categories of stakeholders presented in the matrix.

The next task is the identification of suitable principles. It has been argued here that meta-ethical justification of selected principles must be consonant with bottom-up deliberation. Thus, principlism could be applied in a manner congruent with Beauchamp and Childress original perspective. They articulate ethics as a dialectical relationship between ethical principles and concrete ethical problems, where the emergence of new ethical problems provokes a critical analysis and possible reformulation of existing ethical principles. Due to this dialectical relationship, the reformulation may provoke a modified view of actual ethical problems. In this way, the examination of ethical problems should be a process, not the application of rigid ethical principles (Beauchamp and Childress 2001).

In light of this, it has been suggested by Cotton (in press) that Rawls's concept of 'reflective equilibrium' could provide the suitable basis for grounding the selection and justification of ethical principles within an analytic-deliberative decision-support process that is bottom-up and based upon participant moral judgement. To summarise, reflective equilibrium is a coherentist method of ethical analysis involving the specification, reciprocal weighing, testing, revising, and balancing of principles, rules, background theories, and particular judgements (McCarthy 2003). In the proposed reflective equilibrium-based approach (Cotton in press; 2008) a selection of principles grounded in theory-based perspectives (that have been developed within a community of expertise i.e. the analytic part) is deliberated upon in reference to the bottom-up communicative, dialogic and reflective aspects of public and stakeholder formulated moral judgements (i.e. the deliberative part). Such a deliberative tool could involve the use of adapted elicitation techniques such as image-based (Satterfield 2001; Harper 2002) or narrative-based (Shanahan et al. 1999) qualitative methods for clarifying individuals' moral judgements and values, followed by the elicitation of a long list of ethical principles in order to provide the evaluation criteria against which these judgements are to be critically revised. By applying the range of identified principles to the judgements elicited through group deliberation and subsequent reflection upon the context of the principles in relation to the judgements themselves (and the specificities of the case), the outputs would be a series of 'considered' judgements that are coherent with a set of participant-selected and adapted principles that are in turn, case-specific and relevant to RWM (ibid.).

The outputs of the reflective equilibrium-based tool must then be formulated into a series of ethically informed policy options or alternatives, by reflecting upon the practical implications of their implementation. It is therefore necessary to pragmatically re-contextualise the more abstract elements of ethical deliberation back within the political, social and techno-scientific context of RWM decision making (ibid.). Discourse based-valuation (Wilson and Howarth 2002) has been developed as a means to reach deliberative consensual agreements on valuing environmental resources, and such a methodology could potentially be adapted in order to 'close down' the deliberative process and reach either an agreement on ethically informed actions (resulting in a specific policy option), or else a narrowed range of policy options based upon ethical 'criteria' identified through reflective equilibrium-based deliberation; in a manner that avoids arbitrary weighting mechanisms that reflect an inherent utilitarian bias. It is proposed that when these types of tools are used in concert, this provides a participatory ethical

assessment of RWM technologies which is both meta-ethically justified and compatible with analytic-deliberative decision-support.

CONCLUSIONS

The focus of this article has been to separate specific criticisms of the matrix's design from the limitations of its use in deliberative contexts. The ethical matrix may be a satisfactory tool for deliberating on ethical issues related to technologies in a generalised way (albeit in a fairly limited context of *some* principles and *some* stakeholders) and many users have adopted this approach with a degree of success. However, the matrix in its current format is insufficient as a means for structuring a deliberative process to fully evaluate the ethical issues inherent in the implementation of technologies like those involved in RWM. Participatory decision making requires comprehensive bottom-up evaluations that the limited stakeholder/principle matrix cannot provide. Participatory tools for the consideration of ethics in RWM must therefore extend beyond functionalising a principlist approach that lists a series of comparatively basic principle/stakeholder interactions. They need to incorporate a broader range of 'bottom-up' ethical concerns and stakeholders involved, their actions and inter-relationships, mapping these inter-relationships in a holistic way, drawing together and seeking a coherent balance between ethical principles and stakeholder values. To do this requires expanding ethical assessment beyond the context of a single ethical tool (or toolbox of multiple methods), into a procedural series of methods to identify stakeholders and actor relationships, a series of participant-justified moral principles and coherent deliberation on moral judgements. In this way, a framework for the ethical analysis of technologies such as those involved in RWM can be compatible with participatory and inclusionary decision-making processes, ultimately improving the ethical validity of complex socio-technical decisions.

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