Expertise revisited II – Contributory expertise

Harry Collins, Robert Evans and Martin Weinel

Centre for the Study of Knowledge Expertise and Science (KES)
School of Social Sciences
Cardiff University
Cardiff CF10 3WT
UK

Corresponding author
CollinsHM@cf.ac.uk
+44 (0)2921409637

Abstract

In Part I of this two part paper we tried to elicit the 'essence' of the notion of interactional expertise by looking at its origins. In Part II we will look at the notion of contributory expertise. The exercise has been triggered by recent discussion of these concepts in this journal by Plaisance and Kennedy and by Goddiksen.

Keywords

Interactional Expertise; Contributory Expertise; Technical Phase; Political Phase; Policy

1. Introduction

This is the second part of a two part re-examination of the concepts of interactional expertise and contributory expertise (Collins and Evans, 2002, 2007; Collins 2004a). We will refer to the first part of the re-examination (Collins and Evans, 2015), as 'Part I'. In Part I, we revisited the concept of interactional expertise (IE). In this part, 'Part II', we are concerned with contributory expertise and the broader question of who can contribute in which ways to technological decision-making in the public domain.

2. Who contributes?

We start our discussion with a brief mention of the relationship between interactional expertise (IE) and contributory expertise (CE), pointing out unsolved problems. We then set out the difference between political and technical phases of a technological decision and examine the ways in which they interact with each other; this is important if the various ways of contributing are to be understood.[1] The main exercise, which is an attempt to describe, exhaustively, all possible ways that experts and citizens can contribute to these two phases,

[1] The distinction between technical and political phases is developed at length in Collins, Weinel and Evans 2010 and 2011 as well as here.

starting with the technical contributions and finishing with the political contributions, is set out in several separate sections and tables in the middle of the paper.

Along the way we examine earlier work and introduce a number of new terms to clarify ideas and highlight new distinctions that have emerged since the publication of the original 'Third Wave' paper in 2002. These new terms include, 'target expertise', which refers to the set of technical expertises implicated in a technological decision; a special term is necessary because the target expertise can be different under different perceptions of the nature of a dispute. This leads to a related distinction between political framing and technical formulation that highlights the two different ways in which the relevant target expertise might be changed. We also clarify the notion of referred expertise showing that it is really two things: technical referred expertise and referred discrimination. Finally, we include some terms first introduced in Collins and Weinel (2011) such as 'domain specific discrimination' and 'sociological discrimination', which may be unfamiliar to those who take their categories from the original Periodic Table of Expertise (Collins and Evans, 2007).

The attempt to generate an exhaustive list of ways to contribute is triggered by the argument of Plaisance and Kennedy (2015 – hereafter, PK). They propose that the concept of interactional expertise should be softened so that it can legitimate the ideas of ordinary citizens who want to intervene in the technical phase of public domain decisions. In Part I, we argued against a definition that would enable the mere invocation of the concept to legitimate such interventions. This would exacerbate the very 'problem of extension' (Collins and Evans, 2002, 2007) that the idea of interactional expertise was meant to ameliorate. We also argued that, in any case, interactional expertise was only rarely relevant to such interventions. We now want to work out what rights and expertises can be brought to bear on technological disputes in the public domain so as to avoid misplaced uses of the

concept of interactional expertise. More positively, we want to show how the wider programme known as Studies of Expertise and Experience (SEE) can support contributions to the technical phase based on many different kinds of expertise while also encompassing contributions within the political phase. We hope this will create a more complete analytical context for projects such as that of Plaisance and Kennedy.

2.1 When does practice end and linguistic discourse begin?

The arguments of both PK and Goddiksen (2014; Galindo and Duarte, 2015), arise, in part, out of problems of definition. A clear problem is that interactional expertise is in part understood through its transitive relationship to contributory expertise (CE) – the ability to contribute to an area of practical accomplishment. The boundary between IE and CE has been troublesome from the start, conceptually if not practically, because not all expertises appear to have a practical component. Thus we still have not fulfilled the promise to resolve the difference between IE and CE in cases such as literary criticism. Another example is peer-reviewers and committee members who are understood to be primarily interactional experts but clearly contribute to the technical domain.[2] We still do not know the answer to this kind of question but perhaps it is one of those borderline problems that are philosophically irritating but which do not pose any serious real world problems: there is nothing pressing that we do not know how to handle as a consequence of not having a clear borderline while there is much that we can handle as a result of having a distinction between interactional and contributory expertise. Perhaps there is a solution out there somewhere.

[2] We leave out managers because they are a more complicated case

2.2 The distinction between political and technical phases

Technological decision-making in the public domain can be analysed as consisting of two phases: the technical phase and the political phase. These are not ordered sequentially but refer instead to two different aspects of the overall problem. In the technical phase, the emphasis is on the production of knowledge about the world. In contrast, the political phase is concerned with questions of preference and priorities. Some of the key differences between the technical and political phases are summarised in Table 1 below, which is reproduced from Collins and Evans's, 2002, 'Third Wave' paper.

		PHASE	
		Political	**Technical**
NATURE OF	**Politics**	Extrinsic	Intrinsic
	Rights	Stakeholder	Meritocratic
	Representation	By Survey	By Action
	Delegation	By proxy	Impossible

Table 1: Characteristics of Political and Technical Phases

The first row indicates that in the technical phase political and other influences on results should be eliminated as far as possible. We know from Wave 2 of science studies that political influences on scientific results can never be avoided but, while there will always be *intrinsic* influences, they should never be *extrinsic* – that is celebrated or otherwise endorsed. To make political influences extrinsic is to negate the form-of-life of science.[3] The second row of the table indicates that in the political phase contributions to the outcomes of technological debates in the public domain can be justified if the parties have a stake in those

[3] Though we agree with Heather Douglas (2007, 2009) that science cannot be value free in any absolute sense, we think she may not have given enough consideration to some of the problems of extending technical judging rights to the citizenry – See Collins and Evans, under submission.

outcomes – fairness within a democratic process is the criterion of inclusion -- whereas in the technical phase participation can only be justified on the ground of relevant expertise or experience (i.e. merit). The third row indicates that political contributions can be represented by surveys or votes by those who have a stake in the matter whereas technical contributions are intrinsic to the person of experts because of the way they must continually respond to the details of changing circumstances to which the non-expert population has no access. The final row follows from this in that a political actor can employ someone else to act for them and represent their position whereas an expert cannot ask someone else to take their place unless they are equally expert.

In subsequent publications (e.g. Evans and Plows, 2007; Weinel, 2010; Collins et al., 2010) the relationship between technical and political phases has been set out in more detail, although the core principle that, in a democracy, the political phase should always take priority, remains unchanged. Instead, the developments have led to a richer understanding of how the focus can switch from political phase to technical phase and back again. Thus, for example, we now distinguish between 'upstream mediating' processes through which political concerns and preferences become formulated as technical questions that require expert analysis and 'downstream mediating' processes through which the outcome of this expert analysis is used to inform policy outcomes. When receiving expert advice the defining feature of SEE is not that that such advice must be followed – that would be technocracy – but that the nature and strength of the consensus that informs that advice must not be misrepresented by policy-makers. In other words, policy-makers or citizens do not have to heed expert advice but they should not pretend that such advice does not exist or that is something other than it is.

In Part I we saw one way the distinction between technical and political phases could be applied when we imagined that strong fluxes of gravitational waves, the existence of which has been rejected by the technical community, if combined with the effects of living near power lines might cause cancer. We agreed that this could change the way previously rejected claims were assessed but this would not be a change in the technical phase – the likelihood of the existence of strong fluxes would remain the same and would continue to justify their rejection as far as decision-making within the technical community was concerned. But a change in the political phase would be invited – something very unlikely, according to the scientists, might have to be taken more seriously by those with political responsibility. Keeping the two spheres separate resolves the problem that the *technical* judgements within the esoteric world of gravitational wave physics could become affected by power-line scares. We know, of course, that esoteric judgements can be affected by political judgements but we still need to make the distinction in order to hold the position that these affects should never be extrinsic, only intrinsic, and that it remains the duty of scientists to strive to try to exclude political influence on their *technical* decisions, redoubling the effort if they become aware of such influence.[4]

We now begin the exhaustive listing of ways to contribute to technological decision-making. We start with contributions to the technical phase that are made via interactional expertise in the target domain. These are summarised in Table 2.

[4] This imperative contrasts starkly with those who argue that since political influence is unavoidable it should be endorsed and embraced (Scott, Richards and Martin, 1990; Collins, 1991; Martin, 1994; Collins, 1996). See also footnote 3.

BASIS	DESCRIPTION	COMMENT
Contributory expertise	The standard meaning of technical expertise; the contributory expert will also be an interactional expert.	Traditional technical expertise
Technical Formulation	Determining the boundaries of the 'target expertise' to include those with relevant experience based on a technical understanding of what factors need to be considered.	Often brings in experience-based expertise and may add non-traditional technical expertise to more traditional scientific expertises when technical phase includes problems of application.
Special Interactional expertise	The special interactional expert is invited to contribute in virtue of their technical understanding of the domain	In principle, quite similar to traditional technical expertise but rare in practice given the importance attached to accountability of decisions.
Domain Specific Discrimination	The use of ''non-technical'' expertise by technical experts to judge their fellow experts and peers	Embedded (latent) in both interactional and contributory expertise
Sociological Discrimination	The application of the specialist skills of the expert social analyst to discriminate among technical choices (e.g. the identification of a 'false controversy')	Usually needs deep understanding but formal metrics are accessible without interactional expertise (e.g. citations, impact factors) might make a contribution
Technical referred expertise	The application of specialist expertise from another domain that requires interactional expertise in the new, target domain if the transfer is to succeed	The technical expertise from the source domain is conceptually integrated with the technical expertise of the target domain.

Table 2: Ways of contributing within the technical phase that require interactional expertise

2.2 Technical phase contributions via interactional expertise.

Contributory Expertise: The most straightforward way to contribute to the technical phase is via a relevant contributory expertise – line 1 of Table 2. Here an expert uses their expertise to contribute to the domain to which their expertise pertains. Where the target expertise includes a number of different domains of contributory expertise, then some means of sharing

expertise between the different practice languages will be needed. Here we assume that interactional expertise provides the solution to this problem, though other outcomes are possible (see Collins, Evans and Gorman, 2007).

Technical Formulation: Technical formulation, which is found in the second line of the table, is a new category that is needed to disambiguate the different elements of upstream mediation. Technical formulation concerns the identification of the domains of expertise which are needed to address the technical question and belongs within the technical phase. In contrast, *political framing* (discussed under heading 2.6, below) refers to the process by which the questions addressed by the technical phase are set and prioritised. The difference between technical formulation and political framing is that once a problem is defined by political actors (i.e. political framing), the decisions about which domains of expertise are relevant (i.e. technical formulation) ought to be made by technical experts.

The need for such a distinction can be illustrated by the case of the Cumbrian sheep farmers. They, as the story is told, possessed a body of technical expertise that was relevant to the post-Chernobyl management of sheep. Their expertise, however, did not seem germane to the certified scientists who formulated the problem as something like 'the half-lives of radioactive isotopes and their interactions with soils and vegetation'. In practice, of course, this formulation did not include all the relevant expertises and a more inclusive technical formulation that would have included the farmers was needed – something like 'the ecology of sheep farming on radioactive pastures'. To grasp the technological scope and boundaries of a problem requires technical experts; it is not a matter of ideology or vested interests.[5]

[5] We are assuming here that no one wanted the sheep to stay radioactive any longer than necessary for political reasons (e.g. to further marginalise a traditional rural community in order to promote new industries like

That said, it is clear that there can be a relationship between political framing and technical formulation. For example, political framings that privilege economic interests such as job creation over concerns around health or wellbeing will lead to different technical formulations. On the other hand, the power and influence of some sections of the scientific community means that it sometimes takes determined political action to create the conditions needed to demand a technical reformulation that includes new and more diverse forms of expertise.[6]

Finally, political framing and technical formulation can be confused because political actions are sometimes presented as if they were technical claims. This is exemplified by the controversy over the Brent Spar oil rig.[7] Though all parties to the technical debate ultimately came to agree that it would have been ecologically more sound to have disposed of the Brent Spar at sea, it is possible to argue that the campaign to prevent this, and which led to it being disposed of on land in an an ecologically more damaging way, reduced the legitimacy of disposals at sea in general. Reducing the incidence of disposal at sea in order to protect the marine environment can be presented as a technical aim – pollution levels will be lower – but it can also mask a moral, or quasi-religious motivation, based on the 'purity' of the sea which cannot be countered by technical arguments.[8] For example, should it turn out that oil-rig disposal at sea would benefit fish populations by providing safe havens from nets and new

---

tourism). In these circumstances, not including the farmers was a technical mistake and not a deliberate political act.

[6] In our view Epstein (2009, 2011) confuses the two; he is correct in pointing out that the AIDS treatment testing regime would not have been influenced by the views of the community of sufferers without their political activism but the outcome was technical reformulation not political reframing.

[7] Collins, Weinel and Evans (2010)

[8] From the quasi-religious viewpoint, estimating the benefits that might accrue from disposal of oil rigs is akin to conducting a cost-benefit analysis of torture techniques.

sources of nourishment for marine life, it would make no difference because the sea would still be 'polluted' by oil rigs. None of this is to deny that 'purity' of this kind is a perfectly legitimate political aim; the point here is simply that it should never be disguised as a technical matter.[9]

The question, as always, is who decides? In the case of political framing it is a matter of the normal political process but what about technical formulation? Who is the body of experts who chooses the experts? The examples of AD-X2, Laetrile and the MMR vaccine all suggest that lay people and/or politicians cannot be relied upon to get it right, but the sheep farmer case, along with many other examples of boundary work examined by STS, show that the experts cannot always be relied upon either. Who, then, is best placed to make what is essentially a technical judgement? The answer has to be a combination of contributory experts from within the target domain supplemented by suitably informed, expertise-minded, social scientists. Elsewhere we refer to such a groups as 'The Owls'; they are chosen for their ability to explore reflexively the problem domain and its constituent parts.[10]

Special Interactional Expertise: Returning to Table 2, row 3 is 'special interactional expertise'. Special interactional experts are individuals who possess no practical expertise of direct relevance to the domain but who we can imagine being able to make credible, and even

---

[9] See Huxham and Sumner 1999 for discussion of fish populations and other relevant features of Brent Spar debate. There are, of course, other examples in which such 'quasi-religious' moral positions are used to preclude certain kinds of research. Examples include: eugenics; nuclear weapons testing, certain kinds of medical research and the production of genetically modified organisms for food.

[10] 'The Owls' idea is developed in 'Elective Modernism' (Collins and Evans, under submission). The Owl metaphor begins with Richard Feynman's claim, or supposed claim, that scientists need philosophers like birds need ornithologists. Extending his bird metaphor, Owls are wise birds that a capable of turning their heads to look in opposite directions, both at sociological aspects of science and technical aspects. Though most scientists, as Feynman was effectively pointing out, do not understand how science works -- they understand only how to do it -- a few can look in both directions. There are also some social scientists who can look in both directions.

creditable, contributions to, say, specialist scientific committees tasked with discussing the future of a specialist technical domain. As discussed in the context of the Barish/Collins argument (see Part I), however, in many circumstances the purely interactional expert will not and should not be in a position to exercise the power that goes with the responsibility of the corresponding professional scientists.

Domain Specific Discrimination: Row 4 of Table 2 is domain specific discrimination. This is the ability, acquired through socialisation in a specialist technical domain, to make social judgments between the scientists belonging to the domain and transmute those judgments into technical judgments. This is what scientists do to close disputes, break the experimenters' regress, and so forth. Though Collins and Evans, 2007 does not formally distinguish this ability from 'local discrimination', a footnote in that work (p50, fn. 10), provides a range of examples of social criteria that gravitational wave scientists use to judge the worth of experimental results obtained by colleagues:

> Faith in experimental capabilities and honesty, based on a previous working partnership; Personality and intelligence of experimenters; reputation of running a huge lab; Whether or not the scientist worked in industry or academia; Previous history of failures; 'Inside information;' Style and presentation of results; Psychological approach to experiment; Size and prestige of university of origin; Integration into various scientific networks; Nationality.

Although such judgements are based on a kind of meta-expertise (i.e. expertise about expertise) it is a meta-expertise that comes only with socialisation into the expert community and hence with the acquisition of interactional expertise. It is for this reason that Domain Specific Discrimination belongs in Table 2.

Sociological Discrimination: Sociological Discrimination is found in row 5 of Table 2. It is the application of the specialist skill of the expert social analyst being used to discriminate among technical choices. This requires an understanding of the specialist community and is thus only available to those with at least some interactional expertise in the target domain in order to provide a focus for the application of social science contributory expertise (Weinel 2010; Collins and Weinel 2011).[11] Weinel (2009, 2012), for example, using sociological discrimination, has argued that the publicly visible controversy about the toxicity of anti-retroviral drugs that stalled an effective response to HIV/AIDS in South Africa for several years was an 'inauthentic scientific controversy'. A social scientist familiar with HIV/AIDS research in the late 1990s would have been able to argue that Mbeki was not representing the scientific consensus accurately.

Technical Referred Expertise: The last row of Table 2 returns us to referred expertise. This was classed under meta-expertise in the original (Collins and Evans, 2007) Periodic Table of Expertises but new to this analysis is our splitting it into two parts, one a specialist expertise, which we will call 'technical referred expertise' to save confusion with the old usage, and one a meta-expertise that we will refer to as 'referred discrimination'. We will discuss referred discrimination under heading 2.6. This split better characterises the ways managers from one technical specialty contribute to another technical specialty.

Technical referred expertise is now formally linked to interactional expertise. Technical referred expertise is technical expertise (eg from high energy physics) applied to a different

[11] It might appear that some kinds of sociological discrimination can be accomplished without interactional expertise via the use of metrics to rank scientific contributions (eg. Shwed and Bearman 2010). This might work in some cases (e.g. established papers have high citation counts) but would not work well as a leading indicator or in domains where this infrastructure does not exist (e.g. what is the equivalent for sheep farmers?).

'target specialism' (eg gravitational wave physics). Crucially, technical referred expertise requires both source and target expertise to be understood so the expert must have at least at least, interactional expertise in the target domain.[12] This is what distinguishes technical referred expertise from support and facilitation or merely supplying deliverables (see next heading), because in those cases the expert does not need interactional expertise.

2.3 Technical phase contributions without target expertise.

For completeness and to resolve some confusion it is important to recognise that sometimes contributions to the technical phase can be made without requiring any expertise in the target domain beyond the ubiquitous expertises that link people in society into a broad working relationship. Table 3 lists these

BASIS	DESCRIPTION	COMMENT
Deliverables	A person is brought in to fulfil a specialist technical task of a type that applies across many specialities and does not require interactional expertise in the main domain	Traditional technical expertise from elsewhere which is applied to the technical domain in question without being conceptually integrated
Support and facilitation	Supporting a laboratory as living and working space by supplying technical services	Requires general working expertises

Table 3: Ways of contributing within the technical phase that do not require interactional expertise

Deliverables: In the case of deliverables, experts in the target domain employ experts from another domain to supply certain technical services such as compiling literature reviews,

[12] For further discussion of these distinctions see Collins and Sanders, 2007. Duarte, 2013, also distinguishes between the generic work of the technicians and the domain-specific work of the paleo-oceanographers.

solving a set of equations or analysing data-sets. The difference with technical referred expertise is that the target domain experts take responsibility for melding the deliverable expertise into the target domain. To the extent that any shared understanding is needed, then it is provided by the experts from the target domain, requiring them to have at least interactional expertise of the source domain. Such arrangements are possible because most 'deliverables' are of a general science kind so target experts are already likely to possess the necessary understanding. But if this is not the case, it will be the target experts who make the effort to acquire it. The person supplying deliverables can work to a pre-set formula without understanding the scientific purpose of the exercise.

Support and Facilitation: In earlier discussions (Collins and Evans 2007, p.70-71), we have put forward the distinction between 'making a contribution' by performing a supporting or enabling role and being a contributory expert. We can now see this 'support and facilitation' as another kind of deliverable. An extreme example is the truck driver who delivers the central heating fuel to the scientific laboratory without which it could not function; the truck driver has an expertise without which the laboratory could not function but we would not argue that this means the target expertise ought to be re-framed so as to include it. It is just an outside expertise that is required in a 'non-complex' division of labour in which the parties to the division of labour do not require deep understanding of each others' specialist technical lives.[13] Of course, this is not to say that delivering central heating oil is unskilled: the truck driver will possess a huge amount of ubiquitous expertise in respect of mundane social life, which will be shared with the technical specialists, as well as some esoteric expertises relating to the transport of hazardous chemicals; the point is that there is no need for either

[13] The distinction between complex and non-complex divisions of labour is introduced in Part I

specialist expertise to be shared. Seen this way, the only difference between an equation solver and a truck driver is a sociological one – the former's expertise belongs to the domain of science and might very well be shared by the scientists themselves, the latter does not and is, therefore, much less likely to be shared as scientists. Straightforward management expertise – Gant charts, accountancy, decision-making in respect of how money is spent, and so forth – probably spans these two categories of contribution-making.

2.4 Technical phase contributions via meta-expertise

Table 4 lists the contributions to the technical phase that can be made on the basis of expertise *about* the target domain rather than expertise *in* that domain. In other words, it lists contributions to the technical phase that rely on meta-expertises. As explained in more detail below, there is an important distinction between judgements that do not require any understanding of the target domain and those that assume at least some awareness of its characteristics and nature. The former expertises – those that require no target expertise – are called 'transmuted' expertises as they transmute a purely social judgement (who to trust, who to believe) into a technical one (what exists, how to act effectively). In contrast, non-transmuted expertises include some element of target domain understanding.

Ubiquitous Discrimination: The first form of meta-expertise listed is ubiquitous discrimination. This refers to everyday judgements about trust and credibility but is of little interest as it rarely, if ever, makes a contribution to the technical phase. It is more likely to have an effect on technological decision-making via upstream or downstream mediation in the political phase.

BASIS	DESCRIPTION	COMMENT
Ubiquitous discrimination	Everyday judgements of expert's demeanour etc	Too unreliable to count as a contribution to the technical phase
Local discrimination	Cases where a person has special knowledge of the practices of the experts or the local domain of application.	Typically used to identify a failure to uphold standards; whistle blowing is an important example
Downward discrimination	Use of what can be limited understanding to identify those who know still less	Allows participants in technical phase to set the lower limit or floor on expertise needed
Technical Connoisseur-ship	Familiarity or use of a 'technology' such that preferences reflect back on technical choices	A hybrid in that consumer preferences are integral to technologies
Referred discrimination	Judgements based on experiences in other domains that are sufficiently general as to NOT need conceptual integration into the target domain.	New label to distinguish between referred judgements that do and do not draw on interactional expertise.

Table 4: Ways of contributing via meta-expertise

Local Discrimination: The second row of Table 4 lists, local discrimination, which has the potential to be far more powerful than ubiquitous discrimination and which may, in some cases, make a contribution to the technical phase. Local discrimination relies on knowledge of the particular local circumstances that attend a specific piece of scientific research or research location rather than its technical content per se. For example, local citizens' scepticism about the reassurances offered by official spokespersons representing the Sellafield nuclear re-reprocessing plant (which is near the Cumbrian fells) was justified by their knowledge that the same institution had been less than completely open in the past. Here local knowledge was fed into citizens' social assessments of the institution and was 'transmuted' into judgements about technical claims. In this example there was no direct

contribution to the production of knowledge in technical phase so it might be better seen as downstream mediation.

In other, more unusual cases, local discrimination can lead to a contribution in the technical phase. Imagine, for example, that workers in a plant or local citizens come across details of corrupt practices that indicate that the technical work is not being done properly or according to the norms of science. In this case, making such knowledge public can have an impact on the technical phase because a particular set of data and/or expert will come to be excluded from the technical discussion. This 'whistle-blowing' is of enormous importance; it is an example of transmuted expertise as it does not rely on an understanding of the content of the technical expertise, only on the social judgement that appropriate norms of honesty and diligence have not been followed.[14] The discovery by journalists and other researchers that various scientific groups are in the pay of powerful industries such as the tobacco industry or the oil industry such that their publications and other claims should be discounted is another example of the transmutation of expertise.[15]

Downward Discrimination: Downward discrimination can also rest on a low level general understanding of science but it is understanding of a technical kind. An example is the GMO protestor who argued that GMO crops would be radioactive since radioactive markers were

[14] See also Collins, 2014. Note that this definition of whistle-blowers means that both 'insiders' and 'outsiders' can be whistle-blowers. This means that neither contributory nor interactional expertise are necessary for whistle-blowing (apart from the basic knowledge needed to recognise that the shared standards of science are not being upheld). Whistle-blowing often rests on *citizens*' understanding of the nature of science and its distinctiveness from politics, something which social scientists ought to be concerned to stress.

[15] In practice, it may be necessary for some technical experts to evaluate the whistle-blower's claim to determine its significance for consensus within the target expertise but this would be a normal part of technical phase work. Such filtering and evaluation is necessary because not all claims to whistle-blowing are equally significant. For example, the exposure of the so-called 'Climategate' emails have been presented as whistle-blowing but this reveals more about the lack of public understanding of science then about climate science (eg see Collins 2014)

used in their development (Harvey, 2005). Only a very low level of scientific knowledge is needed to understand that this is incorrect so this is most likely to be the kind of technical judgement made by participants in the technical phase when they decide that a claim is not worth further investigation even when it is outside their core expertise.

Technical Connoisseurship: The application of technical connoisseurship in the technical phase is more complicated. In the original Periodic Table we describe technical connoisseurship in terms of a householder's, or an architect's judgment about whether, say, tiles have been laid properly on a wall or a floor of a kitchen or bathroom but we now think the concept can be applied more widely and relates to the 'social construction of technology' (Bijker et al 1987). For example, citizens' contributions to the design of consumer items such as cars and computers can be seen as the exercise of technical connoisseurship as users contribute via their 'use' of the technology. This follows from one of the central ideas belonging to the sociology of technology, namely that design prerogatives extend well beyond the traditional core-group specialists to encompass a diverse mix of social groups that includes both users and non-users. If this is the case, then the number of legitimate participants might be very large whereas it will be small in the case of esoteric, technical disputes. Where the body of consumers is large the technical phase also extends far into the citizenry.

Referred Discrimination: The final entry in Table 4 is the referred discrimination mentioned in the last section. The example we have in mind is managers who are used to dealing with scientists in one esoteric domain and bring that skill to bear on a new technical domain. The skill applied here is an understanding of humans – *scientists* – rather than a technical understanding of a domain of science, hence the use of the term 'discrimination' which we have traditionally used for judgements about experts. Referred discrimination

occurs when a manager, practised in dealing with scientists in a source domain, applies that expertise to the target domain. For example, managers will know that scientists who champion a particular approach to a problem will often claim, in a strident way, that others' ideas will not work whereas the championed ideas are simple and ready to apply; the skilled manager will know when and how to discount these claims and when not to.

2.5 Contributions in the political phase

We now move from technical contributions to political contributions. As noted in earlier (section 2.1) it is useful to distinguish between upstream and downstream interventions: upstream, society influences the future path of technical debate; downstream it reacts to proffered technical conclusions. In Collins and Evans (under submission) we refer to this as the sandwich model.[16] Table 5 is meant to be an exhaustive list of types of political intervention.

[16] Technical disputes being the filling, the slices of bread being, respectively upstream and downstream political contributions or interventions, and the butter or mayonnaise being institutions that mediate between political and technical phases.

BASIS	DESCRIPTION	COMMENT
Upstream Political Framing	Contributions that seek to delineate the scope of the problem as defined by political actors, stakeholders and the like.	May lead to technical reformulation or to the conclusion that the problem is not a technical one
Downstream Political Framing	Contributions that seek to determine how to respond to the claims of technical experts. Possible responses include adoption, rejection, regulation, prohibition or calls for further research.	May feed into further upstream political framing by raising new questions
Citizenship	The everyday actions of citizens, including the wider scientific community, as they express preferences and make choices.	Normal politics. May also include exit, voice and loyalty paradigm of consumer behaviour
Stake-holding	Similar to everyday actions of citizenship but related to individuals and/or organisations that have some special status with regard to the technical claims being made (e.g. patients, residents, employees, literal and metaphorical ownership)	Normal politics. Implies some level of organisation through which stakeholder claims are articulated and made visible.
Resourcing	Funders, philanthropists, enthusiasts, amateur data-collectors, may alter the direction of research or contribute to its success	Normal politics. May be influenced by success of stakeholders in raising awareness (e.g. breast cancer charities)

Table 5: Ways of contributing or intervening within the political phase

Upstream Political Framing: Upstream political framing is concerned with setting agendas and influencing the kinds of technical work that are prioritised. It is the means by which technical priorities and questions are set and encompasses many different kinds of social

institutions and processes from the private sector market through crowd sourcing experiments and venture capital investors to state sponsored research programmes. To the extent that this political framing claims to represent the priorities and concerns of all citizens, or can reasonably be claimed to affect all citizens, then 'the proper participants are in principle every democratic citizen.'[17] Political framing, and re-framing, where the established frame is replaced with another, perhaps through political actions, sets the scene for the technical formulation or re-formulation discussed under heading 2.4. Defining an issue as a 'public health problem' rather than an 'economic problem', for example, has quite clear implications for which kinds of expertise are relevant and the standards to which such expertise should be held accountable.[18]

Downstream Political Framing: The second row of Table 5 deals with what happens downstream. Downstream political framing is a reaction to the outcomes of technical debates. As with upstream framing, these responses may take place at the level of the individual (e.g. consumer choices) or the organisation (e.g. professional judgement) or the nation state (e.g. regulation to control or prohibit). In addition, the Third Wave perspective argues that, whatever the decision reached, the technical consensus should not be misrepresented in the public debate so as to pretend that a political decision was really a scientific decision. Political decisions are never scientific decisions and politicians should not evade political responsibility by pretending that they are. The pretence can work in two directions. For example, Thabo Mbeki failed to realise or accept that there was strong scientific consensus over the efficacy of anti-retroviral drugs and avoided political

[17] Wynne (2003), quote at p. 411.

[18] Another way of phrasing this concern with how societies' frame problems and determine how they should be addressed would be to talk in terms of 'civic epistemology', e.g. Jasanoff, 2005.

responsibility for his decision not to distribute them in South Africa by claiming that disputes found on the internet indicated that there was no scientific consensus when there was. In contrast, Margaret Thatcher and Ronald Reagan often acted as if there was a scientific consensus among economists that backed up their policies when there was not; indeed, even today the idea that 'there is no alternative' to current economic policies is routinely used by politicians to defend economic policies and the hardship they create.[19] Both these ways of avoiding political responsibility emerge from representing a judgement in the political phase as a technical phase judgement. In another place, we suggest that a panel of experts in the substantive domains involved and in the social analysis of science – The Owls – be tasked with providing an account of the scope and strength of technical consensus in the technical phase of any public technological dispute in order to reduce the chance that the degree of technical consensus will be distorted to serve political purposes.[20]

Citizenship and Stakeholding: The third and fourth rows of the table cover citizenship and stakeholding. These are both matters of making political choices but the more directly the individual contributor is affected by a decision, the more he or she is a stakeholder rather than a citizen. Stakeholders have something personal to lose or gain; citizens prefer this political option rather than that, perhaps for selfless or ideological reasons.

Resourcing: The final row of the table, 'resourcing', concerns the ways in which the work needed for participation in the technical phase is enabled. Financial support can promote a certain position while symbolic and cultural support can ensure that certain technical issues

[19] For a recent example – the 2013 Budget – see: http://www.politics.co.uk/comment-analysis/2013/03/07/david-cameron-s-economy-speech-in-full

[20] See also footnote 10

remain visible within the public domain and therefore remain objects of public concern, more likely to attract material resources.

2.6 Conclusion on contributing to technical debates

The above attempt to list all the ways of contributing to either the technical or political phase within wider technological debates is intended to resolve some of the confusions about the relationship between interactional and contributory expertise and provide a context for our understanding of how specialists and citizens can legitimately affect the world of science and technology. We think the project of Plaisance and Kennedy (2015) could benefit from the application of some of the distinctions made in Tables 1-5 because at least some of the time they appear to be talking about persons who might make a contribution to the technical phase without being either an interactional expert or a contributory expert in respect of the target expertise. In most cases, citizens will contribute through their participation in the political phase. There are some scenarios in which citizens will contribute to the technical phase but, of these, only a small sub-set will depend on the use of interactional expertise. We hope that Tables 1-5 will make the nature of various kinds of contribution clearer.

Of course, in real life types of contribution are often mixed up. A citizen may have a stake in in some technology and this might cause them to acquire some interactional expertise relevant to the technology and/or act politically so as to change the framing of a debate, either politically or technically, or blow the whistle on scientifically corrupt local practices and so on. So why bother with all these analytical distinctions when, as far as the citizen-actor is concerned, it is often all of a piece? The answer is the motivation of the Third Wave, which is to retain a separate sphere for technical debates so as to preserve a notion of expertise. If the politics and the technical aspects of a debate are continually mixed then the difference between politics and science/expertise will disappear and therein lies dystopia.

3. Conclusion

We have argued that the discussions of Plaisance and Kennedy (2015) and Goddiksen (2014) have missed the essence of interactional expertise in so far as it can be distilled from the origins of the concept.[21] We have also argued that their projects could benefit from a more wide-ranging analysis of who can contribute to technological debates and how they can do it. Nevertheless, we are extremely grateful for their work and their proposals. It is only through critical discussions that concepts can gain real depth. We, who include the inventors of the concepts of interactional and contributory expertise, have learned a huge amount about both concepts through having to search back through our archives and through having to think anew about the many problems of definition that beset them and the relationship between them. We hope they are becoming better and richer concepts as a result of the exchanges. No doubt there is much more to be done.

[21] We also note that Goddiksen (2014) suggests that a defining criterion of interactional expertise is that it can be used for communication between language communities. But, as Galindo and Duarte (2015) point out, there are a number of other methods of communication between language groups (set out in Figure 1 of (Collins et al. 2007) and interactional expertise is only occasionally used in this way. See Reyes Galindo (2011) and Duarte (2013).

4. References cited

Bijker, Wiebe, Hughes, Thomas. and Pinch, Trevor. J. Eds. 1987. *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, Cambridge, Mass, MIT Press.

Collins, Harry. 1991. `Captives and Victims': Comment on Scott, Richards and Martin', *Science, Technology and Human Values*, 16, 2, 249-51.

Collins, Harry. 1996. `In Praise of Futile Gestures: How Scientific is the Sociology of Scientific Knowledge', *Social Studies of Science*, 26, 2, 229-44

Collins, Harry. 2004a. 'Interactional Expertise as a Third Kind of Knowledge' *Phenomenology and the Cognitive Sciences* 3(2):125–43.

Collins, Harry. 2004b. *Gravity's Shadow: The Search for Gravitational Waves*. Chicago: University of Chicago Press.

Collins, Harry. 2011. "Language and Practice." *Social Studies of Science* 41(2):271–300.

Collins, Harry. 2014. *Are we All Scientific Experts Now?* Cambridge: Polity Press

Collins, Harry and Robert Evans. 2002. "The Third Wave of Science Studies: Studies of Expertise and Experience." *Social Studies of Science* 32(2):235–96.

Collins, Harry and Robert Evans. 2007. *Rethinking Expertise*. Chicago: University of Chicago Press.

Collins, Harry and Robert Evans, 2015. "Expertise Revisited I - Interactional expertise" *Studies in History and Philosophy of Science Part A* 00(0):000-000

Collins, Harry and Robert Evans, under submission *Elective Modernism* (book manuscript)

Collins, Harry, Robert Evans, and Mike Gorman. 2007. "Trading Zones and Interactional Expertise." *Studies in History and Philosophy of Science Part A* 38(4):657–66.

Collins, Harry and Gary Sanders. 2007. "They Give You the Keys and Say 'drive It!' Managers, Referred Expertise, and Other Expertises." *Studies in History and Philosophy of Science Part A* 38(4):621–41.

Collins, Harry and Martin Weinel. 2011. "Transmuted Expertise: How Technical Non-Experts Can Assess Experts and Expertise." *Argumentation* 25(3):401–13.

Collins, Harry, Martin Weinel, and Robert Evans. 2010. "The Politics and Policy of the Third Wave: New Technologies and Society." *Critical Policy Studies* 4(2):185–201.

Collins, Harry, Martin Weinel, and Robert Evans. 2011. "Object and Shadow: Responses to the CPS Critiques of Collins, Weinel and Evans', 'Politics and Policy of the Third Wave.'" *Critical Policy Studies* 5(3):340–48.

Douglas, Heather. 2007. 'Rejecting the Ideal of Value-Free Science', in Kincaid, Harold ; Dupré, John & Wylie, Alison (eds.) *Value-Free Science?: Ideals and Illusions*. Oxford and New York: Oxford University Press. Pp 120-139

Douglas, Heather. 2009. *Science, Policy and the Value-Free Ideal*, Pittsburgh: University of Pittsburgh Press.

Duarte, Tiago. R. 2013. "Expertise and the Fractal Model: Communication and Collaboration between Climate-Change Scientists." Cardiff University School of Social Sciences. Unpublished PhD Thesis.

Epstein, Steven. 1996. *Impure Science: AIDS, Activism, and the Politics of Knowledge*. Berkeley: University of California Press.

Epstein, Steven. 2011. "Misguided Boundary Work in Studies of Expertise: Time to Return to the Evidence." *Critical Policy Studies* 5(3):323–28.

Evans, Robert and Plows, Alexandra. 2007. 'Listening Without Prejudice? Re-Discovering the Value of the Disinterested Citizen', *Social Studies of Science*, Vol. 37, No. 6, pp. 827-854.

Goddiksen, Mads. 2014. "Clarifying Interactional and Contributory Expertise." *Studies in History and Philosophy of Science Part A* 47(0):111–17.

Harvey, Matthew (2005) "Citizens Experts and Technoscience: A Case Study of GM Nation? The Public Debate." PhD, Cardiff University.

Huxham, Mark and Sumner, David. 1999. 'Emotion, science and rationality: the case of the Brent Spar'. *Environmental Values*, *8*(3), 349-368.

Jasanoff, Sheila. 2005. *Designs on Nature: Science and Democracy in Europe and the United States.* Princeton: Princeton University Press

Kuhn, Thomas S. 1996. *The Structure of Scientific Revolutions*. 2nd edition, enlarged. Chicago, Ill: University of Chicago Press.

Martin, Brian. 1994. 'The Critique of Science Becomes Academic', Science Technology and Human Values, 18, 2, 247-59

Plaisance, Kathryn S. and Eric B. Kennedy. 2014. "A Pluralistic Approach to Interactional Expertise." *Studies in History and Philosophy of Science Part A* 47(0):60–68.

Reyes Galindo, L. (2011). The sociology of theoretical physics, Unpublished PhD thesis, Cardiff University. URL: http://orca.cf.ac.uk/id/eprint/15106

Reyes Galindo, Luis and Duarte, Tiago R. 2015. 'Bringing tacit knowledge back to contributory and interactional expertise: A reply to Goddiksen' *Studies in History and Philosophy of Science Part A* 00, 00, 000-000 http://dx.doi.org/10.1016/j.shpsa.2014.10.005

Scott, P., E. Richards, and B. Martin, 1990. Captives of controversy: The myth of the neutral social researcher in contemporary scientific controversies. *Science, Technology, & Human Values* 15:474-94

Shwed, Uri and Bearman, Peter S. 2010. 'The Temporal Structure of Scientific Consensus Formation' *American Sociological Review* 75: 817-840

Weinel, Martin. 2007. "Primary Source Knowledge and Technical Decision-Making: Mbeki and the AZT Debate." *Studies in History and Philosophy of Science Part A* 38(4):748–60.

Weinel, Martin. 2010. "Technological Decision-Making under Scientific Uncertainty: Preventing Mother-to-Child Transmission of HIV in South Africa." PhD, Cardiff University, Cardiff, UK. Retrieved (http://orca.cf.ac.uk/55502/).

Winch, Peter. 1988. *The Idea of a Social Science and Its Relation to Philosophy*. London ; New York: Routledge.

Wittgenstein, Ludwig. 1958. *Philosophical Investigations: The English Text of the Third Edition*. New York: Prentice Hall.

Wynne, B. (2003). "Seasick on the Third Wave? Subverting the Hegemony of Propositionalism." *Social Studies of Science* **33**(3): 401-417.

5. Acknowledgements

In part, the idea of interactional expertise grew out of research supported by the UK Economic and Social Research Council, notably three grants to Harry Collins: ESRC (RES-000-22-2384) £48,698 `The Sociology of Discovery' (2007-2009); ESRC (R000239414) £177,718 `Founding a New Astronomy' (2002-2006); ESRC (R000236826) £140,000 `Physics in Transition' (1996-2001)