Issues Mapping:

A New Problem Structuring Method for Addressing Science and Technology Conflicts

Abstract

There are new opportunities for the application of problem structuring methods to address science and technology risk conflicts through stakeholder dialogue. Most previous approaches to addressing risk conflicts have been developed from a traditional risk communication perspective, which tends to construct engagement between stakeholders based on the assumption that scientists evaluate technologies using facts, and lay participants do so based on their values. 'Understanding the facts' is generally privileged in conventional risk communication, so the value framings of experts often remain unexposed, and the perspectives of lay participants are marginalized. When this happens, risk communication methodologies fail to achieve authentic dialogue and can exacerbate conflict. This paper introduces 'Issues Mapping', a new problem structuring method that enables dialogue by using visual modelling techniques to clarify issues and develop mutual understanding between stakeholders. A case study of the first application of Issues Mapping is presented, which engaged science and community protagonists in the genetic engineering debate in New Zealand. Participant and researcher evaluations demonstrated that Issues Mapping helped to break down stereotypes of both scientists and environmental activists; increased mutual understanding; reduced conflict; identified common ground; started building trust; and supported the emergence of policy options that all stakeholders in the room could live with. The paper ends with some reflections on the value of using visual models (such as those employed in Issues Mapping) as heuristics. Priorities for further research are identified; particularly how to improve the connection between dialogue and organizational strategy.

Keywords: problem structuring methods, issues mapping, conflict resolution, science and technology, risk communication, dialogue.

1. Problem Structuring Methods

Problem structuring methods (PSMs) involve participants in a discussion where they engage around models. These models help people who might initially have different perspectives on an issue to clarify and develop their understandings, and identify what actions can or should be taken.

Problem *structuring* methods can be contrasted with problem *solving* methods (Rosenhead and Mingers, 2001). The latter assume that, even if the problem is complicated, analysis can allow it to be

understood objectively, and there is a correct or optimal solution to it. In contrast, problem structuring methods start from the assumption that there may be multiple perspectives on what the problem is (Jackson, 2006). Likewise, what counts as an effective solution or an improvement depends on the framing used in an analysis and the values that inform that framing (Churchman, 1970; Ulrich, 1983; Midgley, 2000). With problem structuring methods, it is therefore not possible to talk about 'optimal solutions' in the manner that is common in the OR problem solving literature (Checkland, 1985).

Problem structuring methods can also be differentiated from other approaches to enabling discussion, such as meetings with agendas and focus groups. A distinguishing feature of problem structuring methods is the use of models as 'transitional objects' to structure engagement (Eden and Sims, 1979; Eden and Ackermann, 2006). These models may use words, pictures and/or numbers to represent, for example, people's understandings of a problematic situation; the assumptions underpinning a particular stakeholder perspective; and/or the activities that might be needed to improve the situation. Typically, models are qualitative and are constructed collectively in a workshop, but sometimes they are brought in by a facilitator based on previous inputs from participants and are used to orientate engagement: "the model… plays a key role in driving the process of negotiation towards agreement through discussion and the development of a common understanding" (Eden and Ackermann, 2006, p.766). However, a 'common understanding' does not necessarily imply consensus or agreement across the board: it may be an agreed understanding of the differences between people's perspectives and what accommodations are possible in the circumstances (Checkland and Scholes, 1990).

Rosenhead and Mingers (2004) and Rosenhead (2006) argue that problem structuring methods are particularly useful when it is necessary to address complex issues characterized by "multiple actors, differing perspectives, partially conflicting interests, significant intangibles, [and] perplexing uncertainties" (Rosenhead, 2006, p.759). In the policy literature, these are sometimes called "wicked problems" (Rittel and Webber, 1973). Problem structuring methods are useful for addressing wicked problems because they support participants' *learning* about their own and other perspectives, as well as the broader problematic situation people find themselves in.

Importantly, the *quality* of the engagement between participants matters to the success of problem structuring. Franco (2006) contrasts different forms of conversation, such as persuasion and debate, with *dialogue* (also see Tannen, 1998). Persuasion is when one party tries to unilaterally change the viewpoint of another, and debate happens when two parties enter a conversation with a view to defeating the arguments of the other. In contrast,

> "…participants in a dialogue do not attempt to validate particular propositions or find weaknesses in them. Rather, participants listen to find strength and value in another's position and work together towards a mutual understanding… Dialogue involves the suspension of judgment or pre-conceptions, an equal participation in the conversation by the parties, empathetic listening, and the mutual probing of assumptions… The goal of dialogue is to jointly create meaning and shared understanding between participants…" (Franco, 2006, p.814).

Franco makes the important point that problem structuring works best in the context of dialogue, rather than persuasion, debate or other lower-quality forms of engagement where listening to others is restricted. This echoes earlier research in systems/OR suggesting that problem structuring is most effective when open communication between participants with different perspectives is possible. In the context of coercion or 'pseudo-dialogue' (the pretence of open communication), it is difficult to improve mutual understanding with existing problem structuring methods (Jackson, 1987a; Midgley, 1997).

2. Science and Technology Conflicts

Problem structuring methods have been used to address a wide range of complex issues (Rosenhead and Mingers, 2004). However, they appear to have been underutilized in the context of science and technology conflicts: only a few case studies can be found in the literature (Kartowisastro and Kijima, 1994; Nakagawa et al, 2010). This is arguably because the field of science and technology conflict has historically been dominated by the discourse of risk communication, and until recently there has been little exchange between the risk communication and problem structuring research communities.

Below, we argue that a traditional risk communication approach often limits the potential for dialogue between scientists and other stakeholders, including wider communities of concerned citizens. We suggest that approaches based on problem structuring principles offer more promise for conflict resolution and improved decision outcomes. In this light, we introduce a new problem structuring method, Issues Mapping. We outline its application in the context of a stakeholder engagement programme focused on dialogue around the development of genetically engineered (GE) organisms. We argue that Issues Mapping helps construct engagement differently, making it more dialogical than most forms of risk communication, and hence is more likely to produce fruitful outcomes in resolving science and technology conflicts. Therefore, it is not only the case that problem structuring is most effective in the context of dialogue (as argued by Franco, 2006), but also a good problem structuring method can *enhance* dialogue and improve the prospects for deliberation on complex problems.

3. Risk Communication

Risk communication is now regarded as integral to risk management; see, for example, the new standard ISO 31000 (Standards Australia/Standards New Zealand, 2009). Risk communication first emerged over forty years ago in response to what was seen as the gap between scientific knowledge and social perceptions of risk, and has traditionally been aimed at realigning 'lay' public responses to fit 'expert' technical assessments (Leiss, 1996; Fischoff, 1998; Morgan et al, 2002). Initially, the problem of social resistance to science and technology was constructed as a lack of knowledge on the part of the public. Communication responses were designed to overcome the 'deficit' in the public understanding of science, and thereby reduce risk aversion (Irwin and Wynne, 1996).

However, in the case of many new technologies (such as nuclear power, pest control and food irradiation) public aversion still remained. Promoting science and communicating technical information were found to be insufficient to change risk perceptions and enable acceptance (Slovic, 2000). New methods were called for to engage the public with scientific expertise. Two-way communication between 'risk proponents' and 'risk respondents' was then advocated as a more effective way of increasing public understanding and improving the information base available to decision-makers (National Research Council, 1989). A significant trend was the development of so-called 'dialogue methods', which involved the provision of scientific information and listening to public concerns (Renn, 1998). These methods, which do not usually involve modelling (and are therefore not problem structuring methods), were introduced to improve public trust in science and to reduce the level of conflict around key technology applications (Covello et al, 1988; Chess et al, 1989). 'Dialogue' is now being widely promoted in the field of risk communication to resolve conflicts between 'experts' and 'the public' around controversial health and environmental risks, notably in relation to biotechnologies and nanotechnologies (see, for example, Klinke and Renn, 2002; Renn, 2004; Wardman, 2008; Stebbing, 2009).

Exchanges involving two or more parties are commonly referred to as 'dialogue communication', but arguably this usage does not capture the full meaning and potential of dialogue as described by Buber (1958), Bohm (1996), Franco (2006) and others. *Instrumental* forms of engagement, which are primarily designed to support the smooth implementation of technology proposals, risk policies and/or regulatory decision making, are not truly dialogic. *Authentic* dialogue enhances mutual respect and understanding of the self and others, and can be *transformative* when it supports participants in their efforts to open up new insights and uncover deeper layers of meaning. It offers prospects for personal and even institutional change.

This form of dialogue facilitates the identification of a wider set of potential actions than were apparent prior to the dialogue commencing. Instrumental dialogue may offer the *promise* of meaningful engagement, but it prevents any questioning of the dominant framing of the risk being considered, and therefore reduces the scope for reflection and reflexivity. Instrumental approaches may also obstruct the consideration of alternative frames being employed by different stakeholders; inhibit the identification of the full range of issues and impacts relevant to a proposal; and limit the exploration of alternative strategies and technical options.

A key means by which risk communication approaches prevent the questioning of dominant frames is by assuming that scientists evaluate technologies using facts, while lay participants employ values and perceptions (Cook et al, 2004). This problematic assumption remains dominant in risk communication: see, for example, a recent report for the International Risk Governance Council (Renn, 2005). 'Understanding the facts' is considered the central activity in traditional risk communication, and this has two limiting effects. First, the perspectives of lay participants (assumed to be values alone) are effectively marginalized. Second, the values of scientists and policy experts (which inevitably exist) remain unexposed to scrutiny. Under these circumstances, it becomes virtually impossible to question the value-laden framing of issues that makes a particular fact relevant or not, and genuine dialogue orientated to mutual understanding is frustrated (Irwin and Wynne, 1996; Wynne, 2000).

We argue that problem structuring methods, particularly those that are applied with recognition of the value of authentic dialogue (Franco, 2006), may open up more opportunities for addressing science and technology conflicts than have been developed to date in traditional risk communication. As long as stakeholders are willing to engage meaningfully, dialogue has the potential to generate 'break through' experiences for participants in a risk dispute, even in the case of deeply controversial technologies such as genetic engineering (GE). Establishing a dialogic setting that ensures equal participation and voice for stakeholders (and hence the validation of multiple perspectives) can lead to mutual respect and improved understanding. Under these conditions, fresh insights into the issue may surface, including the emergence of new ways forward for its management. Below, we introduce Issues Mapping, a new problem structuring method that we argue can support and enhance dialogue.

4. The Context for the Development of Issues Mapping

By the early 2000s, the public debate around GE in New Zealand was widely seen as problematic and irreconcilable. In response to increasing social and political tension arising from both the GE debate and

other science controversies, the New Zealand Ministry of Research, Science and Technology (MoRST) funded a trial of dialogue methods in 2002-05. The Dialogue Programme (MoRST, 2005) was aimed at improving 'science and society' engagement and sought to move beyond traditional approaches to science communication predicated on promoting science and increasing scientific literacy amongst the public. It supported a series of dialogue interventions involving scientists and non-scientists in four regions of New Zealand.

In an applied social research project funded under this programme in 2003-04, Cronin and Jackson (2004) proposed that, even though the discussion between scientists and wider society around GE was difficult, and full agreement between stakeholders might not be possible, there were nevertheless opportunities to improve communication. Their research set out to engage scientists and community stakeholders who had an active interest in the development and use of GE biotechnologies. The aim was to involve participants with strongly divergent views to explore if new communication methods based on dialogue could reduce conflict and create improved understanding. Cronin and Jackson's (2004) report, *Hands Across the Water: Developing Dialogue between Stakeholders in the New Zealand Biotechnology Debate*, discussed their trial of adaptations of two established dialogue methods: Appreciative Inquiry (Cooperrider et al, 2003) and the Civil Conversation, developed by Rhonda Pritchard based on the US Public Conversation project (Chasin et al, 1996; Herzig, 2001; Pritchard, 2004). They also trialled a new problem structuring method called Issues Mapping, which is the focus of this paper (also see Cronin, 2007). Issues Mapping structures dialogue around visual representations (models) of the GE risk issue.

The *Hands Across the Water* dialogue project sought to contribute new insights into the way science and technology controversies could be managed. Cronin and Jackson's (2004) research was informed by the literature on public participation, environmental conflict resolution and risk communication, noting *inter alia* the work of Fisher and Ury (1983), Hammond (1988), Creighton (1992), Lofstedt and Frewer (1998), Wynne (1992, 2000), Jackson (2001) and Morgan et al (2002). The project assumed that science and society stakeholders in the New Zealand GE debate would be open to new forms of communication, and would be willing to move beyond risk conflict. This was premised on previous New Zealand research, including Cronin and Marchant (2002) and Hunt (2002), which had indicated significant potential for scientists to respond to public expectations of biotechnology, and for members of the public to articulate scientific concepts and questions. The intention was to create a meaningful space for dialogue.

5. The Theoretical Basis of Issues Mapping

Issues Mapping has been developed at the interface between theories of dialogue; theories of risk and risk communication (viewed in particular through a Science and Technology Studies lens); systems theory; and problem structuring. The effectiveness of Issues Mapping as a problem structuring method will be discussed in more detail later (Sections 10 and 11).

5.1 Theories of Dialogue

'Dialogue' features in many theoretical domains, including communications, human relations, conflict resolution, democratic theory and public relations; for an overview, see Anderson et al (2004). An important dimension of dialogue is *intentional listening*. As Wood (2004: xvi) explains, "genuine dialogue depends less on self expression and other transmissional aspects of communication, than upon responsiveness" to issues and worldviews other than one's own.

Early proponents of dialogue, including Buber (1958) and Bohm (1996), stressed the ability of this form of communication to transform both interpersonal and social relations. Authentic dialogue is intimate, interpersonal communication in which participants come to see parts of themselves in the 'other': it is a transformational process that enables participants to recognize their common humanity through a face-to-face conversation based on empathy and mutual respect. Dialogue therefore serves as a medium of exchange that can bring to the surface deeply held views and beliefs, grounded in community values (Habermas 1984). Gergen et al (2001) discuss the concept of 'transformative dialogue': a form of interchange that moves the parties from separate and antagonistic realities and practices to a relationship with common realities. They note that this requires relational responsibility, self-expression, coordination and reflexivity leading to what they refer to as the "collaborative construction of new realities" (Gergen et al, 2001, p.697).

Although we recognise the value of these theories of dialogue, we nevertheless question some of the assumptions in the earlier literature. For example, Bohm (1996) places great emphasis on the suspension of preconceptions. This sounds fine until we realize that it is only possible for an individual to interpret a communication from someone else by employing concepts with existing meanings (Weimer, 1979; Von Foerster, 1979; Von Glasersfeld, 1985; Maturana, 1988; Maturana and Varela, 1992; Gregory, 1992). Therefore, preconceptions are inevitable.

A related issue with some understandings of dialogue is the assumption that dialogue communication is completely free from the effects of power relations. Bohm (1996), Habermas (1976, 1984) and others talk about eliminating the effects of power. This is problematic because power relations do not only take the form

of one participant coercing another. Power can also be present in the form of the preconceptions discussed above, and these can be reinforced or challenged through the selection of the participants and dialogue setting, and the construction of the process used. Foucault (1980) explains how today's preconceptions may be established through historical power relations, and they may constrain what it is considered legitimate to say or do (also see Flood, 1990, and Brocklesby and Cummings, 1996, for discussions of the relevance of this to systems/OR). One commonly cited example is the privileged status accorded to scientific knowledge, which 'trumps' other forms of knowledge such as those that have been developed and used over multiple generations by indigenous people (Smith, 1999; McPhail, 2004). Often participants may not even be aware of the preconceptions, or assumptions, that they are taking for granted in a dialogue. Therefore, the critical point is that dialogue consists of open communication, free from the effects of *coercion* (rather than power in general), where all preconceptions are *in principle* available for scrutiny. In practice, however, it is not possible to scrutinize *all* preconceptions, and therefore eliminate the effects of power relations, because dialogue would have to be extended infinitely: every probing of preconceptions would involve the deployment of concepts based on further preconceptions, which would in turn need to be scrutinized, ad infinitum (Ulrich, 1983). A more reasonable indicator of dialogical engagement is that it enables explorations of *boundaries*: who should participate in discussions; what issues and forms of knowledge should be included, excluded or marginalised; and what values should drive processes of inclusion, exclusion and marginalization (Ulrich, 1983; Midgley, 2000). In other words, *a dialogue involves openness to reflection on the conditions that constitute it*, even if that reflection can never be comprehensive.

A third concern with some earlier ideals of dialogue arises around the need for facilitation. Bohm's (1996) dialogue method assembles a group of 20-40 people in a circle, normally without a facilitator or a topic, and allows the conversation to simply emerge. He proposes that a sampling of an entire culture can be achieved in a 'micro-culture' of this size, reflecting multiple views and value systems. Thus what he calls an "impersonal fellowship", involving authentic trust and openness, can develop in a group, even without the participants having a shared history (Bohm, 1996: x). More recent dialogue methods, including Issues Mapping, rely substantially on expert facilitation to overcome problems of dominance by some participants, and to maintain an etiquette of dialogue (Cronin, 2007): i.e. to foster mutual respect and affirmation, and to focus the discussion on questions of inquiry rather than assertions or 'win-lose' dynamics (Gergen et al, 2001).

We suggest that the most effective approach requires authentic, transformative and pragmatic dialogue. Such an approach, which allows for the facilitated questioning of taken-for-granted framings

without assuming that this will entirely eliminate power relations, fits well with the use of problem structuring methods. The latter are often deployed in 'real world' situations that impose constraints on the extent and duration of stakeholder and citizen participation. High quality problem structuring in the context of dialogue therefore involves critical reflection on these constraints alongside the mutual exploration of assumptions, leading to the identification of new ways forward for action.

5.2 STS Theories of Risk Communication

Issues Mapping draws on the above understandings of dialogue theory and is also informed by critical theoretical challenges to traditional risk communication coming from Science and Technology Studies (STS). For an overview of this field, see Hackett et al (2008). As noted above, the practice of risk communication has moved through several distinct phases: from the advocacy of expert 'risk assessments'; to analyzing and managing public 'risk perceptions' based on a deficit model (a belief that the public are simply ignorant about science and technology); towards engaging the public in two-way communication and 'dialogue'.

Issues Mapping was developed in direct response to the 'mental models' approach in risk communication advocated by Morgan et al (2002). This approach starts with experts defining the 'actual' risks of a technological proposal, and then these are contrasted with the 'perceived' risks of the lay public. The framings of the public are then modelled to identify where they deviate from the 'actual' risk data held by the experts. Finally, risk communication initiatives are used to overcome the gap between lay and expert assessments: i.e. to bring the lay assessments into line. In contrast, Issues Mapping assumes that both 'lay' and 'expert' stakeholders use mental models; both have social perceptions of risk, and develop assessments through a process of framing; and all views are relevant, although based on different premises (see Wynne, 2000, for further thinking on why these assumptions are more appropriate than the ones implicit in Morgan et al's approach).

5.3 Systems Theory

Also lying behind Issues Mapping is a systems theory of conflict, which explains how stakeholders with different framings stereotype each other's perspectives, leading to highly ritualized forms of conflict (Midgley, 1992, 2000; Midgley et al, 1998; Midgley and Pinzón, 2011). In the New Zealand GE debate, the participants had fallen into a set-piece conflict based on stereotyped views of 'scientists' and 'the public', which was amplified by the news media. This antagonistic communication was regarded by the

regulatory/policy sector as unavoidable, and policymakers also assumed that the actors and issues prominent in the public domain represented the full complexity of stakeholder concerns. In order to disrupt stereotypes of stakeholder positions and move beyond ritualized posturing, Issues Mapping does not assume that either 'lay' or 'expert' stakeholders form homogenous groups: rather, it seeks to reveal and access a diversity of viewpoints.

5.4 Problem Structuring

Most significantly, Issues Mapping involves problem structuring: models of the risk perceptions held by both technical experts and the community are developed and compared (details are in the next section). A total 'landscape' of the issues can then be generated, identifying areas of overlap and agreement as well as areas of disparity. This 'shared model' of the risk landscape is then fed back to participants as a basis for discussion and engagement. Risk communication is therefore transformed from a process of communicating *the* risks from scientists to the public (and seeking to realign community responses with expert calculations) into a process of facilitating dialogue between participants about *multiple meanings* attributed to risks.

6. The New Zealand GE Dialogue Case Study: Developing the Issues Mapping Method

Participant recruitment to the *Hands Across the Water* dialogue project (Cronin and Jackson, 2004) was targeted at key protagonists in the GE debate: i.e. GE scientists and members of community interest groups. It was decided to work with these key stakeholders rather than others (business, farming or 'the general public') because the ritualised conflict between 'scientist' and 'community' groups was widely perceived as central to the discourse in New Zealand society. Nevertheless, it was acknowledged that these were simplified labels: scientists were also members of the community, and many in the interest groups were also trained scientists. Several participants challenged these labels to avoid being given a narrow 'pro' or 'anti' association. It was explained that the terms were 'shorthand', and a diverse range of opinions was being recruited within each group.

Following discussion with key organizations in the science, government, industry and community sectors, and using the professional networks of the researchers, a total of 93 people were initially recruited into the project: 46 scientists and 47 community participants. The 'scientists' included those working on GE in the laboratory, or as programme leaders or managers in a range of universities, government research institutes and private companies. Their fields of interest included theoretical biology, food, medicine and agricultural applications of biotechnology. 'Community' participants included members of community

interest groups with concerns about the environment, Māori issues (Māori are the indigenous people of New Zealand), trade and development, safe food, health, sustainable agriculture and spiritual (including Christian) values.

Respondents were invited to take part as individuals rather than as representatives of their group, under strict conditions of confidentiality, and to present their personal opinions rather than the official policies of their organizations. This was important to ensuring that participants could contribute without direct reference to the formal roles and scripts that they had adopted in the public risk debate about GE.

Within the wider *Hand Across the Water* project, the Issues Mapping method was implemented in 5 stages, as outlined below:

1) *Gathering baseline information*. Telephone interviews were completed with a group of 66 respondents (29 community and 37 scientists) to generate preliminary information on their general views about biotechnology and the public debate about GE. Taken from the initial 93 recruits, this telephone sample comprised a representative mix of science/community participants, including Māori and non-Māori and men and women in public/private sector and community organisations, across New Zealand.

2) *Interviews*. In depth, individual, face-to-face interviews were held with 24 participants (12 scientists and 12 community) on their perceptions of GE generally; their views on the motivations of and their trust in other stakeholders; their views on the way the GE debate had been conducted in society; and their expectations for future engagement. Participants were asked to rank the acceptability of a range of GE applications, including 9 transgenic/non-transgenic applications; 10 possible end uses, such as agricultural and medical; and 8 containment-related applications, from strict laboratory containment to full scale field release. Respondents were also presented with 8 value statements related to the GE debate and asked which of these issues were personally at 'the heart of the matter' for them. The carefully worded 'heart of the matter' question was based on the approach originally used in the Public Conversations project (Chasin et al, 1996) and the Civil Conversation (Pritchard, 2004).

3) *Production of risk acceptance models*. A series of graphic representations was then created to illustrate the responses from the interviews (see Figure 1 below). The individual risk acceptance rankings were collected in Microsoft Excel and presented as bar graphs to show ranges of acceptance for the different GE applications on a three point scale: least acceptable, neutral and most acceptable. Responses were mapped for the full group of participants (n=24) along with contrasting models showing separate science and community rankings (Figure 2). Responses to the 'heart of the matter' question were collected in a concentric circle diagram, showing those matters which were most central and most peripheral to

respondents' concerns (Figure 3). Again, rankings were shown for the full group and for scientists and community respondents separately. This enabled participants to locate themselves in the discursive landscape alongside and in contrast to others.

4) *Issues Mapping Workshop*. A mixed group of 10 participants (5 scientists and 5 community stakeholders) took part in a half day workshop, led by an expert facilitator. Participants took part on a first name basis, and were not identified as 'scientist' or 'community' unless they chose to indicate their backgrounds during the discussion. Following the approach used in the Public Conversation method (Chasin et al, 1996; Herzig, 2001; Pritchard, 2004), participants were invited to focus on personal narratives relevant to the issue of GE, and were also introduced to some general ideas about dialogue. The focus of the workshop was to present the risk acceptance and the 'heart of the matter' models, and invite respondents to engage with each other about the results. The models illustrated areas of overlap/agreement and disagreement between the two groups of respondents. Seeing the total picture of the discourse created significant discussion about how the GE debate itself had been constructed and experienced by participants. Science and community participants were then invited to work in matched pairs to ask inquiring questions of each other (avoiding assertions and rebuttals) about their responses to the models and the issues that had been raised. An important component of the process was a shared sit down meal, half way through the workshop. This served to engage protagonists in closer proximity than they had experienced previously in the GE debate, and created a 'civil setting' for discussion which added to the atmosphere of respectful listening. Participants were lastly invited to consider what they agreed or disagreed on concerning the GE issue; the issues that were a priority for everyone, even if people took different positions on them; where there was common ground; and where they would like to see the GE debate going in the future.

5) *Evaluation*. Participants took part in a short evaluation discussion at the end of the workshop, and were invited to complete a final written evaluation form two weeks later. The research team and workshop facilitator also did a team evaluation after the workshop. The evaluation results are discussed in more detail below.

7. Process of Application and Illustrative Models

The risk acceptance and 'heart of the matter' models were not intended as a quantitative measure of risk perceptions. Instead, the aim was to highlight the narratives that emerged from the interviews and to re-present the issues back to participants in pictorial form. The purpose of the Issues Mapping process was, therefore, to use the images as a heuristic device to help participants 'see' where they were situated in the

wider debate and to support their engagement with others in the dialogue workshop that came next. Some details about how the Issues Mapping method was used are presented below, with selected models as illustrations.

Respondents were asked in the interviews to rank a series of real world GE technology examples on a continuum from the least to most acceptable. The following ten GM applications were presented to illustrate a range of end-uses for the technology:

a) Human gene therapy to treat a disorder that causes illness such as cystic fibrosis

b) Putting a synthetic human gene into the gene of a dairy cow, so that it is reproduced and can be extracted in quantities from the cow's milk.

c) Using a green fluorescent protein (say from a jelly fish) as a marker to make a mouse glow so you can tell that it has been genetically modified.

d) Changing part of a sheep gene, to increase the muscle growth in the sheep

e) Changing the genes in a white clover plant to reduce its vulnerability to viral disease

f) Putting another plant gene in broccoli or asparagus to increase its shelf life

g) Putting a fish antifreeze gene in strawberries to increase their shelf life

h) Putting another fish gene in the gene of a salmon to make it grow faster

i) Altering the genes of a microbe for pollution control (e.g. to take up heavy metals)

j) Putting a microbe called Bt in corn to work as a pesticide

The ranking results are presented in the graph below:

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Taken together, respondents indicated that the most acceptable examples were:

a) Human gene therapy to treat a disorder that causes illness such as cystic fibrosis

i) Altering the genes of a microbe for pollution control (e.g. to take up heavy metals)

e) Changing the genes in a white clover plant to reduce its vulnerability to viral disease

The least acceptable end uses were:

g) Putting a fish antifreeze gene in strawberries to increase their shelf life

h) Putting another fish gene in the gene of a salmon to make it grow faster

These rankings supported findings from the baseline interviews that human and environmental health uses are seen more favourably than purely commercial applications of GE.

The scientists generally found all uses of GE more acceptable than the community respondents, as shown in Figure 2. Importantly, the models showed where scientists' risk acceptance was higher or lower, and the contrasting rankings served to break the stereotyped view that all scientists were pro GE technology, and all community members were anti GE.

PUT FIGURE 2 IN HERE

The models served as an illustration to show the acceptance rankings among scientists and the community, where they disagreed and where they overlapped. These zones of commonality were significant: they demonstrated that the GM debate was not simply a division between 'science and society', but there were important areas where scientists and community respondents agreed. The areas of disparity were also significant. They showed where the conflict was most pronounced and provided a platform for discussing the issues face-to-face with others, in the context of a facilitated discussion.

In addition to ranking GE technology applications, respondents were asked to consider what issues were 'at the heart of the matter' for them personally in the GE debate. This question was deliberately worded to surface the normative elements in the discourse, and to provide a basis for sharing values with other participants. Drawing on the results from the baseline survey of respondents, eight key issues were listed that appeared to be common in the discourse about GE. These were:

1. *The environment*
2. *Māori culture and values*
3. *Food safety*
4. *Methods of agricultural production*
5. *Ethical and spiritual issues*
6. *Foreign investment in New Zealand*
7. *Public input to decisions on science and technology*
8. *Medicine and human health*

Each of these statements was put on a small card, and respondents were asked to locate them on a concentric circle diagram. Figure 3 shows the combined results for scientists and community respondents, and then some separate results can be found in Figures 4 and 5.

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Across all 24 respondents, including both science and community, *the environment* was the most central issue. The environment card was placed at the centre of the diagram 18 times. Looking at the next circle out, the issue most commonly located here was *Māori culture and values*. In the third circle out, *public input to decisions on science and technology* was the top issue.

There were significant similarities and differences between the science and community respondents on the relative importance of each of the 8 issues. The environment was equally central for both groups. As illustrated in Figure 4 below, this emerged as a significant new insight for both the scientist and community members (as well as the researchers).

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While the *environment* issue was the highest topic of common concern between scientists and the community, the issue that showed the most disparity between the two groups was *ethical and spiritual values*, as illustrated in Figure 5:

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Only 2 scientists regarded this issue as most central to them, whereas 10 of the community participants put it in the innermost circles. Scientists located this issue in every part of the circle diagram, showing considerable diversity within their group over the centrality (or otherwise) of ethical and spiritual concerns. This finding reinforced the comments in the baseline survey, indicating the differential framings of scientists and community participants around the GM issue. It also connects with the wider risk communication literature that discusses the importance of ethical values, and the limited opportunity for these to be considered in technocratic science and technology risk management procedures.

8. General Discussion of the Results

The project findings indicated an unexpected consensus between science and community participants around the importance of protecting environmental values and promoting sustainability. Across both groups there was reasonably strong support for medical applications of biotechnology, with less support for agricultural applications. In the dialogue workshop, it became clear that one of the shared values influencing risk acceptance or rejection was public benefit: medical applications were perceived to generate new

possibilities for health gains, making the risks more acceptable. In contrast, agricultural applications were perceived as providing little added value other than increasing private profit. In the latter scenario, the risks were more likely to be perceived as outweighing the benefits. The science and community groups both showed greater risk acceptance for contained research than for field tests or full release of genetically modified organisms. Community respondents, however, tended to regard ethical and social issues as more central to the GE issue than did scientists. Regarding their experience of the GE debate in New Zealand society, both groups had concerns about a conflict-based approach to communication, which they saw as being exacerbated by news media reporting and adversarial discussion formats. Most were able to identify positive motivations behind the involvement of others in the issue. There was common recognition of the increasing commercial pressures on scientists in the modern knowledge economy.

Overall, the two stakeholder groups were able to achieve common ground while recognizing some areas of disagreement. This not only provided a welcome shift from the kind of discussion they had experienced previously, but also suggested areas for future policy consensus and socially acceptable technology innovation: for example, focusing on GE technologies in containment and for medical applications, rather than on full scale field releases of GE crop applications (also see ESRC Global Environmental Change Programme, 1999). Participants found that a dialogue setting allowed them to move out of the entrenched positions they normally occupied in the public domain. They also indicated a strong preference for using these forms of communication in the future, and for scientists to be more responsive to the social context of their work.

9. Evaluation

The Issues Mapping method was evaluated by participants after the workshop (all 10 participated in the evaluation discussion and 7 returned questionnaires). Respondents appreciated meeting face-to-face and getting to know each other, and saw value in the non-confrontational dialogue approach because of the way it dissolved stereotypes of scientists and community members. There was positive feedback on the process: e.g. asking inquiry questions in pairs and using active listening skills (writing down what their partner had said and reading it back to them). When asked what surprises the workshop held for them, participants noted:

"The amount of agreement between the two groups."

"The absolute non-existence of any apparent 'conflict' or 'judgementalism'."

While a few participants felt that the process was limited because they had not changed the views of others, most were positive about the dialogue process including "the willingness of people having 'set' ideas to communicate with others." When asked whether the dialogue experience had changed the way they were engaging with others in the debate since the workshop, there were several positive responses including:

"I am probably a bit more cautious and don't assume anymore that all scientists are pro GE, but my own views have not changed on the subject."

"Perhaps I am more interested in ascertaining the underlying values of other people."

"I am careful to listen more and see the strengths in all the arguments and gently challenge the things I think are wrong."

The research team also prepared an evaluation of the entire *Hands Across the Water* research programme, within which Issues Mapping was one of three methods tested. This indicated strong potential for dialogue methods to reduce conflict around the biotechnology debate. Some of the key learnings from the programme are summarized below.

At the time of Cronin and Jackson's (2004) work, the social discourse on GE in New Zealand, as elsewhere, was being widely constructed as a conflict between 'science' and 'society', with homogeneous values and expectations within each sector and a wide divide between the two. It was often characterised in polemical terms such as:

- Rationality versus Emotion
- Facts versus Fears
- Experts versus Public
- Progress versus Obstruction.

'Science' and 'scientists' were constituted as institutional agents unquestioningly in favour of GE technology. 'Science' was said to be synonymous with evidence, logic and fact. To be in favour of GE was to be in favour of science, and to be against GE was to be against science. Reflecting this framing, before the dialogue intervention we recorded comments from scientists such as:

"I support research in GM. That's what science is all about, and progress."

"People object because they don't fully understand the technology."

"There are a lot of fears."

Comments from the community included:

"[I am] passionately against the release and use of GE in the environment, humans and animals."

"… it always harms the environment, and it's only there to make money for unscrupulous chemical companies."

The GE debate had been experienced as a discourse of polarization and conflict. In their initial interviews, participants observed:

"Both sides abuse each other and don't want to get to a position [of agreement] – they are holding onto dogma" (Scientist).

"There is an over-reaction on both ends, and it's not profitable for anyone" (Community).

The Issues Mapping process (as part of the wider *Hands Across the Water* dialogue research project) set out to explore what lay behind these apparently intractable positions, to find ways to reach across the divide, and to establish areas of commonality and opportunities for ongoing engagement and exchange. We found that, even in a short time period (the half-day Issues Mapping workshop), considerable progress could be made in moving the discourse from competitive debate into dialogue (see Tannen, 1998, for a discussion of the distinction between these two terms). Key comments from participants after the Issues Mapping workshop included:

"We had things in common!"

"We could put a boundary [around areas of acceptability and unacceptability] and it was the same."

"When I looked at the original questions I had posed [in the interview] I was appalled!" [This participant realized that they had largely made statements instead of asking inquiry questions.]

"We need to put the debate into a room where people can engage with each other."

"A valuable insight was the finding that we really make initial assumptions and these shape our interactions with others. Defeating that might help achieve a more tolerant discourse."

"How can we grab this process before the next big debate?"

While not originally intended as a decision-making process, the Issues Mapping method not only achieved a reduction in risk conflict but also opened up the prospect for enhanced risk decision making. Participants found that they could identify a number of areas of common ground on policy matters, including:

- The benefits of reducing the use of pesticides and herbicides.
- That there was likely to be greater acceptance of GM when it provided benefits to human health.
- Other technical alternatives need to be looked at first, before using GM as a 'quick fix' for problems.

- There is a need for greater research on the effects of GE, particularly horizontal gene transfer, and effects on health and food.
- We can never guarantee 100% safety with any technology.

Reporting the overall *Hands Across the Water* project findings to MoRST, the authors' conclusions on the Issues Mapping method were:

- The dialogue workshop was not as polarized as other experiences when people had engaged with each other in the public domain, and as depicted by the news media.
- Traditional stereotypes of 'scientist' and 'community' values and risk preferences did not always apply, and indeed could be substantially challenged through the Issues Mapping process.
- There was significant common ground across stakeholder groups: for example, both scientists and community interest groups placed a high priority on the environment.
- The stakeholder groups nevertheless differed over the centrality of ethical and spiritual issues, but instead of being dismissive of other perspectives, were able to hear about and respectfully acknowledge them in the context of the Issues Mapping process.
- Both scientists and community stakeholders wanted better forms of dialogue in the future, and more information from each other and from the government.

The entire MoRST Dialogue Programme (in which *Hands Across the Water* was one of four projects) was also evaluated by an independent review panel. They concluded that dialogue

> "increases transparency in the science process and can advance critical inquiry. Because more viewpoints are involved, there is more potential for new positions on any research problem to emerge. Dialogue to improve understanding among those occupying different positions on controversial issues reduces the level of unproductive conflict" (Winstanley et al, 2005: 5).

In summary, our observation is that, in its first trial, Issues Mapping succeeded in its aim of moving stakeholders beyond the entrenched conflict that had characterized science and society relations prior to the intervention. While it is important not to make exaggerated claims for a method based on a single case study (Midgley et al, 2007), we nevertheless agree with the view expressed in the independent evaluation (Winstanley et al, 2005) that Issues Mapping, along with the other dialogue methods trialled in the *Hands Across the Water* research programme, shows promise as a problem structuring method to address a wider range of science and technology risk conflicts than the GE debate alone. Further applications (Cronin and Midgley, 2010; ESR, 2011) will test whether this promise can be realized.

Having presented Issues Mapping and its application in the context of the New Zealand GE debate, we will now engage in two reflections on the strengths and weaknesses of Issues Mapping as a problem structuring method. First, we will examine its use of models as heuristic devices. Second, we will look at how this application of the method connected with organizational decision making on GE technologies. The latter reflection will point the way to an important area for further research.

10. Issues Mapping as a Problem Structuring Method: the Use of Models as Heuristic Devices

The use of models was pivotal in the intervention: both the 'heart of the matter' and the risk acceptance models clarified values and issues of risk acceptance/aversion in a manner that structured the stakeholder dialogue and enabled a focused, mutual inquiry. Nevertheless, we follow Franco (2011) in observing that the Issues Mapping approach to developing and using models is not typical of all problem structuring methods. Many applications of problem structuring methods involve the refinement of models in the workshop context by the participants. Therefore, the development process is fully participative, which is said to be important in facilitating stakeholder commit to any emerging new understandings or proposals for action (Ackoff, 1981). In contrast, the Issues Mapping approach develops models from prior interview data and brings them fully formed into the workshop context.

Having said this, there is still a substantial element of participation in the development of the models, in the sense that the models are a combination of the individual participant interview responses. We also note that the workshop participants are drawn from the set of interviewees, so they know that their previous inputs have contributed to the construction of the models and do not view these models as an 'alien' imposition on the dialogue. This is similar to the construction of models in some applications of soft systems methodology (SSM). Checkland (1996) clarifies that approximately 50% of SSM applications involve the researcher in developing all the models following interviews (also checking back with the interviewees to ensure accuracy). Hybrid approaches are also possible: for instance, Boyd et al (2004) developed a set of rich pictures following interviews with homeless children and then facilitated dialogues with agency representatives and children to develop models of (and ultimately proposals for) desirable new services. The rich pictures themselves were not changed through the dialogues, but were nevertheless very useful starting points for multi-agency engagement in more participative forms of modelling.

Clearly the Issues Mapping models had value as heuristic devices in the application described in this paper, even though they were not revised by the participants once they were brought into the workshop context. This suggests that there is no 'one best way' to develop and use models in problem structuring. The

important thing is that they have a heuristic role, providing a focus for stakeholder learning. Essentially, it was not the *models* that changed in the Issues Mapping workshop, but the *understandings of the participants*: the models helped the participants to position their own personal perspectives in relation to the diverse 'landscape' of other perspectives, and they developed an appreciation of the common and divergent values underpinning their positions on GE.

11. Connecting with Decision Making

Having argued that a key strength of Issues Mapping is its use of models as heuristic devices to enable stakeholder learning, we should also look at the connection between this case study of dialogical problem structuring and organizational decision making (especially in relation to government policy).

It is common to find that establishing a strong connection between a specific intervention and decision making is problematic due to the complex array of factors that may impact on a decision, including but not limited to the intervention (Duignan and Casswell, 1989). However, in this case the issue is further complicated by the political dynamics that surrounded the commissioning and framing of the original *Hands Across the Water* research and the wider MoRST Dialogue Programme, of which it was a part. These dynamics are described in detail by Cronin (2008), but essentially there was a step-by-step shift in the discourse of MoRST (the commissioner) from an initial recognition of the need for dialogue to inform central government policy making, to a focus on enhancing individual scientists' communication skills in their interactions with local communities. Issues Mapping was very successful in terms of reducing interpersonal conflict between scientists and the community, but additionally it highlighted the potential of dialogue as an institutional practice to inform science policy and risk regulation. Participants in the Issues Mapping workshop commented that it not only helped to promote better mutual understanding, but both scientists and community participants also saw the value of continued dialogue to prevent the emergence of future unproductive science and society conflicts and, importantly, they found that new common ground on policy matters could be identified.

This emergent deliberative potential, arising from a relatively limited dialogue experiment, was a surprise to the participants, the researchers and those who commissioned the wider dialogue programme in MoRST. In their independent review of the four projects funded under the programme, Winstanley et al (2005) recommended that MoRST include dialogue strategies in the development of future public policy for science and technology. As it happened, neither this recommendation nor the original aim of the programme of informing central government policy were realized, as the Ministry set about revising its framing of the

research after it was commissioned. Commenting on this experience, Cronin (2008) notes that the revision reflected a political movement away from experiments with deliberative democracy in central government to "the privatization of public talk" (p.285): scientists were encouraged to undertake stakeholder engagement largely at a local, interpersonal level. Meanwhile, at the national level, Cronin suggests the government chose to deprioritise dialogue in favour of a declared policy of "aggressively" promoting the biotechnology sector in order to "keep abreast of developments", build capacity, fund research, promote investment and commercial growth, foster global linkages and ensure a workable regulatory regime (New Zealand Government, 2003).

Interestingly, subsequent interviews with senior civil servants in MoRST (conducted after the *Hands Across the Water* project), suggested that they were unable to recognise that there had been a disconnect between dialogue and decision-making (Cronin, 2007). In these discussions, the civil servants showed little insight into the fact that the reframing of the research (driven by the policy goals of politicians) was instrumental in severing the link with decision making in central government.

This experience clearly points to the need for further research on how dialogue methods, such as Issues Mapping, can be most effectively connected with decision making by science organizations, industry and government. To this end, two of us are now working with other colleagues on a new intervention using the Issues Mapping method, funded by the Foundation for Research, Science and Technology (the main New Zealand state funder of public good science) (Cronin and Midgley, 2010; ESR, 2011). This new project is engaging science, industry, government and community stakeholders to consider a variety of biotechnology, nanotechnology, nutrigenomic and sustainable agriculture applications to food production. At the time of writing, we are in the middle of facilitating a series of Issues Mapping workshops in three cities (including a Māori-specific workshop), to engage participants in dialogue on risk acceptance and 'heart of the matter' models that have been developed from interview data generated earlier in 2011. Following the workshops, participation will focus on two organizations that want to integrate these dialogue outcomes into their strategic decision making on investments in new science and technology: one science organization specializing in food applications, and one industry that uses some of the technologies that the science organization generates. The idea is to undertake a systemic intervention that feeds the outputs from Issues Mapping into a problem structuring workshop with key strategic decision makers to look at the implications for their investments and future innovation pathways. This workshop will be designed creatively in response to an analysis of the decision making context (Midgley, 2000), and is likely to draw on modelling methods from well established problem structuring approaches, such as Strategic Choice (Friend and Hickling, 2005),

Soft Systems Methodology (Checkland and Poulter, 2006), Strategic Assumption Surfacing and Testing (Mason and Mitroff, 1981) and/or Strategic Options Development and Analysis (Eden and Ackermann, 1998). Thus, we will be testing the proposition that Issues Mapping can be more effectively connected to decision making by:

1. Focusing on the implications for strategic investments early in the innovation cycle, before organizations have gone so far with a technology that they cannot afford to change direction (also see Burgess and Chilvers, 2006; Pidgeon and Rogers-Hayden, 2007; and Doubleday, 2007), and
2. Taking a 'pluralist' or 'multi-methodology' approach (Jackson, 1987b; Mingers and Gill, 1997; Midgley, 2000), which involves mixing methods in response to analyses of stakeholder purposes and the contexts in which they are engaging.

12. Conclusion

At the time of the *Hands Across the Water* dialogue project, the GE issue was widely seen as an entrenched and irreconcilable conflict between scientific 'facts' and social 'values'. This interpretation had been used to prioritise and justify particular policy options, especially a reliance on regulatory risk management, and had given rise to a preference for managing the public discourse around GE through conventional risk communication procedures. The dialogue project proposed, however, that there was potential to break through that conflict and generate new understandings. It assumed that the positions adopted by participants in the debate, including their views of the technology and its ecological, social, economic, cultural and spiritual impacts, reflected the mental models of participants (informed by their values, interests and experiences).

The application of the Issues Mapping method, first developed during the *Hands Across the Water* project, demonstrated that it was possible to change the tone and content of the discussion and thereby deconstruct the mental models that participants were using. It introduced a *transformative* dialogue element, inviting participants to think about the representations of other participants and to become more aware of the processes that had led to their own constructions of the issue. It also provided an opportunity to reflect on the wider dynamics underlying the construction of the GE debate in the public sphere.

Problem structuring methods, such as Issues Mapping, allow for the representation of key actors and issues involved in a risk conflict; enable a wide range of perspectives to be articulated and appreciated; and encourage participants to see the issue in the round rather than simply from their own point of view. The use of models as heuristic devices is critical to this, as the models help participants visualise their own

perspectives in relation to those of others and thereby enable better mutual understanding. Compared with conventional risk communication methods, Issues Mapping and other problem structuring methods provide an opportunity for a wider range of impacts and possible solutions to be considered.

However, these benefits can only be realised if the method is used in the context of authentic and transformational dialogue. Dialogic communication has the potential to open up deeply conflicted risk disputes so participants can identify areas of common ground. It is based on bringing people together in a respectful, private conversation, away from the pressures of risk politics conducted in the glare of public controversy. In this sense, dialogue can be personally transformative for participants; and it can be transformative of societal risk discourses, and potentially of policy discourses too.

Problem structuring, using Issues Mapping or any other method, is unlikely to enable productive outcomes if 'dialogue' is approached instrumentally (manipulated to prevent challenges to dominant framings) rather than authentically; is used for public relations (the management of public opinion) rather than individual and organisational learning; is focused solely on tactical rather than strategic and normative issues; is conducted after key decisions have already been made; or is set up to create an illusion of participation while protecting the real decision makers, outside the room, from exposure to challenge. It is the latter problem that we have encountered in the New Zealand policy domain (Cronin, 2008), and it is still an open question in New Zealand and elsewhere as to how much dialogical problem structuring will be used in central government policy and regulatory settings. We believe, however, that there is significant potential for using such methods to support decision making in science and industry, as organizations in these sectors are becoming increasingly aware of the importance of incorporating stakeholder values into strategy. It is also the case that many governments across the world are searching for workable approaches to deliberative democracy. We believe this provides a significant opportunity for applying dialogic problem structuring methods to aid statutory governance.

The door is open for enabling engagement between science and industry organizations and their external stakeholders to improve innovation outcomes, which is where our current research is focusing (ESR, 2011). There are increasing calls for moving dialogue 'upstream' in the innovation cycle: i.e. enabling dialogue before organizations have invested so much in a new technology that they cannot afford to change strategic direction. The challenge now is to capitalize on the first experimental success with Issues Mapping and to further develop it as a *deliberative* process, by adding other problem structuring methods to involve the public and interested stakeholders in the upstream assessment and selection of future science trajectories. A greater challenge is to move engagement even further upstream to impact on the *formulation and design*

of new technologies that will achieve more widely acceptable technical, economic, environmental and social outcomes. The democratization of science and technology decision making represents a tremendous opportunity for those interested in Issues Mapping, and also for the problem structuring research community more generally.

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