Social Spaces of Research Communication: Investigating atmospheres in zones of trade

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Social Spaces of Research Communication:

Investigating atmospheres in zones of trade

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Abstract

The roots of the 'contentious' relationship between science and society in the United Kingdom are frequently attributed to poor communication, if there is any communication at all, between academic researchers and various publics. This research explores how and why researchers working in various fields of science are practicing diverse roles in the process of research communication beyond academia.

The aims of the research were threefold. First, it aimed to capture researchers' views on their diverse practices in communication of their research beyond academia and whether these reflected social spaces and associated atmospheres in which they were working. The second aim was to investigate the role of university boundary spaces (communications office, knowledge transfer/ business engagement, science outreach) in the communicative practices. The third aim was to ascertain how the recently integrated 'impact' component within the UK national Research Evaluation Framework (REF) may influence communication practices of researchers. In order to address these aims, a qualitative investigation was conducted based predominantly on semi-structured interviews and documentary analysis.

The research uses a qualitative methodology involving interviews with a purposely selected sample of relevant academic or academically related actors, mainly selected from a University Institution which forms the case study for this research.

Research communication beyond academia is found to be a diverse and contingent process constituted through interactions that are concurrently tangible and ephemeral between certain human and non-human actors. Researchers engage in a variety of activities for the purposes of research communication which are contingent on the interactions between animate and inanimate actors in the social spaces where engagement events occur. These interactions often rendered engagement spaces as trading zones, identified according to the outcomes for all the animate and inanimate actors involved. At the university level, there are boundary spaces which coordinate the formation of trading zones between researchers and publics; where research communication occurs through relations-focused and transactions-focused practices. The introduction of the 'impact' component within the latest version of the UK research evaluation framework can potentially lead to the narrowing of engagement practices due to valuation that is placed on the framework criteria.

The thesis makes an original contribution by demonstrating the value of an interdisciplinary approach combining theories and methods from social geography and other fields of research to the public understanding of science, public engagement with science and science communication. Furthermore, it provides new insights on the ways that researchers view their practices of research communication and how these relate to institutional and societal contexts in which they work.

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Dedications

To my parents

To my grandparents

Statement of Copyright

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List of Abbreviations

BE – Business engagement

BEKT – Business Engagement / Knowledge Transfer.

CSU - Case Study University

KT – Knowledge Transfer

MarComm – Marketing and Communications

MR – Media Relations

MRO – Media Relations Officer

PE – Public Engagement

RC – Research commercialization

SM – Strategic Marketing

UK – United Kingdom

1 Chapter 1: Introduction

1.1 Introduction

The relationship between science and the wider society has been what can only be described as contentious[1]. Science and science-based technologies have made enormous contributions to advancement of societies through social, cultural and economic developments and more broadly to improving the welfare of people in modern societies. However, these advances have precipitated the emergence of contentious public issues concerning the effects on human societies of outputs from areas of research such as biotechnology (Bauer *et al*. 1998; Bucchi & Neresini 2002; Gaskell 2001; Gaskell *et al*. 2000; Priest *et al.* 2000; Wagner *et al*. 1997), nanotechnology (Burri & Bellucci 2008; Cacciatore *et al*. 2011; Cobb & Macoubrie 2004; Currall 2009; Macoubrie 2005, 2006) and synthetic biology (Douglas & Stemerding 2013, 2014; McFadden 2012; ter Meulen 2014) in addition to the long standing and the more recently emerging areas of concern regarding applications of science, such as nuclear energy (Corner *et al*. 2011; Pidgeon *et al*. 2008) and shale gas extraction (Jaspal & Nerlich 2014; Whitmarsh *et al*. 2015; Williams *et al*. 2015). Many researchers working in these areas have been employed at universities, which are also under increasing pressure to work towards better integration within their communities (Lebeau & Cochrane 2015) and to justify the public expenditures invested in them (Universities UK 2014; 2015a; 2015b). Individual researchers have not remained isolated from these developments. The pressures have trickled down to the individual researchers commanding them to consider engagement beyond academia as a part of their professional role – "thou shalt communicate" (Gregory & Miller 1998, p.1). This research explores how and why researchers working in various fields of science are practicing diverse roles in research communication beyond academia. In the next section, I offer a justification for the focus on scientists and their activities in research communication as a suitable research focus within the wider relationship between science and society in the United Kingdom.

1.2 General Problem Area

In the United Kingdom, the publication of the Royal Society report entitled 'Public Understanding of Science' (Bodmer Report) in 1985 marked the beginning of what became known as the era of the 'public understanding of science'. This report was born of scientists' perceptions that

[1] In the U.K., there was a perceived anti-science sentiment which was spurred by environmental and anti-nuclear protest that occurred throughout the 1970s.

there were growing anti-science sentiments amongst various publics and the recognition that these sentiments may translate into tangible effects on science funding. The negative attitudes towards science were attributed by researchers to the lack of knowledge on the part of the general public. As a result, researchers were encouraged to inform various publics (addressing the 'deficit' of knowledge) about science and research with the aims of fostering a more positive outlook towards science and technology. The rationale was that greater knowledge would lead to a more positive outlook amongst the various publics. The broader ultimate goal of this impetus was to maintain the security of funding for scientific research. A number of initiatives came under the scrutiny from social science, dubbing them as performing under the 'deficit 'model of communication (Wynne 1991; Irwin & Wynne 1996) and calling for a shift towards participation, dialogue and engagement (Council for Science & Technology 2005; Wilsdon & Willis 2004). The move towards more dialogue-based interaction approaches with various publics was in large part precipitated by a crisis of trust towards scientists and scientific institutions as rooted in issues surrounding BSE (Jasanoff 1997), MMR (Boyce 2007) amongst others. Since then, there has been a proliferation of various formats of engagement in order to 'involve' various publics in 'dialogue' concerning scientific and technological development (e.g., Chilvers 2010). Moreover, calls for openness, reflexivity and transparency in science have not subsided with further impetus emerging towards public involvement at the early stage of scientific development (Wilsdon & Willis 2004). The issue of improving communication between scientists and various publics has been a constant presence across the narrative of the relationship between science and society in the United Kingdom. The emphasis placed on better communication is part of the international trend in rhetoric over the last twenty plus years calling for improvement in the relationship between science and society (e.g., Hargreaves & Ferguson 2000; House of Lords 2000; Royal Society 1985). As a result, scientists have been instructed on numerous occasions to consider communication with publics to be their 'duty' (Leshner 2005; Rothwell 2002; Royal Society 1985).

1.2.1 Focus on Scientists

Over the past 25 years, there has been a paradigm shift in science communication – "a shift in which scientists have searched for engagement with various audiences" (van der Sanden & Osseweijer 2011). However, in the U.K., the report, *The Role of Scientists in Public Debate,* noted that

> "Research into the field of 'public understanding of science' has tended to focus on identifying and understanding the views of the general public towards science. Little effort has been made to understand how scientists themselves perceive increasing calls on them

> to become more involved in communicating their research to the public, and to increase dialogue on the social and ethical implications of this research" (MORI, 2001, p.1).

For example, in the U.K. every four to five years a survey is conducted on the public attitudes to science and technology (see Ipsos MORI / Department of Business, Innovation & Skills, 2014, 2011; MORI 2005; Office of Science & Technology and Wellcome Trust 2000; People Science & Policy Ltd/TNS 2008). By way of contrast, such a concerted effort with research focus on scientists has not developed in the United Kingdom. This research niche is of particular interest because

> "In practice, it is individuals or small groups of technical experts who come into contact with publics, not science as an institution or an establishment. And it is therefore the practices of individuals which will frame and shape the communication process" (Davies 2008b, p.414).

A more limited body of work has addressed researchers' views, attitudes, motivations, assumptions and experiences in the context of their engagement beyond academia. Some large scale studies have focused in on scientists in general (MORI 2001; Vetenskap & Allmanhet 2003). Other studies have focused on researchers working in sectors of emerging technologies such as nanotechnologies (Corley *et al*. 2011; Dudo *et al*. 2014; Patra 2013; Rip 2006; Scheufele *et al*. 2007; Villanueva-Felez *et al*. 2015) and biotechnologies (Burchell 2009; Cronin 2010); or scientists at particular events (Wilkinson *et al*. 2011); or in particular organisations such as universities (Nielsen *et al.* 2007; People Science and Policy Ltd. 2006). In the U.K., limited work has focused on highlighting the multiplicity and diversity of individual researchers' engagement trajectories, their conceptualisations, and views (e.g., Burchell *et al*. 2009; Davies 2008a; Davies 2008b; Middleton-Price 2002; Poliakoff & Webb 2007; Porter *et al*. 2012; Watermeyer 2012a; Wilkinson *et al*. 2011). Ultimately, knowledge concerning how scientists practice engagement beyond academia, what influences these practices, and how they perceive their relationships with various publics is valuable knowledge in working towards creating a 'culture of engagement' (Casini & Neresini 2013) within research-intensive universities (especially in the United Kingdom).

1.3 Research Questions & Methods

In order to address the problem area elaborated in the previous section, a qualitative investigation (based on semi-structured interviews, limited participant observation and documentary analysis) was devised. The aim of the strategy was to explore the experiences of researchers and others involved in research communication within a research-intensive university in the United Kingdom. The project was concerned with the following research questions:

> 1) **How do researchers view their practices in communication of their research beyond academia?**

2) **What roles do university boundary spaces play in communication of research beyond academia?**

3) **How has the recently implemented 'impact' agenda within the U.K. national Research Evaluation Framework influenced communication practices within these spaces of science communication?**

1.4 A Note on Definitions

Before proceeding to provide an outline of the thesis, I would like to address some of the definitions that are embedded throughout this work. In the first instance, 'science' and 'scientist' have a number of meanings to various publics in the United Kingdom. In this context, these definitions may be more narrowly defined than in other cultures and languages (Science for All Expert Group 2010). For the purposes of this work, '**science**' is understood as a systematically organized body of knowledge on a particular subject in the physical, biological, engineering, mathematical, health and medical, natural, and social disciplines (Arts and Humanities are left out from the definition). The relationships between these disciplines are represented in Figure 1.1.

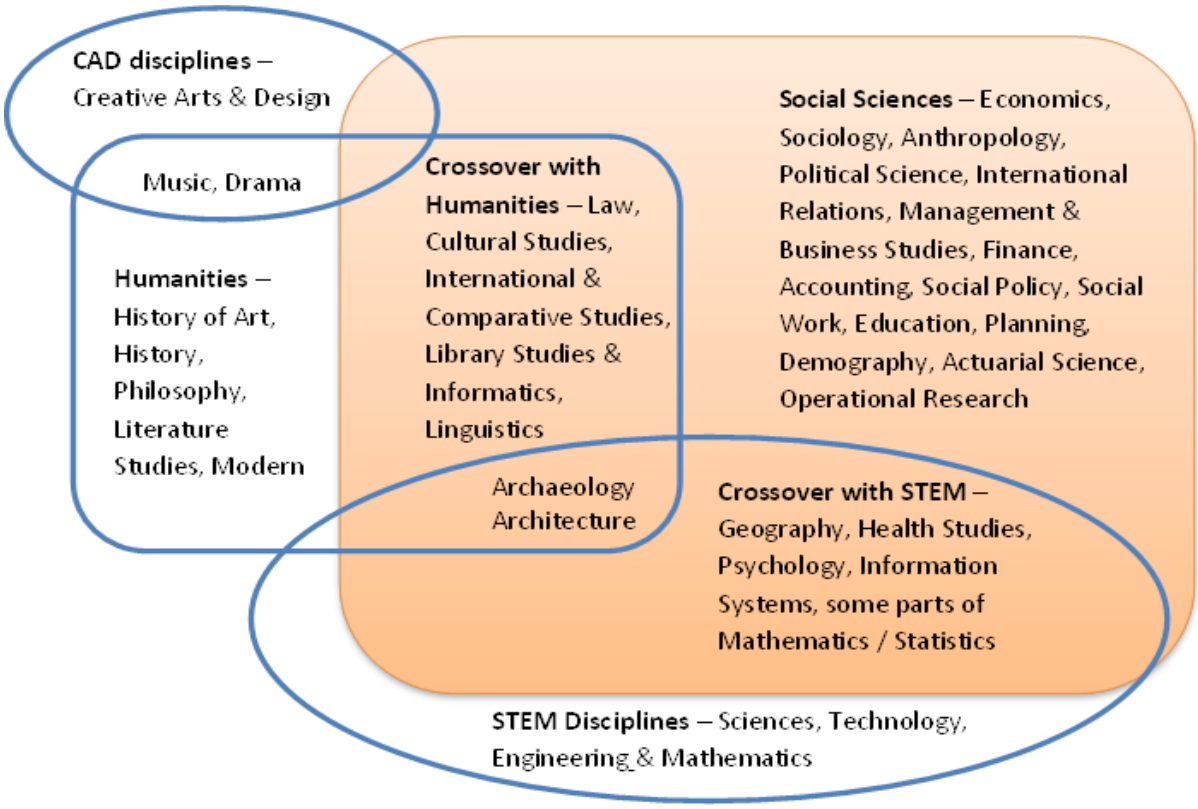

Figure 1.1 - Relationships between disciplines (Bastow *et al.* 2014)

'Science' can also be then understood as the intellectual and practical activity which includes the systematic study of the structure and behaviour of the physical, natural and social world through observations and experiments. Science as an activity (research) is carried out by individuals, here

referred to as researchers, in a number of settings, including academic institutions such as universities. Therefore, '**researchers'** are defined as professionals working in a university who are engaged in conception or creation of new knowledge, products processes, methods and systems, and in the management of the projects concerned. In terms of communication, the primary activity associated with being an academic researcher is 'scholarly communication'[2]. **Scholarly communication** is the process whereby academic researchers share and publish their research works and findings (Borgman & Furner 2002) in order to make them accessible to the wider academic community (e.g., other university researchers) (Halliday 2001). The extent of the reach of scholarly communication can be expanded beyond the immediate academic space through dissemination via social media (e.g., Wilkinson & Weitkamp 2013). However, research travels to spaces beyond the academic space through various mechanisms and in various forms. For the purposes of this dissertation, the umbrella term to encompass the various mechanisms through which research travels in its various formats is '**research communication'**. In relation to non-academic sphere, these mechanisms are understood as **public engagement** (PE) and **knowledge transfer** (KT). A recent report from *Sciencewise*, identifies **public engagement** as:

"1. Science communication (e.g. science festivals; science museums' activities etc.);

2. Discussion between researchers and the general public;

3. Involvement of lay people to assess new science and technologies (consultation; e.g. online and offline user panels and focus groups);

4. Dialogue to gauge the opinions of the public, deliberate and inform policy making;

5. Co-production of knowledge and/or development of solutions through collaboration between different stakeholders, including service users and affected people" (Bussu 2015, p.1).

From the foregoing categorisation, and for the purposes of this thesis, 'science communication' is understood to be a sub-set of public engagement. One of the ways that researchers can then engage beyond academia through 'science communication'.[3] **Science communication** can be defined in a broad manner as "communication of science by scientists to people not involved with research in their field" (Pearson 2001, p.122). This can encompass communication between "groups within the scientific community, including those in academia and industry; the scientific community and the media; the scientific community and the public; the scientific community and government, or others

[2] Feng and Widén-Wulff (2011) subdivide scholarly communication into three main stages: communication in informal networks, initial dissemination via conferences and preprints, and the formal publication of research in peer-reviewed scientific journals.

[3] If one assumes that academic researchers are also members of various publics, then science communication can also reach other researchers both within and outside of the immediate discipline.

in positions of power and/or authority; the scientific community and government, or others who influence policy…" (Office of Science & Technology and Wellcome Trust 2000, p. 137). Communication between researchers and business/industry can also undertake multiple forms (here referred to as knowledge transfer (KT) activities) including intellectual property (IP) transfer such as patenting and licensing, spin off companies as well as inter-organisational relationships (collaborative research or contract research) (Bercovitz & Feldman 2006. Bonaccorsi & Piccaluga 1994; Carayol 2003; Cohen *et al*. 2002; D'Este & Patel 2007; D'Este & Perkmann 2010; Schartinger *et al*. 20002). There are three forms of collaboration. *Collaborative research* refers to arrangement between the parties aimed at cooperation on R&D projects (Hall *et al.*2001). *Contract research* is specifically commissioned by firms and usually refers to research that is directly commercially relevant to the firms (D'Este & Perkmann 2010). Consulting refers to "research or advisory services provided by individual academic researchers to their industry clients (Perkmann & Walsh 2008)" (D'Este & Perkmann 2010, p.9). Finally, other terms used in the analysis within this thesis are introduced in Chapter 2, and subsequently used and developed throughout the thesis.

1.5 Thesis Structure

The thesis is situated across eight chapters. This introductory chapter (Chapter 1) is followed by the literature review (Chapter 2) which frames the research questions and constructs the theoretical framework used for the analysis. Chapter 3 outlines the methods used in order to address the posed research questions. Chapter 4 situates the present work within an elaboration of the science-society relationship in the U.K. context. The next three chapters (Chapters 5, 6, 7) are empirical and report on the information collected in this study and the corresponding conclusions. Chapter 5 looks at the diverse research communication practices undertaken by researchers, the socio-geographical spaces in which communication takes place and how these contribute to the social relationships between scientists and publics. Chapter 6 looks at the institutional spaces that facilitate research communication and knowledge exchange. Chapter 7 looks at how the various socio-geographical space in which communication takes place have recently been affected by the 'impact' agenda introduced in the U.K. Research Evaluation Framework. Finally, in Chapter 8, I provide a discussion of the reported findings and offer some final conclusions. In the rest of this section, I elaborate in further detail on the contents of each chapter.

Chapter 2 reviews the literature that is used in order to frame the questions and construct the theoretical framework that is drawn upon in the thesis. Specifically, the thesis draws on the literatures from science communication / public engagement, social geography (relational space, atmospheres), as well as literature from the branch of sociology of expertise and experience which

focused on 'trading zones' and finally literature grounded in identity theory. This framework enabled the further elaboration of how research is communicated beyond academia within this thesis.

Chapter 3 addresses the design of the research which was implemented in order to produce the present work. Reasoning concerning the choice of methods, sampling and analysis are discussed. In order to attain a more nuanced picture of the researchers' (and those that help them communicate) understanding of research communication, a qualitative approach was adopted that was primarily based on semi-structured interviews with supplementation through participant observation and document analysis with an interpretive approach guiding the data analysis.

Chapter 4 offers a familiar (across the academic literature) timeline of the evolution of the science-society relationship in the U.K. (or as I call it, the emergence of the 'atmosphere of engagement'). This evolution follows the following path: Starting from the publication of the ground-breaking Bodmer Report in 1985 which ushered in the era of the 'public understanding of science' in the U.K. (1985 to mid-1990s) and transitioning into the era permeated by the 'mood for dialogue' (2000 to 2010/present) and onwards towards characterising the relationship as science for-/with-society (2010 to present).

Chapter 5 focuses on the interviewed researchers' engagement practices. The chapter reveals their multiplicity, heterogeneity and ongoing evolution. Numerous models of communication were implemented, although a one way (deficit-based) communication model is still dominant. Considering engagement events as emergent reveals identity work conducted by researchers as they engage with various publics who are often imaginary and are only enabled to enact being publics within the context of these engagement events. For researchers, participation in various engagement activities is not a purely altruistic activity, and as such, can be motivated by instrumental gains. I discuss, in particular, how engagement events can be understood in terms of the concept of 'trading zones'.

Chapter 6 expands on the idea that 'boundary zones' and 'trading zones' which frame research communication. I focus on university boundary spaces (communications offices [CO], business engagement / knowledge transfer [BEKT] and science outreach [SO]) in order to investigate their mediating role in research communication through coordination of the formation of the trading zone. The chapter reveals that the communication office and BEKT zones attempt to negotiate dual roles in focusing on transactions-based interactions and relations-based interactions; with science outreach being subjected to pressures to engage in the former type of interactions whilst also

primarily engaging in the latter types of interactions. In attempting to negotiate the two roles separately results in a limited engagement of researchers, and thus encourages the more informal engagement practices that were highlighted in Chapter 5. Ultimately, this raises broader questions about the role of these spaces and the purpose of research communication undertaken by academic researchers.

Chapter 7 addresses the notion of 'societal impact' of research, a component that was integrated into the recently completed Research Excellence Framework (REF) in the United Kingdom under the parameter of 'impact'. This parameter is used to assess the academic research that is emerging from the country's higher education sector. In particular, the focus is on how 'impact' will affect the functioning of the described trading zones. Interviews with researchers revealed what is potentially an emerging trading zone that is relatively narrow and places value on particular forms of research communication that are rooted more in transactions-based interactions rather than relations-based interactions.

In the final chapter (*Chapter 8*), I bring the work of the previous chapters together, review the gathered evidence and provide the answers to the research questions which support the arguments of the thesis. I offer a discussion of the findings and draw the appropriate conclusions. Moreover, I offer a set of recommendations at the organisational level (e.g., university level). Finally, directions for future research are also suggested.

2 Chapter 2: Literature Review & Theoretical Approach

2.1 Introduction

This thesis draws on different disciplinary perspectives to explore processes of research communication as experienced by researchers and other university specialists in communication. My research combines conceptual frameworks from human geography, sociology of experience and expertise and identity theories. A socio-geographical perspective on spaces of practice and relational space leads to a focus on how the places, contextual settings and atmospheres formed in the spaces for communication of science influence the ways that researchers practice research communication. Moreover, viewing research and communication of science in terms of 'trading zones' (viewed in conjunction with this geographical literature) presents questions of how the 'scientific' space articulates with other spaces of public engagement, how these 'zones' are constituted as socio-geographical spaces and what this means for practice of communication. Theories of identity, applied to the scientists' sense of their professional and personal 'scientific' roles, leads to questions concerning how individual motivations and purpose interacts with spaces of scientific research communication, and these also connect with geographical ideas about relational space.

The chapter will unfold in the following order. I will first look at the literature concerning geographies of science and corresponding atmospheres. Next I will outline previous research concerning researchers' engagement practices and draw general lessons concerning definitions of science communication and public engagement. The chapter then outlines the various communication models associated with science communication. The chapter then carries a discussion of trading zones and role identities as they pertain to processes of communication of science beyond academia. Finally, the chapter concludes with discussion of a conceptual model linking the themes reviewed here, which has been applied in the research presented in this thesis.

2.2 Geographies of Science

According to scientists, science is a contextually neutral activity that is free of influence from the specificities of the setting in which it takes place. The production of scientific knowledge occurs in a variety of spaces[4]. These spaces include, but are not limited to: settings that may be variously located within a laboratory, museum, field, garden, hospital, asylum, body, public house, coffee

[4] For overview of geographies of science see Powell (2007), Finnegan (2008), Naylor (2005).

shop, tent, ship (e.g., Livingstone 2000). Less commonly recognised spaces where scientific practices have occurred include nurseries, storefronts and kitchens (von Oertzen *et al*. 2013). Considering the multiplicity of the spaces of scientific knowledge production, an obvious line of enquiry is whether it matters where scientific knowledge is made. Livingstone (2003) suspects that, across "the spectrum of scales from particular sites through regional settings to national environments, the "where?" of scientific activity matters a good deal" (p. 3). This may appear to be 'obvious and unexceptional' (Naylor 2005, p. 2); after all 'Where else could science take place but in places…and how else could it travel but across spaces?' (Shapin 2003, p. 90 in Naylor 2005, p. 2). Shapin (1998) described this as the issue of 'travel'. For him the pertinent question becomes, 'How does science, which is locally produced, travel?'(see Shapin 1998, p.7). "How does science travel – within and between communities of practitioners, for example, or from "expert" to "lay" audience?" (Withers & Livingstone 2011, p.2)[5]. This thesis contributes, in part, towards answering the question, 'How does science travel from "expert" to "lay" audience?

The idea that 'space' pervades 'science' and plays a substantial role in shaping it is encompassing and fertile for various avenues of research at differing scales. It is impossible to provide a comprehensive account of the work that has investigated the places of science. Science has been practiced, tested and re-tested and disseminated from a vast number of spaces[6]. Outram (1996) focuses on the museum as a space for determination of different approaches to science of nature – the scientific battle between Jean Baptiste Lamarck and Georges Cuvier had an inherently spatial character to it. Kohler (2002a, 2002b) investigated the contentious relationship between the laboratory and the field. Schaffer (1998) demonstrated the localised and socialised nature of physics laboratories in nineteenth century Britain. Shapin (1988) conducted work on the place of experiment in seventeenth century England in which he made the connection between the practices of knowledge making and the spatial distribution of participants.

> "My subject is the place of experiment. I want to know where experimental science was done. In what physical and social settings? Who was in attendance at the scenes in which experimental knowledge was produced and evaluated? How were they arrayed in physical and social space? What were the conditions of access to these places, and how were transactions across their thresholds managed?" (Shapin 1988, p. 373).

The work conducted by Schaffer and Shapin adhere to what Powell (2007) calls the 'socio-spatial school' (p. 313) and argue for the mutual constitution of the spatial and the social – "The threshold of the experimental laboratory was constructed out of stone and social convention"

[5] In relation to the latter part of the question, we can begin to ponder whether spaces of science communication are extensions of the spaces where science is carried out or whether the two spaces need to be considered as separate entities.

[6] For a thorough introductory treatment of geographies of science in book form see Livingstone (2003). For an overview of geographies of nineteenth century science, see Livingstone & Withers (2011).

(Shapin 1988, p.383). The work by Shapin (1988) on the place of experiment in seventeenth century England demonstrates 'connections between empiricist processes of knowledge making and the spatial distribution of participants, pointing to the ineradicable problem of trust that is generated when people have direct sensory access to a phenomenon and others do not" (Shapin 1988, p.374). Consideration of this historical example provides a comprehensive background to the ways that contemporary communication of science is practiced.

Traditionally, in the West, the accepted pre-condition for production of universal knowledge was the need to 'retire' from society (Shapin 1990). In this context, solitude was both a practical and a symbolic consideration. In practical terms, solitude meant that experimental philosophers of the day dedicated themselves to the experiments without being subjected to societal distractions. In symbolic terms, solitude was a required condition that contributed to claiming of authenticity of knowledge that was produced. Models of space that accommodated these criteria did exist: especially the monastic cell and the hermit's hut. Monasteries did provide the required solitude – "here was a model of space perceived to be insulated from distraction, temptation, distortion and convention" (Shapin 1988, p. 384). This ideal space for the production of scientific knowledge subsequently acted as the dissemination point for that knowledge into the wider society. However, monasteries did not provide appropriate conditions for development of experimental activities, which began to play an increasingly important role in the practice of science during the Enlightenment. The developing practice of scientific experimentation during the seventeenth century integrated the necessity for making intellectual practice more public. This is elaborated further in the next quote.

> "…experimentalists like Boyle and his Royal Society colleagues in the 1660s were engaged in a vigorous attack on the privacy of existing forms of intellectual practice. The legitimacy of experimental knowledge, it was argued, depended upon a public presence at some crucial stage or stages of knowledge making. If experimental knowledge did indeed have to occupy private space during part of its career, then its realization as authentic knowledge involved its transit to and through a public space"(Shapin 1988, p. 384).

Noticeable in the above quote is a transition from knowledge production and broader communication as being separate to the communication being integral to the confirmation of scientific knowledge as authentic. This processes occurred through the 'act of witnessing' (Shapin 1988, p. 375) in the laboratories which were situated in the homes of scientists themselves or in the homes of their gentlemen patrons (Shapin 1988)[7]. In cases where the laboratory was not situated in the homes of the gentlemen, they were permitted access in accordance with the social norms of the

[7] In fact, however, there were a plethora of other types of venues within which science did take place in the mid to late-seventeenth century England, including coffee shops, instrument makers' shops and apothecary's workshops.

day. The status (or 'condition') of gentleman, reflected the requirement for suitably 'qualified' social groups as witnesses, regarded as meeting the condition of reliability and objectivity of experimental knowledge and judgement.

Therefore, the performance of experiments in solitude was not sufficient to establish the validity and value of scientific knowledge. 'Public' attestation of the newly created knowledge was also required. For the scientist's claims to be recognized as "knowledge" they needed to be produced in an appropriate setting (i.e., laboratory - in this case, Boyle's home) and also, in the words of Steve Shapin, to receive validation from 'the experimental public' was important for the confirmation of empirical findings. Considering this event in terms of who was present at the time, reveals the social stratification of the social space within the physical space. A social distinction was made between the attendants who operated the equipment and Boyle himself. The former group had the technical knowledge concerning the instruments, but lacked the social standing to be included in the social space where scientific knowledge was evaluated. Moreover, Shapin (1988) comments that other observers were situated in a different epistemic space from those who were socially and cognitively sanctioned to judge about experimental reliability. The technicians who were being paid to carry out their work and their 'testimony' would not be granted credibility for that reason. In contrast, a gentleman's word would receive greater credibility in part because what he said was not said with consideration of renumeration. Pronouncements by gentlemen in the 'house of experiment' were part of appropriate behaviour that gentlemen were obliged to observe in the house of another (Shapin 1988), so that only certain types of observations were allowed to be made by the privileged audience (Shapin 1988). We therefore see a socially defined space of communication which is defined in terms of performance of certain expected behaviours by the public (both general and in particular) that make up the audience, as well as by the scientists. This resulted in the creation of a 'gap' between 'trying' of an experiment and 'showing' of an experiment. "The shift from "trying" to "showing," from delving to demonstrating, we might say, is a spatial manifestation of the move from the context of scientific discovery to the context of justification"(Livingstone 2003, p. 24). This shift can be understood as a shift from production of scientific knowledge to its communication.

The 'house of experiment' established by Boyle prefigures the emergence during the enlightenment period of more public 'spaces' for science communication, illustrated in England by the Royal Society (which provided a model for other learned societies established subsequently, such as the Royal Geographical Society [8]and the British Academy[9]). These provided a recognized,

[8] http://www.rgs.org/HomePage.htm

socially constructed 'space of science communication' where individual scientists shared their findings with a wider public during especially constituted meetings. Initially, these were rather socially exclusive events that required appropriate behaviour. At the Royal Society there was an expectation of attendees "to validate experimental knowledge as participants, by giving witness to matters of fact, rather than to play the role of passive spectators to the doings of others"(Shapin 1988, p. 390). However, over time, for the Royal Society, and for the wider scholarly community, the practice of formally communicating scientific findings has expanded and diversified, to incorporate a wider range of settings and media. This has led to a much more complex contemporary arena for research communication that situates my research.

Whilst it is vital to know how knowledge is made in particular places, it is equally important to investigate how transactions occur between places (Shapin 1998). If science is indeed a socially and spatially localised product as Shapin (1998) suggests then how do its various versions travel? Thus it is interesting to consider "how some knowledge spreads from one context to many, how is that spread achieved, and what is the cause of its movement?" (Powell 2007, p. 313). Science travels from, through, and to various spaces in 'prefabricated and more malleable forms' (Finnegan 2008, p. 378). The preceding discussion has highlighted that spaces of science are, in part, physically defined spaces that constitute the context in which scientific information is produced and is then communicated and endorsed. Simultaneously, spaces of science are social and cultural spaces that constrain and enable particular kinds of scientific practices and determine who may participate in the communication and endorsement process. By extension, spaces of science communication can be subject to analogous processes of constraint and enablement, particularly in instances where the space functions as both a space for carrying out of science and its communication. Therefore, for the purposes of this thesis, physical and social spaces of science communication are interpreted as constructs that influence the credibility and acceptance of scientific knowledge in society. The social spaces are understood through a geographical perspective as 'relational spaces' (Harvey 1996; Lefebre 1991; Massey 1992, 1998, 1999, 2005). Drawing specifically on the work of Massey (2005), space is understood as a product of interrelations and is constituted through interrelations. Space is a "sphere of possibility of the existence of multiplicity in the sense of contemporaneous plurality; as the sphere in which distinct trajectories coexist; as the sphere therefore of coexisting heterogeneity" (Massey 2005, p. 9). Finally, space is always evolving and is therefore never finished and is never closed. The ways that researchers behave and interact with other actors in these spaces (whilst also forming 'new'social spaces) is crucially important to the role of science in society and form an important focus for my research.

[9] http://www.britac.ac.uk/

2.3 Atmospheres

As we imagine the diversity of spaces from which science emerges we are "impressed with the vastly different atmospheres they exude" (Livingstone 2003, p. 30). Considering the idea of the 'atmosphere' surrounding and determining research communication is also important for this thesis. The next quote demonstrates that the description of the spaces of knowledge production draws on the idea of an 'atmosphere'.

> "The claustrophobic darkness of the alchemist's workshop and its roaring furnace and smelly stills stands in marked contrast to the clinical brightness and flickering screens of the modern medical technology laboratory. The wide-open-airy spaces of the field contrast sharply with the fusty alcoves of the archive and stuffed displays of the museum. The controlled exhibits of the botanical and zoological gardens are very different from the diagnostic spaces of the hospital or the asylum. Even to express things this way, of course, is to run the risk of caricature. Laboratories, gardens, museums, observatories, hospitals, and so on all come in a wide variety of shapes, sizes, and configurations. But these stereotypes do have sufficient imaginative currency to convey something of the range of sensory experiences that such sites induce with their different sights, sounds and smells. Each constitutes a different suite of optical, acoustic, and olfactory spaces." (Livingstone 2003, pp. 30-31)[10].

The quote alludes to the idea of understanding atmosphere in terms of its material and ephemeral ('affective') qualities. In order to begin considering these dimensions, we commence by exploring some of the geographical literature that has recently been emerging on the topic of atmospheres.

In the social geographical literature the term 'atmosphere' draws on an analogy associated with the physical environmental conditions in which we live in. McCormack (2008) describes an atmosphere as a meteorological phenomenon, "a turbulent zone of gaseous matter surrounding the earth and through the lower reaches of which human and non-human life moves" (p. 413). The atmosphere is the envelope of gas (mixture of) which surrounds the earth's surface. It extends vertically for thousands of kilometers, consists of five primary layers[11] and becomes increasingly thinner or 'rarified' as one proceeds further out. Thus, an atmosphere can be imagined as a heterogeneous medium (its gaseous composition is variable at different levels.) The atmosphere also contains major chemical constituents[12] that enable life, exerts a force (atmospheric pressure) on the terrestrial elements are surrounded by it, and acts as a protective layer around life on the earth. Human life and livelihoods created in spaces such as fields and gardens, as well as 'wild' spaces are

[10] Also see Livingstone (2000, p. 286).

[11] The five primary layers, which are referred to as spheres, are troposphere, stratosphere, mesosphere thermosphere and exosphere (from lowest to highest).

[12] Major constituents of the earth's atmosphere: include nitrogen, oxygen, argon, carbon dioxide, neon, helium and methane as well as water vapour.

only able to exist through the presence of an atmosphere. Therefore, we see an atmosphere as enabling, cohesive and protective for modes of human practice, while also differentiated and constituting spatially divided settings which vary in their accessibility and 'livability' or 'comfort' for human actors.

In geography, the concept of the atmosphere, or 'affective atmosphere', has been the focus of recent interest among numerous scholars (Adey & Bissell 2010; Adey *et al.* 2013; Anderson 2009; Ash 2013; Bissell 2010; Edensor 2012, 2014; Ellis *et al*. 2013; McCormack 2008, 2014; Shaw 2014). The use of 'atmosphere as a concept'[13] has emerged and evolved as a way to consider "the relationship between space and bodies and, specifically, how changes in the constitution of a space, whether in its characteristics or in the bodies within it, alter the affective experiences of these spaces" (Shaw 2014, p. 88). Atmosphere can also be understood in terms of concepts of 'affect' as "something distributed yet palpable, a quality of environmental immersion that registers in and through sensing bodies while also remaining diffuse, in the air, ethereal"(McCormack 2008, p. 413). This definition conceptualizes atmosphere as an impersonal or transpersonal intensity (McCormack 2008; Stewart 2007). These 'intensities' (Deleuze 1997, p.181) register at the "imperceptible, pre-conscious, pre-individual scale of measure" (Clough 2008, p. 140). The suggestion here is that "an atmosphere pre-exists the presence of those who are suddenly subsumed within its affective field" (Edensor & Sumartojo 2015, p. 252). However, an atmosphere need not be considered to be distributed only amongst human bodies. If one adopts a heterogeneous perspective on what constitutes the concept of 'bodies', then atmosphere can be understood as

> "generated by bodies – of multiple types – affecting one another as some form of 'envelopment' is produced. Atmospheres do not float free from the bodies that come together and apart to compose situations. Affective qualities emanate from the assembling of the human bodies, discursive bodies, non-human bodies, and all the other bodies that make up everyday situation" (Anderson 2009, p. 3)

In other words, we can then understand it as "propensity: it is a pull or a charge that might emerge in a particular space which might (or might not) generate particular events and actions, feelings and emotions" (Bissell 2010, p. 273). It is worth noting that Anderson's definition suggests that affective atmospheres emanate from bodies rather than being produced by them and therefore they are not reducible to bodies. Reduction of an atmosphere to its affective qualities suggests the pre-existence of the atmosphere in relation to the presence of the bodies that are then consumed within it. The foregoing definition equates affect and atmosphere – the heterogeneity with which an atmosphere

[13] Anderson (2009, p.78) has highlighted various conceptualizations of 'atmosphere' by different authors: transmission of other's feeling (Brennan 2004); qualified aura (Bohme 2006); tone in literature (Ngai 2005); mimetic waves of sentiment (Thrift 2008); or more broadly a sense of place (Rodaway 1994).

can be characterized is reduced.. However,as Edensor & Sumartojo (2015) point out, “atmospheres are multiply composed out of phenomenological and sensual elements, and the social and cultural contexts in which they are consumed, interpreted and engaged with emotionally as well as affectively” (p. 252). Therefore, we can draw parallels to the heterogeneous constitution of the Earth’s atmosphere to indicate that the force-field of an atmosphere is composed of emotions, sensations, meanings, materialities and affects (Bille *et al.* 2014; Edensor 2012; Edensor & Sumartojo 2015).

Therefore, as suggested at the beginning of this section, the concept of the atmosphere can be considered in relation to spaces of science. The spaces of workshops, museums, botanical gardens, laboratories, fields and hospitals constitute particular settings, foster, and are influenced by a number of atmospheres. Considering that some of the spaces of science can also function as spaces of science communication, the concept of the ‘atmosphere’ can also be applied in relation to science communication in order to provide a more nuanced understanding of the communicative interaction. Physical spaces of science communication may be ‘staged’ in order to generate a particular atmosphere. For example, science festivals may be staged within city centres in order to ‘bridge’ the connection between local population and science by fostering an atmosphere of ‘fun’ and ‘learning’ around science. Whilst attempting to engineer an atmosphere around an engagement event can be ‘planned’, the emergent atmosphere is in part a result of the interactions between the bodies within the given space (e.g., the communicative interaction between publics and scientists). These interactions may be tightly controlled (e.g., according to medical protocols in hospitals) or staged (e.g, exhibitions in museums) thereby influencing the human performance of research communication. The ways that individuals interact with each other, and with elements of the setting as well as the broader historical and cultural contexts, influence the atmosphere that emanates from within those spaces. Each new body entering that space will experience the ‘atmosphere’ in a different way and will in turn contribute to the constitution of that atmosphere by being there. However, as Böhme (1993) points out, becoming aware of the atmosphere that is around us, may make us uncertain “whether we should attribute them to the objects or environments from which they proceed or to the subjects who experience them” (p.114).

“Is there anyone who has not, at least once, walked into a room and “felt the atmosphere”?” (Brennan 2004, p.1). The question implies that the affective state undergoes a transmission to the new arrival by bodies that were already present within that room. Therefore, according to Brennan, the constitution of the atmosphere can, at least in part, be attributed to affect. This is explained in further detail in the next quote.

> "The transmission of affect, whether it is grief, anxiety, or anger, is social or psychological in origin. But the transmission is also responsible for bodily changes; some are brief changes, as in a whiff of the room's atmosphere, some longer lasting. In other words, the transmission of affect, if only for an instant, alters the biochemistry and neurology of the subject. The "atmosphere" or the environment literally gets into the individual. Physically and biologically, something is present that was not there before, but it did not originate sui generis: it was not generated solely or sometimes even in part by the individual organism or its genes" (Brennan 2004, p. 1).

In particular, Brennan highlights the role of 'unconscious olfaction' (2004, p.9), or in more simple terms 'smell'. Drawing on neurological studies, she provides the example of pheromones which are 'molecules that can be airborne and that communicate chemical information'(p. 9), which can be subconsciously sensed in a variety of ways. This focus "points to how one's state of affect produces a substance that is emitted and which may then, through social interaction, be absorbed by others whereby the former's affect is transmitted to the latter"(Borch 2010, p. 234). It is notable that this physical transmission due to pheromones is not the only means of transmission; other signals between human bodies may include facial expression and posture or tone of voice. For example, Lin (2015) considers the affective design and atmospheric manipulation of spaces of transportation (airplanes) – Singapore (SIA) airlines aimed to (pre)shape) the passenger experience by employing flight attendants (known as Singapore Girls) in order to "imbue its cabins with certain strategic atmospheres by design"(Lin 2015, p.1)[14]. The role that was played by these women was "as affective / affecting bodies capable of instilling a desirable of 'Oriental' comfort among/for Singapore Airlines customers" (Lin 2015, p.1). In relation to research communication, this perspective demonstrates that researchers themselves and various intermediaries can influence the emotional and psychological conditions that help to determine the transmission of knowledge and ideas and will impact on the ways that scientific findings are understood and acted on.

Atmospheres cannot be wholly attributed just to individuals. When walking into a room, the atmosphere one senses is not just from the interaction between human bodies, but can also be attributed to the interaction between human and non-human bodies (as well as between non-human bodies). Whist the Singapore Airlines flight attendants played a central role in engineering an atmosphere, this process was in large part enabled by the cabin of the airplane within which the attendants performed their work. The cabin is constituted of a number of objects (e.g., seats, windows, in flight magazines, monitors) which emanate their own atmosphere as well as contribute to the overall atmosphere. Ash (2013) has argued that technical objects are not lifeless and in fact actively produce spatio-temporal atmospheres, which shape humans who are immersed in these atmospheres. Biehl-Missal (2012) has argued that the atmosphere of imagery exerts an aesthetic

[14] This atmosphere was one of "hybrid Orientalism that was at once alluring, familiar and efficient" (Lin 2015, p.2).

influence on people. Therefore, it is important to consider the atmospheres generated by various non-human bodies; and the subsequent their influence on the 'broader' atmosphere. Consideration of objects and settings further indicates that research communication is not just dependent on the researchers. Instead, objects and settings exude their own atmospheres. As a result, they can affect the conditions of research communication and have an impact on the communicative process and whether the conveyed information is understood in an appropriate manner.

The idea of 'staging' of an atmosphere implies the notion of designing of atmospheres (Edensor & Sumartojo 2015). For architects and design professions the need to produce an atmosphere has been an issue of prominence (Borch 2014; Griffero 2014; Pallasmaa 2014; Zumthor 2006). Borch (2011) has suggested that various atmospheres (e.g., calm, panic, fear) can be designed into architectures through the arrangement of objects in space as well as the use of different odours, sounds and colours. For example, Biehl-Missal and Saren (2012) draws on the example of a Starbucks coffee shop to demonstrate the manipulation of an atmosphere to create an atmosphere of 'seductive consumption' thereby rendering the atmosphere as both "an opportunity for aesthetic pleasure and an instrument for aesthetic manipulation" (p. 176). Healey (2014) looks at the affective atmosphere of contemporary retail spaces and the role of air conditioning in the creation of thermal comfort and how that may contribute to the possibility of shopping through subdual of intentional subjectivity. The overall point here is that atmospheres can be designed "in highly organized and pervasive fashion" (Edensor & Sumartojo 2015, p.257) with the aim of "soliciting a range of sensory apprehensions, affective and emotional responses and habitual, reflexive performances…" (Edensor & Sumartojo 2015, p.257). Considering the notion of 'atmosphere staging' in relation to research communication allows for a focus on how effort can be made in order to influence the emotional and psychological conditions that help to determine the transmission of knowledge and ideas and their impact on the ways that scientific findings are understood and acted on.

The way individuals respond to an atmosphere is contingent on the historical and cultural contexts, which condition the effects of the atmosphere. "For example, the ecstatic atmosphere that suffused the huge post-war celebrations that marked the end of the Second World War in London's Trafalgar Square was engendered through a populace primed to experience release from the long years of war and deprivation, combining sentiments of 'national unity, timelessness and stability for public consumption' (Sumartojo 2014, p. 65)" (Edensor & Sumartojo 2015, p. 257). Cultural expectations and habits also modulate the anticipatory atmospheres that pervade British cities on Saturday evenings (see Edensor 2012; Shaw 2014). In the broader sense, focusing on the cultural and historical contexts emphasizes the notion that atmospheres are subject to change over a period of

time or suddenly through unexpected events resulting in attunement of some to be absorbed by the atmosphere. In relation to research communication, or how science travels beyond academia, this requires consideration of the evolution of the relationship between science and society in the United Kingdom in the recent past (for an overview of the evolution of this relationship, refer to Chapter 4.

Secondly, the poor design of the atmosphere may not find synergy and co-participation from the intended subjects. For example, Edensor (2014) described numerous attempts made by Manchester City Football Club (MCFC) to generate a stronger atmosphere during game days at the stadium – playing powerful upbeat songs prior to the arrival of players, introducing former players, moderating light levels in accordance with time of the day during which the game is conducted, distributing 'free' items such as scarves and fan cards, as well as requesting that the fans should wear a particular blue colour of the football club (see Edensor 2014, p.6). In response to these measures, the fans have adopted a number of their own practices in order to 'improve' the atmosphere on match days. The fans "possess an agency and reflexivity that resists forms of affective management that seem contrived or superficial" (Edensor 2014, p.6). Therefore, 'staging' of an atmosphere may not result in establishment of a connection with individuals for whom the atmosphere was initially designed and lead to forms of 'resistance'.

Finally, the way atmospheres are experienced depends in a number of ways on cultural values, prior experience, as well as personal background. Whilst claiming that "the staging of atmosphere is a way of being together, of sharing a social reality" (Bille *et* al. 2014, p. 4), they also suggest that "the paradox between pre-reflexive experience and staging raises the question whether the orchestrated atmosphere is actually shared by the users…" (p. 4). For example, for some individuals attending, a science festival may prove to be a stressful event which may highlight their inadequate scientific knowledge and ability, whereas for others the environment may be prove to be fun and stimulating. Therefore, certain atmospheric intensities can favour some participants who are 'already attuned' (Edensor & Sumartojo 2015, p.258). Particularly in relation to communication, this suggests that atmospheres create possibilities for different processes or outcomes, which are also contingent on the combination of diverse aspects of the social, cultural and historical setting and the interactions between individuals, with their particular characteristics and preferences, and the attributes of the settings they experience. Ultimately, this raises the question 'What does an atmosphere make it possible to do, to perceive and to share?'(Bille *et al.* 2014, p.3). I will focus on this question further in the next section, in relation to research communication by considering the literature on science communication / public engagement with particular focus on engagement practices (beyond academia) of academic researchers.

2.4 Public Engagement: Definitions, Researchers' Practices and Determining Factors

In relation to 'science' and 'society', I suggest that an atmosphere can contribute to the formation of 'connections' between the two parties. In academic literature, these mechanisms for connecting science and society have been grouped and described under a number of headings including 'public understanding of science activity' (Pearson *et al*. 1997), 'public engagement of science' (Bauer & Jensen 2011), 'public service activities' (Nivakoski *et al*. 2015), 'science dissemination' (Torres-Albero *et al*. 2011), 'public communication of science and technology' (PCST) (Dudo 2013; Jensen *et al*. 2008). Concurrently, these subheadings have been coupled with various definitions of these activities that connect academic researchers with various publics. Pearson (2001) defines science communication in a very broad way as the "communication of science by scientists to people not involved with research in their field" (p.122). Burns, O'Connor and Stocklmayer (2003) define science communication as "the use of appropriate skills, media, activities, and dialogue to produce one or more of the following personal responses to science: awareness, enjoyment, interest, opinion-forming, and understanding" (p. 183). Drawing on this definition, Poliakoff and Webb (2007) adopted a broad scale view of public engagement in defining it as "scientific communication that engages an audience outside of academia" (p.244). Nerlich, Elliot & Larson (2009) define science communication as "reporting of technoscientific, especially, biotechnological knowledge and developments to non-scientists through popular science books and journals, newspapers and magazines, the broadcast media and 'public engagement' activities such as science fairs museums and cafés scientifiques (see Stocklmayer *et al*. 2001)" (p.1). For Bauer and Jensen (2011), "PE activities include a wide range of activities such as lecturing in public or in schools, giving interviews to journalists for newspapers, radio or television, writing popular science books, writing the odd article for newspapers or magazines oneself, taking part in public debates, volunteering as an expert for a consensus conference or a "café scientifique," collaborating with non-governmental organizations (NGOs) and associations as advisors or activists, and more" (p.4). *Sciencewise*, identifies public engagement as:

"1. Science communication (e.g. science festivals; science museums' activities etc.);

2. Discussion between researchers and the general public;

3. Involvement of lay people to assess new science and technologies (e.g. online and offline user panels and focus groups);

4. Dialogue to gauge the opinions of the public, deliberate and inform policy making;

5. Co-production of knowledge and/or development of solutions through collaboration between different stakeholders, including service users and affected people"(Bussu 2015, p.1).

The National Co-ordinating Centre for Public Engagement (NCCPE)[15], in the U.K. also sees public engagement as a broad process, but emphasizes its 'two-way' nature.

> "Public engagement describes the myriad of ways in which the activity and benefits of higher education and research can be shared with the public. Engagement is by definition a two-way process, involving interaction and listening, with the goal of generating mutual benefit." (NCCPE 2014)[16]

Overall, there are a number of conceptualisations of the mechanisms that link academic researchers and various publics. These mechanisms are based on various communication models ranging from those based on a dissemination approach to those that are more dialogue-based. . Overall, the definitions suggest that the 'science-society' space is constituted through a spectrum of heterogeneous practices.

In order to begin to construct how the 'science-society' space is constituted we can look at a number of large scale studies which provide empirical insight into the engagement practices of researchers (e.g., Burchell Franklin & Holden 2009; Davies 2013b; Middleton-Price 2002; Royal Society 2006; UK-IRC 2009; Wellcome Trust 2000) that have focused on academics in the U.K. A survey (*The Role of Scientists in Public Debate)* was commissioned by the Wellcome Trust (2000) in which 1540 scientists in higher education institutions across the U.K., were interviewed to ascertain their understanding of, and attitudes towards science communication. More than half of the surveyed researchers (56%) had participated during the previous year in one or more of the 15[17] forms of communications activity included in the questionnaire. The survey showed that 32% had given non-scientific presentations; 29% had spoken to the media; 24% had participated in open days at their institutions; 13% had written or published work. The Royal Society (2006) conducted the follow up study through a web-based survey of 1485 research scientists and engineers in U.K. higher education institutions[18]. Of the surveyed sample, 74% had taken part in at least one science

[15] NCPPE website: http://www.publicengagement.ac.uk/

[16] http://www.publicengagement.ac.uk/explore-it/what-public-engagement Definition was accessed from the NCCPE website in August 2014.

[17] The options provided were: participating in open days for the general public at institutions; talking at schools and colleges; talking to TV or radio journalists; talking to journalists at national newspapers; speaking on TV/radio; talking to journalists at local newspapers; presenting at public conferences, other than scientific conferences for scientific professionals; speaking at public meetings; talking to journalists in the popular science press; speaking at non-scientific academic conferences; publishing articles in the popular science press; writing for the national press; writing for the local press; publishing articles in the computer press; talking to journalists in the computer press; an of these; none of these.

[18] There were additional samples of RC unit staff, Wellcome Trust fellows, Royal Society Fellows. There were also 41 follow-up in-depth telephone interviews as well as interviews with national stakeholder organisations.

communication activity. These included, in order of popularity, public lectures, talking with policy-makers, talking to schools, non-specialist publication, public dialogue/debate. Another survey (1065 recipients[19]) was conducted by the British Society for Human Genetics on *The Role of Genetics Professionals in Public Debate* (Middleton-Price 2002). Similar activities were reported by the respondents as in the other surveys; 14% of respondents talked at schools and colleges, 12% spoke at public conferences/debates, 11% talked to journalists at national newspapers, while 10% each talked to journalists at local newspapers, spoke on TV/radio, and participated in open days for the general public at institutions. Finally, a report published by LSE centre for the Study of Bioscience, Biomedicine, Biotechnology and Society (BIOS), entitled *Scientists on Public Engagement: from communication to deliberation*, also reported on similar activities to those mentioned in the previous studies (Burchell, Franklin & Holden 2009). Smaller studies have also shed a light on particular engagement activities with which researchers were involved. Davies (2013b) conducted a survey of contract research staff across U.K. universities[20]. This study too maintained a consistency with those previously reported – giving a public talk or lecture (43.8% of total), going into a school (39%), involvement in a university open day (37.6%), writing for public audiences (34.3%), being involved in a science festival, volunteering activities as well as knowledge transfer activities or working with industry (22.4%). A survey conducted in 2008-2009 by the UK-Innovation Research Centre (UK-IRC) investigated knowledge exchange activities between academics (over 22,000 researchers responded to an online survey representing a 17% response rate)[21] and various societal sectors (Aubreu *et al.* 2009). In the preceding year, researchers in engineering and material science were most likely to have taken out a patent – over a quarter of researchers in those disciplines reported this; 15% of researchers in biology, chemistry and veterinary science also reported doing so. A further step toward engagement beyond academia involved licensing research outputs to a company – over 15% of researchers in engineering and material science reported doing so whilst just over 5% of researchers in biology / chemistry / veterinary science reported this activity. Researchers also engaged in formation of spin out companies over the period in question – over 10% of researchers in engineering and material science; approximately 5% of researchers in physics and maths; less than 5% of researchers in the social sciences. However, the most popular activity amongst the surveyed researchers was conducting consultancy via the research – approximately 30% of researchers in engineering and material science; just under 15% of researchers in physics and maths; approximately 15% of researchers in biology/chemistry/veterinary science. This survey again

[19] The survey had a 25% response rate.

[20] This survey received 273 complete entries. The distribution of disciplines was 22.1% from physical sciences and engineering, 22.1% from the social sciences, 3.2% arts and humanities.

[21] Respondents were approximately split in half between social science, arts and humanities on the one hand versus health sciences, biology, chemistry, veterinary sciences, physics, maths and engineering and material science on the other.

reaffirms the varied ways in which researchers engage with the various sectors in society thereby demonstrating the heterogeneity and malleability of the science-society space.

These surveys of U.K. researchers echo the previous presented definitions and demonstrate the 'many faces of engagement' (Antonsen *et al*. 2014, p.3). Activities encompassing science communication / public engagement are very heterogeneous (Davies 2013a; Davies 2013b), and constantly changing for the researchers, who are often involved in multiple activities and relationships with public groups beyond academic institutions. Moreover, engagement is no longer limited to in-person types of activities. The popularity of social media has emerged to present researchers both with challenges and opportunities (Kaplan & Haenlein 2010)[22]. Scott Montgomery has argued that "the online world [leads] to science participation and to new expressive forms, but by doing so it shows that the boundaries once assumed to divide scientific endeavour, in its essence, from other domains such as politics, economics, and the wider contemporary culture, are largely mirages" (2009, p.86). One of the primary media through which science is being 'opened' up is through social media, in particular through blogging (e.g., Wordpress[23], Blogger[24]) and micro-blogging (e.g., Twitter[25]) platforms. Blogging as a general form of public communication has seen a dramatic increase in popularity since the 2000s. However, there has been a slow growth in 'science blogging'[26] (Trench 2012). "Scientists have been relatively slow to embrace [the web's] potential…among a few million scientists worldwide, only perhaps one or two thousand are blogging, at least about science" (Hannay 2007, p.20). A 2007 survey BioInformatics LLC[27] (in Van Eperen & Marincola 2011) reported that 77% of the respondents participated in some type of social media at the time when the dominant forms of online engagement were discussion groups and message boards[28]. A 2010 analysis by the Research Information Network (RIN) in the UK found that only 13% of the respondents admitted to using web 2.0 tools such as blogs, wikis, and social networking web sites for scholarly communication at a frequency of once a week or more; 45% used these tools occasionally, and 39% did not use them at all. These results were very much contingent on the field in which researchers were working. Wilkinson and Weitkamp (2013) reported that only a small number of U.K. environmental researchers were "actively using social media to disseminate their research findings, with many continuing to rely on academic journals and face-to-face

[22] A number of guides have been produced in order to inform academics about social media. For examples, see JustPublics@365 (n.d.), Mollettt et al. (2011), Palmer (2014), Paton (2014), Research Information Network (2011).
[23] Wordpress (http://www.wordpress.com) is a full online content management system.
[24] Blogger (http://www.blogger.com) is a free weblog publishing tool from Google, for sharing text, photos and videos.
[25] Twitter (http://www.twitter.com) is an online social networking service that enables users to send and read short 140-character messages called "tweets".
[26] For a definition and historical overview of 'science blogs' see Zivkovic (2012).
[27] BioInformatics LLC (http://www.gene2drug.com/) is a life science consulting firm that provides market intelligence to companies which serve the life science, medical device and pharmaceutical industries.
[28] See Anderson (2008).

communication to reach both academic and public audiences" (p. 1)[29]. Lupton (2014) conducted an international online survey of 711 academics[30] concerning their use of social media – 97% of the respondents confirmed that they were using social media as a part of their academic work[31]. Respondents were using a number of social media networks for academic purposes: Twitter (90%), Facebook (33%), YouTube (21%), personal blogs (25%), multi-author blogs (16%). The emergence of social media tools within the context of higher education has further diversified the science-society space. However, from the available research it appears that it is somewhat limited in terms of adoption amongst researchers. Those researchers that have engaged with it have been able to use it as both a dissemination tool as well as a dialogue tool.

The survey findings strongly suggest that scientists' engagement practices demonstrate that the 'science-society' space is constituted through a multiplicity of activities (both in person and online), which are characterised by diverse interrelations between researchers and publics, which are contingent and are always evolving (most recently through the emergence of social media tools for the purposes of dissemination and dialogue). There are a number of "factors and processes that lead scientists to interface with nonscientists" (Dudo 2013, p. 479). There have been a number of studies that have attempted to address in an empirical fashion factors that are salient to the scientists perceptions of the mechanisms linking them with various publics (science communication, public engagement, etc.) and behaviours (e.g., Bauer & Jensen 2011; Davies 2013a; Dunwoody, Brossard & Dudo 2009; Dudo 2013; Gascogine & Metcalfe 1997; Jacobson *et al*. 2004; Martin-Sempere *et al*. 2008; Marcinkowski *et* al. 2014; Neresini & Bucchi 2011; Pearson *et al*. 1997; Peters *et al*. 2008; Poliakoff & Webb 2007). These factors have included: public duty; public accountability (in other words, accountability to the taxpayer); gaining public approval; the need to maintain and/or increase public funding; promotion of own area of research; desire to education and/or inform; recruitment of new scientists and science students. Recent work by Dudo (2013) identified key factors which made a strong contribution to scientists' public communication activities, and included: scientists' status, communication autonomy, use of print and online media, intrinsic rewards, communication training, perceived behavioural controls, normative beliefs, and level of medialization. The relationship between gender and public communication activity is yet to be fully determined – some research has suggested that male scientists were more likely to engage (Bentley & Kyvik 2011; Kreimer *et al*. 2011), whilst other research found a greater prominence of female scientists in public communication (Jensen 2011; Jensen *et al*. 2008). Regardless of gender,

[29] Questionnaire was sent to 504 researchers. There were 149 valid responses (29%). The biggest single group of respondents came from the UK (15%).

[30] Largest response groups were from the UK (37%), Australia / New Zealand (25%), USA (20%), continental Europe (10%).

[31] The survey was publicized using a number of social media networks, including Twitter. Therefore, it is not surprising that the vast majority were using social media as part of their academic work.

researchers who are performing well academically (e.g., publication record) also engage beyond academia to a greater extent (Bauer & Jensen 2011; Boltanski & Maldidier 1970; Peters *et al*. 2008). Organizations and their structures within which researchers function can also affect their engagement practices (Jacobson *et* al. 2004; Marcinkowski *et al*. 2014). For academic scientists working in universities, within their primary activity of doing research, communication is occurs in the form of dissemination via academic journals. This method is underpinned by a one-way model of communication. This model can also be found in the analysis of various engagement initiatives undertaken by researchers. But this model is not the only model underpinning engagement activities. These models are discussed in greater detail in the next section.

2.5 Science Communication Models

Engagement activities can be underpinned by a number of science communication models. A number of different conceptual models, reviewed below, have been put forward to examine the ways that communication operates and the relationships of the key actors in the process.

Canonical Model

When considering the '***communication of science to the public***', the communicative relationship between science and society, a standard account has been postulated under a number of titles, including 'canonical account' (Bucchi 1996; Bucchi 1998; Shapin 1990), 'dominant model' (Hilgartner 1990) and 'diffusionist model' (Lewenstein 1995). Whilst the names differ, these accounts are based on similar arguments. First, science as an enterprise has become too specialized to be accessible in terms of understanding by the general public. As a result, a process of mediation is necessary in order to make scientific findings both accessible and relevant for the general public. The mediation process may be carried out by a 'third party' who bridges the 'gap' between scientists and non-scientific publics; journalists would typically occupy this role by providing simplified accounts for public consumption. This absolves researchers of responsibility for the process and maintains the social 'neutrality' of their scientific role. Frequently, the process can be described as 'linguistic translation' (Bucchi 1996).

This ('canonical') account is based on a number of assumptions about the relationship between science and society. The main assumption is that the two exist as separate entities. Practically, this implies that the processes of knowledge production and communication are not integrated. Once researchers have produced the scientific knowledge (and deem it reliable) it can then be distributed (for example, by journalists) to non-experts in the public domain. A graphic representation of the canonical account is presented in Figure 2.1.

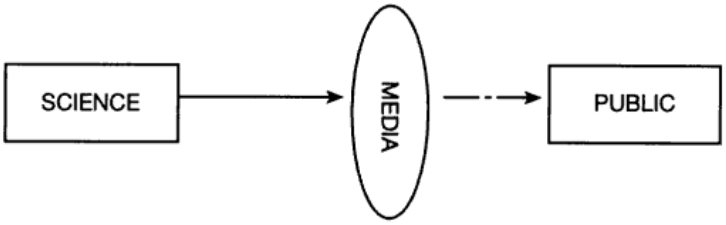

Figure 2.1 – Transfer model of science communication (Bucchi 1996).

Framed through the parameters of the canonical account, the communication process in the broad sense is concerned with the transfer of knowledge from scientists to public. As such, science communication is a one-way linear process occurring between demarcated entities of science and society. The knowledge that is being transferred is not subject to major changes as it transitions from one context to another – this implies that an idea originating in the scientific community can be easily transferred to the public. Within this relationship, there exists a role of a mediator, which is frequently performed by the media. Media is allotted the role of being a major channel through which scientific ideas travel from the domain of science into the public domain. However, this task is not necessarily accomplished to necessary standards (especially, in the eyes of researchers) due to what may be limited competencies and/or the influence of other priorities, such as commercial interests. Finally, for science communication, the 'target' is 'the public', which is envisioned to be amorphous in nature and is generally passive. Implicitly, this suggests that the relationship between the public and the media should be amicable in order for the communication process to occur in accordance with the proposed model. However, both governments and scientists alike have come to acknowledge that if the public and media are sufficiently hostile, they can constrain or even veto a research program that is deemed contentious (Miller *et al*. 1997).

Deficit Model

Public hostility in the form of negative attitudes towards science and technology have been attributed to a lack of public understanding or knowledge (in other words, a 'deficit' on the part of the public) of science. It is through the process of science communication that this deficit in knowledge and/or understanding can be addressed. Therefore, the dominant model of science communication is connected to the (cognitive) deficit model of public understanding of science (Wynne 1991; Ziman 1991). The reasoning for this model of science communication is grounded in the cross-national empirical evidence that highlights a robust, but not a particularly strong positive correlation between one's "textbook" scientific knowledge and the favourability of one's attitude toward science (Bauer *et al*. 1994; Evans & Durant 1995; Miller *et al*. 1997; Sturgis & Allum 2004).

It is not surprising that the 'deficit' model of science communication has come under substantial criticism as research in the fields of science communication and more broadly in the area of 'science, technology and society'. Firstly, criticism has focused on the relationship between public attitudes towards science and technology and public understanding of science. The deficit models holds that the 'negative' attitudes towards science and technology are due to a lack of understanding of science. An implication of this approach is that better scientific communication would result in more positive attitudes. However, this does not necessarily hold true. Various studies on the perceptions of biotechnology have demonstrated that increased science communication does not lead to the reduction in hostility towards particular biotechnological applications (Bucchi & Neresini 2002; Gaskell & Bauer 2001). Douglas & Wildavsky (1982) have suggested, for example, that people focus their attention selectively on risks associated with science and technology based on perceptions that are current in their cultural milieu rather than on a scientific knowledge .

Another criticism of the 'deficit' model of science communication is associated with the method through which data are used to make the case for the presence of a 'deficit', namely surveys. They have come under scrutiny in terms of how such research incorporates and interprets measures of scientific understanding (Hayes & Tariq 2000; Peters 2000). Furthermore, in the contexts of scientific controversies, different parties will select different knowledge areas as being of importance (Peters 2000). As a result the selection of development of knowledge measures may not necessarily correspond to the views of all the parties involved; and does not substantial proof of a 'deficit'.

Another criticism of the deficit model centers on the presence of other knowledge domains that may influence attitudes towards science and technology. This has been described as the 'contextual model' (Lewenstein 2003, p. 3) or 'contextual perspective' (Sturgis & Allum 2004, p. 58). This perspective transitions from viewing the public as 'empty vessels' waiting to be filled with knowledge to individuals who process information "according to social and psychological schemas that have been shaped by their previous experiences, cultural context, and personal circumstances" (Lewenstein 2003, p.3).

In relation to surveys, the main thrust of this perspective is that "surveys take the respondent out of social context and are intrinsically unable to examine or control analytically for the potentially variable, socially rooted meanings that key terms have for social actors" (Wynne 1995, p.361). Wynne (1992), in critiquing the survey reliance on textbook knowledge scales, has suggested that to capture the knowledge domains of relevance to public attitudes towards science requires "three elements of public understanding to be expressly related: the formal contents of

scientific knowledge; the methods and processes of science; and its forms of institutional embedding, patronage, organization, and control" (p. 37).

Despite the historical ubiquity of the canonical model of communication, numerous studies (particularly since the 1950s) have engaged critically with it through empirical work. Before moving on to the other models that have been since proposed, I will review in broader terms what these studies have indicated about the communication process, as summarized by Bucchi (2004). Science communication from the scientific domain to the public arena is not a linear process and can originate both in the popular domains and in the public sphere (Lewensein 1995a, 1995b; Bucchi 1996, 1998). Various publics do not receive scientific information in a passive manner; there is a complex process of transformation with potential to affect the scientific debate (Wynne 1989, 1995; Epstein 1996). Therefore, overall, a clear demarcation between science and society cannot be established as suggested by the canonical transfer paradigm and evoked by members of the scientific community through rhetorical strategies (Hilgartner 1990). To capture the constantly changing relationship between science and society, the science communication process can be envisioned as a continuous sequence of 'expository levels' transitioning from one into another with variation characterized in terms of 'degree' rather than in 'kind' and indicative of the mutual influence of one on another (Cloitre & Shinn 1985; Hilgartner 1990; Lewesntein 1995a; Bucchi 1996, 1998). Representation of the science communication process as continuous in nature is addressed in further detail in the next section.

Continuum Model

In the canonical model, science communication was essentially envisioned as a two stage process. In the first stage, the 'canon' of scientific knowledge is produced and developed by scientists; in the second stage, mediators (e.g., media specialists) spread a streamlined version of this message to various publics. This implies a 'clear' demarcation between knowledge production and its subsequent dissemination. Hilgartner (1990) has offered a critique of this model of science communication, arguing that the utilization of this dichotomous model enables scientists (and others whose authority is grounded in science) to protect their authority over the domain of knowledge production. In his view, this 'dominant view of popularization' is "a serious oversimplification that cannot, on its own terms, provide an adequate model of the process through which scientific knowledge spreads" (Hilgartner, 1990 p. 533). The oversimplification is based on the assumption that it is possible to differentiate between 'genuine knowledge' and 'popularized knowledge'. In order to acknowledge the 'permeable' nature of this boundary, a 'continuity model' of science communication has been suggested (Cloitre & Shinn 1985; Hilgartner 1990). This model argues that

scientific knowledge is presented in many contexts using variable styles of communication. Therefore, ''popularization' is a matter of degree" and the "boundary between real science and popularized science can be drawn at various points depending on what criteria one adopts, and these ambiguities leave some flexibility about what to label as 'popularization' " (Hilgartner 1990 p. 528). The model is presented in Figure 2.2 with situation of the communication process in relation to the knowledge production process (downstream implies communication following the process of knowledge production; whilst upstream implies communication (prior to the knowledge production process).

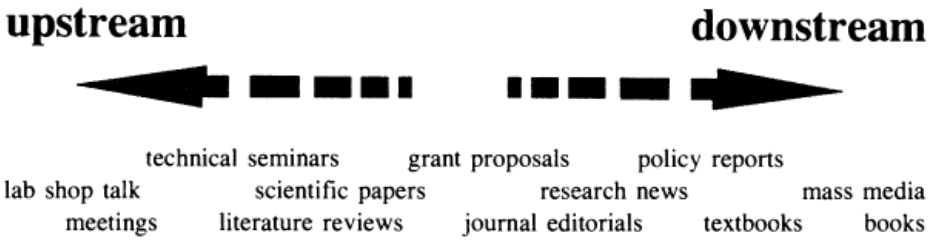

Figure 2.2 - Continuum Model of Science Communication (Hilgartner 1990).

Cloitre & Shinn (1985 in Bucchi 1996) have offered one of the more extensive models of communication within which they identify four main 'levels' in the process of scientific communication (see Figure 2.3): intraspecialistic, interspecialistic, pedagogical and popular. The scientific journal is the prototype for the intraspecialistic stage, which is the distinctly esoteric stage. The interspecialistic level includes various texts ranging from interdisciplinary articles in 'bridge journals' (e.g., Nature, Science) to papers given at meetings (researchers belonging to the same disciplines but working in different areas). The pedagogical level incorporates teaching of the corpus of science that has already been established and is therefore characterized by a historical perspective and the cumulative nature of science as a whole. Finally, the popular level incorporates texts such as science articles that are published in the daily press. This model describes science communication as a 'cognitive trajectory' (Bucchi 1996, p. 378) through which scientific ideas progress from the intraspecialistic level to the popular level via the intermediary stages. "The communicative path from specialist to popular science can thus be illustrated as like a funnel that removes subtleties and shades of meaning from the knowledge that passes through it, reducing it to simple facts attributed with certainty and incontrovertibility" (Bucchi 2008, p. 62).

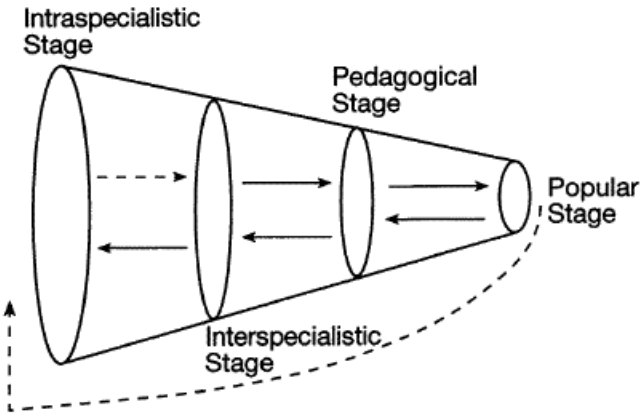

Figure 2.3 - Cognitive trajectory of science communication [continuum] (Bucchi 1996).

Although the 'continuum model' does offer a degree of departure from the 'demarcation' perspective, it does not move away from a particular directionality of the communication process. The 'continuum model' is still based on a transfer paradigm whereby knowledge is transferred from the upstream science communication level to the downstream level (Bucchi 2004). The model does account for the possibility that, during the transfer, knowledge can be transformed, so it is not the case that (scientific results) undergo a simple transportation from one level to another. However, the direction of transformation is for the most part pre-established situated at the specialized level (Bucchi 2004). Therefore, the continuum model of science communication appear to describe "a more complicated transfer" (Bucchi 2004, pp.272-273).

'Deviation' Model

The continuity model provides a useful frame of reference in terms of describing a flow of information from the 'intraspecialistic' stage all the way to the 'popular' stage in what can be considered as 'ideal circumstances'. However, "certain communicative situations (in Shinn and Cloitre's terminology, 'deviations') cannot be accounted for within the canonical model or the continuity model of public communication of science" (Bucchi 1996, p. 382). In certain cases, such as when there is a necessity to either defend or extend the boundaries (that define science, or disciplines within science, or paradigms within a discipline) communication does not progress through the prescribed stages and instead proceeds directly to the 'public level'. Cloitre and Shinn (1985) refer to instances when an orderly sequence does not occur, as 'deviations'. Deviation to the public level can occur as a result of political, social and institutional pressures. The result is such that the scientific debate moves beyond the boundaries of science (e.g., from the pages of scientific journals) and into the public domain. Under these conditions, it is possible that scientific knowledge claims can be subject to influence from non-scientific parties.

> "The popular stage can in this sense provide an open space where stimuli, ideas and information may be merged and exchanged among different actors and across disciplinary fields, in the absence of the constraints and conventions which bind scientific work and communication at the specialist level" (Bucchi 1996, p. 386).

Web Model

In contrast to the uni-directional dissemination model and the bi-directional continuum model of science communication, Lewenstein (1995a, p.426) suggests a "web of science communication" model, which accounts for the many forms of scientific communication interacting with each other. He suggests that instead of a 'spectrum', "it might be better to describe a circle or a sphere, with all forms of communication leading to each other" (p.426). In this model, which was developed through the example of the cold fusion science communication saga, mass media moves to occupy the central place (see Figure 2.4) with other the forms of communications media being dependent on the role of mass media.

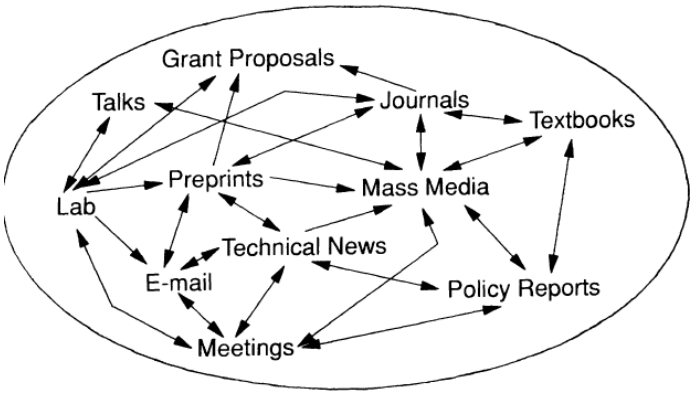

Figure 2.4 - Web of Science Communication Contexts (Lewenstein 1995)

This more 'complex' version of science communication stresses the interconnectedness across permeable boundaries of various forms of communication. The general point of this model is that analysis of the role of any particular media in science cannot be accomplished in isolation and instead analysis should focus on the analysis of the complexity of interactions amongst all media (for an empirical example using this model, see [Gregory 2003]). Furthermore, while the paper focused on communication amongst scientists, the centrality of the media in the model also suggests that whilst the scientific communication was not specifically aimed at other publics (apart from scientists) it certainly did go through other trajectories and therefore reached other audiences. Therefore, whilst still maintaining a sense of directionality and the importance allotted to the flow of

knowledge from one party to another, the multiplicity of trajectories depending on context is acknowledged by this model. [32]

Hydrological Cycle Model

Goulden (2011) has built on the river metaphor (uni-directional flow of the continuum model), Lewenstein's (1995a) 'web of science communication' model and Gieryn's (1999) "cultural cartography" work to suggest a hydrological cycle model in order to bridge gap between knowledge production and communication (communication, for example, was the focus of Lewenstein's model). Using the corresponding language of the hydrological cycle (whereby scientific knowledge is represented by the analogy with water in the cycle), the model is explained as follows:

> "Water does not simply materialize upstream, before flowing downstream and out into the oceans. Instead, through the processes of evapotranspiration and precipitation, the water continually circulates, following regular patterns, but always with the possibility of "freak behaviours. As the water moves downstream the river may cut back on itself in many places. Additionally, water will not always flow along the recognized river channels, but can also "deviate" along different paths – perhaps feeding into bedrock to reappear downstream as a spring. Continual processes of upheaval and erosion change structures of land, and hence patterns of flow, over time" (Goulden 2011, p. 585).

The model incorporates the idea of systems of feedback between science and society and 'inherent instability' in the process. Thus, further migration downstream will result in the process of exchange occurring between an increasing number of entities. Moreover, within the framework of this model, no two episodes of communication will be identical. Whilst a pattern may occur, there is an inherent contextual instability within and across frames, which is particularly evident in contexts of controversial science. Finally, this model also recognizes that there is a lack of demarcation between science and society, an observation that is consistent with the continuum model of science communication.

'Double helix' model

Bucchi (2004) also draws on the idea of an ongoing exchange between science and society to focus on the variability in intensity of these interactions around certain issues. He describes the communicative relationship between science and society "…as 'cross-talk' between the specialist and public discourse or as a 'double helix' coupling the two dimensions under certain conditions" (Bucchi 2004, p. 269). Here, the specialist scientific discourse and the public discourse are not considered as layers of the same discourse but rather as two different types of discourse which

[32] Despite various public outlets having an active role in communication of scientific knowledge, public(s) did not have any impact on any of the knowledge claims that were being made (see Lewenstein [1995, p. 428]).

'cross talk' under particular conditions. This process is enabled through boundary objects and trading zones (These are addressed later in this chapter).

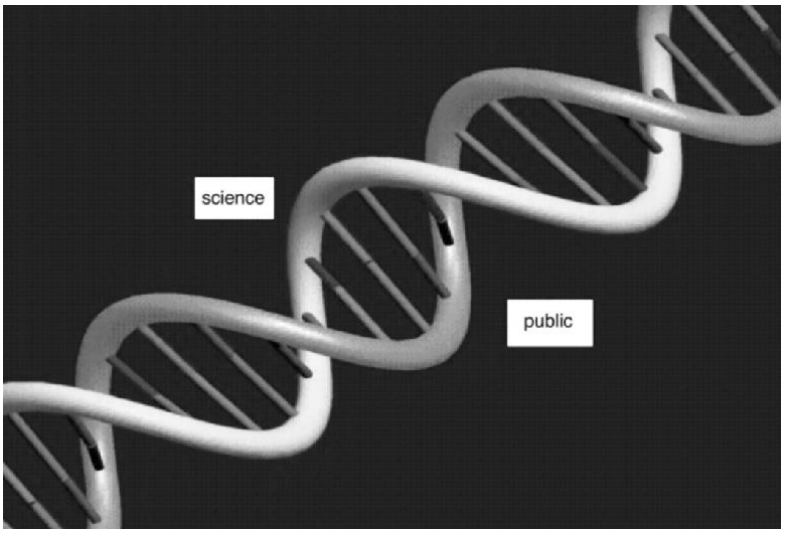

Figure 2.5 - Double Helix model of science communication (Bucchi 2004).

Adopting this approach has several implications. Through the frame of this model, science communication is not viewed only as a cause, but also as a result of developments in both scientific and non-scientific discourses. This implies that an intersection zone (i.e., a trading zone) is formed, which in turn can facilitate exchange across a number of discourses, thereby reinforcing itself in a recursive fashion. Another advantage of this model is that it reframes communication as a process which sustains the actors' interaction (rather than being a starting point for interaction). The formation of an intersection zone requires the occurrence of several conditions, such as discursive conditions, as well as social and affective. Therefore, the focus is on the mutual nature of the communicative encounter which shapes both the public and specialist discourse. The encounter contributes to the constitution of the atmosphere associated with the discourse in question as well as to the broader 'atmosphere of engagement'. This model renders atmosphere of engagement simultaneously broader and more polarizable, due to the "alteration between the phases of 'apparent communication between science and the public' and 'actual communication between science and the public' "(Bucchi 2004, p. 280).

Emergence Model

Whilst the 'double helix model' of science communication focuses on the relationship between science and society at the level of discourse, "in practice, it is individuals or small groups of technical experts who come into contact with publics, not science as an institution or an establishment"(Davies 2008b, p.414). Therefore, besides considering the communicative relationship between science and society at the wider level of social discourse (around particular

topics), it is necessary to explore the relationship at the level of individual scientists and their public engagement practices. Drawing on the critical studies in public understanding of science (Michael 2002; Irwin & Michael 2003; Jensen 2005; Lezaun & Soneryd 2007), Horst & Michael (2011, p.286) have proposed a *model of emergence* to represent of the communicative relationship between science and society where there is no privilege associated with direction of informational flow. Instead of conceptualizing communication as a flow of knowledge and values from one party to another, communication is seen as a "constitutive force in shaping entities such as science, publics and society" (Horst & Michael 2011, p.286). In this model, science communication is conceptualized as an event in which the event itself and the various elements that contribute to it are emergent. The event is regarded as "an actual occasion comprised of the coming together of numerous entities that are social and material, human and non-human, macro and micro, cognitive and affective, available and unavailable to consciousness"(Horst & Michael 2011, p.286). This coming together of various bodies results in the production of an emergent atmosphere, which reconstitutes the atmosphere that may have pre-existed the interaction. Through this productive interaction (through which the atmosphere is reconstituted), the constitutive elements are changed. In the case of science and society, they both emerge, as "as more or less changed" (Horst & Michael 2011, p.286). For the actors, science communication is an event through "…which novel relations and identities emerge" (Horst & Michael 2011, p.286). Adoption of the emergence model in relation to science communications characterizes the public space of science communication in terms of heterogeneity, contingency and instability. Therefore, any number of elements, human and non-human can 'become together' in variable ways.

2.6 Conceptualising Publics

The discussion of the various communication models explicitly engages with scientists' construction of the public. Welsh and Wynne (2013) trace the changes in the elite imaginaries of the public from "passive non-entities, circa 1950-1990 (continuing); as incipient threats due to presumed deficits in their grasp of science 1900-2000 (continuing); and, since circa 2000, as politicised threats requiring state control"(p.540). Similarly, the elite imaginaries of publics can be situated in parallel to the changes in the communicative relationship between public(s) and scientists. The period of 1960s to 2000 was dominated by the 'public understanding of science' agenda that became synonymous with deficit model of science communication. Within the parameters of this model the public is imagined as a homogeneous entity that lacks scientific knowledge (e.g., scientific literacy), which contributes towards fostering negative attitudes towards science and technology in the wider society. Literature grounded in the traditions of STS has critiqued the idea that "the public" is homogeneous in nature and can be described as a "black box" (Irwin & Wynne 1996). Instead, STS

scholarship recognises the plurality of heterogenous "publics" (Rayner 2003 in Cotton & Devine-Wright 2012). In particular, criticisms of the deficit model have highlighted the public as active citizens with valid knowledge that is of relevance within the context of the decision making process (corresponds to the dialogue model of communication) (Irwin & Wynne 1996). This perspective on the publics can be correlated with the emergence of the public engagement agenda circa 2000 in the U.K. However, how experts construct publics is likely to be situated somewhere between the conceptualisations offered by the two models (Davies 2008a, 2008b). The way scientists construct publics affects the framing of interactions that are potentially feasible between the two parties (Maranta *et al*. 2003). Overall the "understanding how experts construct publics is critical in any attempt to understand their patterns of public engagement" (Burningham *et al*. 2007, p.25).

2.6.1 Imagined Publics

The idea that publics are constructed in engagement is crystallised in the concept of "**imagined lay person**" (ILP) developed in the work of Marranta *et al*. (2003). The ILPs are "conceptions of lay persons as they are manifested in the products and actions of the experts…Imagined lay persons need not be explicit. Nor need they have any resemblance with real lay persons. Rather, imagined lay persons are functional constructs in expertise" (Marranta *et al*. 2003, p.151). Thus researchers engaging in the construction of ILPs do so by "…according to them more or less significance, competence, and differentiation" (Walker *et al.* 2010, p.934). For example, Burningham *et al*. (2007) report that for companies in the chemical industry the public is conceptualised primarily as "consumers" and "neighbours" in possession of concerns that need to be addressed instead of parties with knowledge that dictates engagement. These categories were not necessarily synonymous with "public" or "citizens". Therefore, this study demonstrated the multidimensional representation of the public and its connection to their knowledge and modes of engagement. Drawing on the work of Marranta *et al*. (2003), Barnett *et al*. (2012), focus on the renewable energy sector in order to "reveal interdependencies between the principles and practices of engagement and the nature of the imagined publics with whom engagement is being enacted" (p. 37). The found that industry actors conceptualised publics in terms of two key dimensions: lack of knowledge and presence of concern. Three broad groups were identified as those supporting the renewable energy projects ("supporters"), those in opposition of the projects ("opponents") and those individuals without a view ("did not have a view"). These studies and others have demonstrated that construction of publics is connected to assessment and characterization of their knowledge and the modes of engagement with them. Demarcation of 'the public' into various categories still renders 'the public' in part as an ungraspable or 'phantom' entity (Latour 2005; Lippmann 1925; Marres 2005).

2.6.2 InfraPublics

"The existence of a public is contingent on its members activity, however notional or compromised, and not on its members' categorical classification, objectively determined position in the social structure, or material existence…They are virtual entities not voluntary associations" (Warner 2002, pp.88-89 in Hawkins 2011, p. 543). Drawing on the work by Warner (2002), Hawkins (2011) suggests that "what calls a public into being is not a common identity but a shared acceptance of a distinct form of address or response to an affective modulation "(Hawkins 2011, p. 543). Consequently, contexts of publicness and of publics such as engagement events are sites in which 'potential or 'infrapublic'' (Hawkins 2011, p. 551) can emerge through engagement with science through various practices. However expansive or limited these practices are, they contribute to the constitution of the atmosphere associated with that particular engagement event and more broadly towards the constitution of the overall 'atmosphere of engagement'. Consideration of 'publics' as 'infrapublics' "challenges the reification of publics, the assumption that they already exist and are waiting to be convinced by the appeal of reason or that they are coherent collectives who share a common conviction. Rather, the idea of an infrapublic, like the infrasensible, foregrounds the political as a field of potential where transformative actions or construction of new collectives might emerge…" (Hawkins 2011, p.551).

2.6.3 Publics-in-General (PiGs) and Publics-in-Particular (PiPs)

Engagement events can become sites where publics are formed and performed (Felt *et al*. 2007). The performance of publics occurs in relation to other entities including the issue in question as well as its corresponding technoscientific dimensions, various actors, as well as other publics. Publics establish their own position by enacting 'publics in general' (PiGs) and 'publics in particular' (PiPs). PiG can be regarded as "emergent not least through its complex relations to science-in-general" (Michael 2009, p. 621)[33]. 'Science-in general' (Michael 1992) is "science understood in terms of general characteristics such as the use of hypothesis testing, or the production of particular sorts of arcane knowledge, or a commitment to epistemic (or even "civilizational") progress" (Michael 2009, p. 620). Thus, it is a public that can be defined, against, or identified with, such a science-in-general; and to a certain extent has always been there. PiG is something that always "been there". In contrast, PiPs emerge in relation to technoscientific issues (e.g., Marres 2007; Latour 2007). Consequently, PiPs can be defined as "those publics that have an identifiable stake in particular scientific or technological issues or controversies" (Michael 2009, p. 623). In relation to issues of techscientiic impact, PiPs can be narrowed to a geographical area. Within this context, the

[33] PiG can also be thought of as "a self-creating, free-standing and sustaining singularity" (Michael 2009, p. 621)

performances of PiPs can enact alliances with other actors (e.g., the media, experts, political actors) and can be connected to specific projects, programs and other initiatives. There are several strategies for PiPs to enact their 'public-in-particularness'. A strategy may involve establishing own reality and authenticity which may involve processes of creating connections and boundaries between self, other PiPs and science. And yet another strategy can involve the process of demarcation of limits, and within, a PiP. PiPs can also differentiate themselves from PiG. Publics can exercise selectivity in their interaction with science (Levy-Leblond 1992) based on the criteria of 'interest'.

2.7 Trading Zones

The process whereby various a in the context of an engagement event attain a degree of change can be conceptualised as a "trading practice" (Lieto 2013). The practice can be conducted through a combination of 'boundary objects' or 'trading zones'. 'Trading Zone' has often been used "to denote any kind of interdisciplinary partnership in which two or more perspectives are combined and a new, shared language develops" (Collins *et al*., 2007, p.657). This is a space where the 'problem of communication' is resolved. In this section, using the work of Collins and colleagues (e.g., 2007) and others, I explore its relevance in relation to science communication. I begin by exploring the roots of the concept as grounded in the issue of (in)commensurability as discussed by Kuhn (1962), followed by Galison's (1997) refutation of its assumptions and the consequent development of the 'trading zone' concept towards a more general model of trading zones postulated by Collins and colleagues (2007).

The answer to the question concerning the resolution of communication problems can be considered first through the work of Thomas Kuhn. Kuhn (1962) suggested that science is conducted under the auspices of 'paradigms'. Their foundations are grounded in the undertaking of 'normal science' which "means research firmly based upon one or more past scientific achievements, achievements that some particular scientific community acknowledge for a time as supplying the foundation or its further practice" (Kuhn 1962, p. 10). As a part of doing 'normal science' the following principle problems are addressed: determination of significant fact; matching of facts with theory; articulation of theory. Addressing these problems ultimately leads to refinement and reinforcement of the paradigm. Whilst the solidification of the paradigm is an achievement, the process of its creation does not render it exclusive to one particular group of people. This means that, in theory, a single paradigm may serve numerous scientific groups. However, it is not the same paradigm for all of these groups. Therefore, normal science can be defined by a number of traditions that do overlap but are not coextensive. This implies that by the simple process of working within these paradigms, those scientists, even those within the same discipline, will face difficulty in

creation of a meaningful space of communication as a result of having different constructions of reality. In essence, within the process of communication, researchers would be talking past each other. This has been described as the problem of 'incommensurability' which may relate to methodological, perceptual / observational and semantic aspects of science and the ways it is reported. Incommensurability occurs between specialized fields *within* disciplines. However, it is further exacerbated when researchers *cross* disciplinary and expertise boundaries.

The idea of 'incommensurability' as introduced by Kuhn (1962) is taken up and rejected[34] by Galison (1997) who draws on the anthropological tradition of studying interaction of unlike cultures. Focusing on scientists and engineers that engaged in the development of radar and particle accelerators, Galison (1997) demonstrates how they were able to engage in constructive communication in order to complete the projects. Scientists and engineers, who according to Galison are two culturally dissimilar groups, yet not homogenous but intercalated internally, were able to communicate in what he terms 'trade zones'. A trade zone refers to "a social, material, and intellectual mortar binding together the disunified traditions of experimenting, theorizing and instrument building" (Galison 1997, p. 803).

> "Two groups can agree on rules of exchange even if they ascribe utterly different significance to the objects being exchanged; they may even disagree on the meaning of the exchange process itself. Nonetheless, the trading partners can hammer out a local coordination, despite vast global differences. In an even more sophisticated way, cultures in interaction frequently establish contact languages, systems of discourse that can vary from the most function-specific jargons, through semispecific pidgins, to full-fledged creoles rich enough to support activities as complex as poetry and metalinguistic reflection" (Galison 1997, p. 783).

Within these 'spaces', these two groups of researchers developed liminal vocabularies ('systems of discourse': simplest of these 'inter-languages' is 'jargon', more complex is a 'pidgin', while a 'creole' is a completely new language). Therefore, a lack of a common language is suggested to act as a catalyst for the development of a new language (with various degree of similarity) that would enable communication. Previous research has suggested that a language barrier can actually aid in communication by avoiding a potential confrontation between people with differing beliefs, customs and concepts (Ribeiro 2007a). Therefore, 'trading zones' are not just metaphors (Gorman *et al*., 2004) and instead provide a connection between "place, exchange, and knowledge production" (Galison 1997, p. 784).

However, a trade does not necessarily have to occur within a 'trading zone' (Collins *et al*. 2007). Collins *et al.* (2007) define '**trading' zones** as "locations in which communities with a deep problem

[34] Galison wrote *How Experiments End* (1987) in which he attempted to capture experimentation as a distinct form of reasons from theory. By that point he had already formulated a picture of the physics community as "intercalated, quasi-autonomous subcutlures of theory, experiment, and instrument making" (Gorman 2010, p. 26). However, this also made the problem of incommensurability worse.

of communication manage to communicate. If there is no problem of communication there is simply a 'trade' not a 'trading zone' " (p. 658). Hence, in order for a trading zone to actually emerge, there has to be a problem of communication. I have demonstrated in Chapter 4 that that the 'problem of communication' (or lack thereof) has been central to the emergence of the 'atmosphere of engagement' in the U.K. Furthermore, the definition of trading zones provided by Collins *et al*. (2007) renders them as more dynamic entities, compared with what Galison (1997) was suggesting. In a more general sense, "when a trading zone is organized around kinds of people it is far more dynamic than implied by Galison's original formulation. The very identities and interest of participants, as well as the character of the objects being exchanged, can change as a result of the trade and thus reconfigure collaboration or bring it to an end" (Navon & Eyal 2014, p. 334). Hence, 'engagement agenda' emerged in the U.K. with the view of improving the problem of communication broadly between science and society and has evolved through a 'supposed' transition from initiatives grounded in one way models of communication to those situated more in dialogic approaches (see Chapter 4 for the historical evolution of this transition). Therefore, at the scale of engagement events, they can be understood to be as a trading zone between various entities (human and non-human), and in particular, between researchers and various publics.

The goal of creating a 'trading zone' is the "sharing of expertise" (Gorman *et al*. 2004, p. 65). Collins and Evans (2002) have distinguished between three levels of expertise which can potentially be shared within a trading zone when more than one party is involved (e.g., more than one scientific discipline):

1. *None*;
2. *Interactional Expertise;*
3. *Contributing*.

In the first level, sharing of expertise does not occur. There is no knowledge exchanged between the involved parties. Such dynamic corresponds to Kuhn's 'incommensurability'. Individuals positioned in the old paradigm cannot communicate with individuals positioned in the new paradigm even though they may be working in the same setting. This can occur between different disciplines but also between different cultures. For example, Gorman (2005) refers to the classic study by Latour & Woolgar (1986) of laboratory life where a sociologist or an anthropologist studies the scientific laboratory without necessarily making an effort towards understanding the scientific content of the work being undertaken, thereby maintaining the degree of incommensurability between the parties.

In the second level of expertise, ***interactional***, the requirement is for partial sharing of domain-specific knowledge. In other words, various parties need to possess enough expertise to be able to interact with another party; one may know less than an expert in a particular area, but enough to communicate. To continue with the example from above, a sociologist or anthropologist who are studying a laboratory would acquire enough scientific knowledge to be able to engage in meaningful domain-specific discussions with researchers. Another example of this comes from Epstein (1995) who describes how AIDS activists who underwent a process of educating themselves in scientific terminology to the point that they were able to engage in meaningful interactions with the researchers.

In the third level of expertise**, *contributing***, one party possesses enough expertise to be able to contribute to the domain of the other party. Epstein (1995) describes how AIDS activists, in order to represent the wider interests of the community within the clinical trials process learned the scientific language and attained a greater level of legitimacy within their interactions with the scientists. Specifically, through the processes of education and strategic alignment with appropriate parties, the activists were able to contribute towards the trials becoming less rigorous from an experimental standpoint, but gaining in ecological validity from the standpoint of AIDS treatment. Therefore, by becoming more like scientists, a number of activists were able to contribute to AIDS research in a very direct manner.

The three types of described expertise can be situated on a continuum, "shifting not only as an individual learns more about a domain of expertise but also as the nature of the problem shifts"(Gorman 2005, p. 290). Possession of these types or levels of expertise influences the nature of corresponding trading zones. Using the work of Galison (1997) and Collins & Evans (2002), Gorman (2002) proposed a framework for multidisciplinary collaboration (Table 2.1) by linking the three kinds of expertise to various trading zones.

Trading Zone	Elite (exclusive)	Boundary Object	Shared Representation
Expertise	None	Interactive	Contributory

Table 2.1 - Framework for Interdisciplinary collaboration (Gorman 2002).

When there is no expertise being shared (no trade occurring between the parties), the trading zone can be dominated by the 'elite'. The 'elite' is the dominant force within this trading zone and those who are not a part of the 'elite' have to conform to their view or they are ignored. Within the context of such dynamics, the knowledge possessed by the 'elite' is 'black-boxed' for other participants in the trading zone. Subsequently, access to the knowledge is stringently controlled. Moreover, the communication is conducted in a top-down manner, basically corresponding to 'orders' which must be obeyed. An example of this dynamic is found in the

agricultural and manufacturing schemes which were rolled out in the Soviet Union (Graham 1993; Scott 1998). There was no consideration allotted to the experiential expertise of farmers, workers and engineers.

In contrast, the second type of trading zone, 'interactional', is grounded in the process of collaboration of experts on a common project. "This kind of trading zone includes a continuum, from limited, adversarial interactions… to a more constructive engagement among interacting experts who agree on common goals" (Gorman 2002, p. 934). An example of this is a 'boundary object') trading zone where experts interact through the development of 'creoles' within the context of development of a technology or system such as a radar (Galison 1997) or MRI (Baird & Cohen 1999). The boundary object links the parties together enabling them to engage in two-way communication even though, for the individual parties, the boundary object may carry separate meanings that are commensurate with their specific disciplinary expertise.

The third type of expertise, 'contributory', corresponds to the emergence of the 'shared representation' trading zone, where "participants share a common understanding of a goal and collaborate closely" (Gorman 2002, p. 934). In summary, the relationship among the three levels of expertise, the three types of trading zones and the three levels of intergroup communication is summarised in Table 2.2.

	State 1	**State 2**	**State 3**
Trading Zone	Elite Control	Approximate parity	Shared mental model
Shared Expertise	None	Interactional	Contributing
Communication	Orders	Creole	Shared meanings

Table 2.2 - 3 Types of Trading Zone and their respective levels of expertise and communication (Gorman 2005).

Drawing on the work by Galison (1997), Ribeiro (2007), Gorman (2002) and others, Collins *et al*. (2007) propose a more general model of trading zones. The general model is developed by considering the dimensions along which the trading zone can vary: the extent that power is used to enforce trade (collaboration-coercion axis) within the zone and the end-state culture of the zone (homogeneity-heterogeneity axis). A graphical representation of the general model is presented in Figure 2.6.

	Homogeneous	Heterogeneous	
Collaboration	**Inter-language**	**Fractionated**	
		Boundary Object	Interactional Expertise
Coercion	**Subversive**	**Enforced**	

Figure 2.6 - General Model of Trading Zones (Collins *et al*. 2007).

Figure 3 presents ideal types of trading zones. Trading zones represents spaces where problems of communication and co-ordination find a resolution. They are summarised in the following table (Table 2.3) based on the proposed axis.

TRADING ZONE	Collaboration - Coercion	Homo/Hetero-geneity
Interlanguage	High collaboration	High homogeneity
Subversive	High coercion	High homogeneity
Enforced	High coercion	High Heterogeneity
Fractionated	High collaboration	High Heterogeneity

Table 2.3 - Characterizing Trading Zones.

Inter-language trading zones form through the development of 'in-between' (simplest – jargon; more complex – pidgin; creole – new language), vocabularies via which communication is accomplished. A typical example of such zones is development of a new scientific field. For example, Galison (1997) describes growth of new science, biochemistry, which developed through evolution of the relationship between chemistry and biology, manifestation of which was the creation of a completely new language, a 'biochemistry creole'.

An enforced trading zone is characterised by a maximum degree of coercion and a minimum level of homogeneity. The authors' example of is slave labour. The slavers and the enslaved are two distinctly different groups and physical force is used to conduct the trade of service for food and the relief from punishment. Another example of an enforced trading zone occurs when "the expertise of an elite group remains 'black boxed' as far as the other participants are concerned" (Collins *et al*. 2007, p. 659). This wave corresponds to 'Wave One' of the metaphor suggested by Collins & Evans (2002), metaphor where science and technology were being imposed from the academy upon the public, top down grounded in the assumption that science held universal truths and knowledge possessed by other groups of people did need to be considered by the experts. To this day, some scientists would still argue that this approach is viable and appropriate (e.g. acquisition of medical opinions regarding treatments) in some situations, despite the benefits gained from interdisciplinary

and multidisciplinary collaboration more generally. However, in some such cases, an enforced trading zone can be seen as beneficial in nature and to some extent even beneficial and desirable.

In the interlanguage trading zone described by Galison (1997), the new language is a combination of components adopted from both parties. However, communication can also be achieved when the language of one party overwhelms the other and subverts the benefits of scientific knowledge by blocking access to valuable knowledge from other sources. A ubiquitous cultural example of this dynamic is the emergence and spread of the American-style fast food (e.g., MacDonalds) which undermines knowledge and use of healthier traditional diets. In scientific debate, subversion of scientific language can be a mechanism through which cultural subversion can operate – for example, the colonization of thought in the field of physics by Einstein's language to explain ideas previously expressed using Newtonian language of physics. In the case of science communication we see that in most Western societies scientific explanations have replaced folk theories as cultural accounts for everyday events (sunrise and sunset, where do babies come from, etc.). It should further be noted that subversive trading zones can be established through technological or physical means. "For example, for most PC users Microsoft's Windows software is technologically coercive – it is the operating system that is most readily available. Over time it has become default option and most users use it because they have never thought of using anything else" (Collins *et al*. 2007, p. 660). Fans of other systems such as Linux or Apple may find themselves in situations where they have to use the Windows systems or in the very least ensure that their applications are compatible with it. Under the condition that these individuals ideally would not prefer to use Windows, the developed trading zone is one of subversive nature.

Thus, we have seen that 'interlanguage zones' function through the development of new cultural tools for communication. Subversive trading zones function through imposition of one culture above others creating one commonly used means of communication. In contrast, enforced trading zones function with very limited cultural interchange. In the final type of trading zone, the 'fractionated zone', the interchange is accomplished through fractions of cultures. Two types of this trading zone are *boundary object trading zones* and *interactional expertise trading zone*. The former type is mediated by material culture whereas the latter is dominated by a linguistic interchange. In the boundary object trading zone the operative medium is the object itself, a physical item. However, it may hold different meanings to the involved parties. The classic example of a boundary object trading zone is found in the work Star & Griessemer (1989) who studied how different groups of scientists, trappers, amateur collectors as well as university administrators collaborated in the process of collecting and cataloguing specimens for the Museum of Vertebrate Zoology at the

University of California, Berkley. There were numerous boundary objects involved, including political actors such as the state of California. The linguistic equivalent of the boundary object is interactional expertise, involving linguistic exchange that leads to the 'internalization of the tacit components of a strange language' (Collins *et al*. 2007, p. 661). In other words, linguistic socialisation among those participating in the trading zone leads to acquisition of interactional expertise. "While acquisition of interactional expertise does not provide full grasp of the strange form of life – it provides no access to the other parties' material culture except in so far as that material culture is represented in discourse – it is surprising how much can be done, is done, and, indeed, must be done, with the language fraction alone" (Collins *et al*. 2007, p. 661). An example of the interactional expertise trading zone is the case of AIDS activists explored by Esptein (1996) where AIDS activists developed interactional expertise in order to create a trading zone including medical researchers and practitioners; both groups retained their identities in separate cultures although the degree of cooperation increased with the increased acquisition of shared interactional expertise

In summary, trading zones are "places where cultures meet, languages are learned and tacit knowledge [is] shared" (Collins *et al*. 2007, p.665). These zones can be characterised by a range of possibilities across the axes of coercion/collaboration and heterogeneity/homogeneity (Figure 2.7).

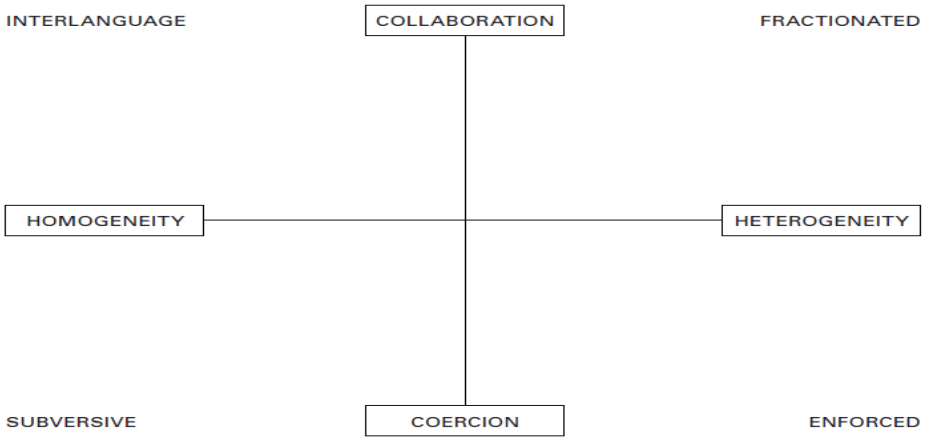

Figure 2.7 - Parameters of Trading Zones (Jenkins 2010).

Degree of expertise and levels of immersion are also important for the ways that trading zones operate according to these models. "To possess expertise in a given domain demands developing the tacit knowledge associated with its practices. The development of the domain-specific tacit knowledge, in turn, calls for experience or 'immersion' within the field. This implies a causal connection between having experience, developing tacit knowledge and acquiring expertise within any given field" (Ribeiro 2013). Ribeiro (2013) defines 'types of immersion' as 'the various kinds of experience one or more individuals can go through within a form of life or collectivity, such as practice, reading, watching and so forth' (Riberio 2007, p. 17). He proposes five types of

immersion: non-immersion, self-study, linguistic socialisation, physical contiguity, physical immersion. *Non-immersion* refers to the individual remaining separate from a particular form of interaction (e.g., a 'typical scientists' not participating in communicating to non-academic audiences). Through *self-study*, an individual enters the experts' domain without interacting directly with the experts. An example of this is through reading. *Linguistic socialisation* occurs through immersion solely in the relevant linguistic community (Collins & Evans 2007); talking to the experts away from the site in which their activities are carried out. *Physical contiguity* refers to the "proximity to the practices of a domain that falls short of active involvement or 'hands on' experience" (Ribeiro 2007b, p. 713). *Physical immersion* refers to the 'hands on' practice (Collins & Evans 2007) required to become a practitioner. In relation to research communication, different researchers gain different degrees of expertise in public engagement through various forms of immersion in engagement events at various stages in their career.

The application of the concept of 'trading zones' to research and communication of science (viewed in conjunction with the geographical literature reviewed above) presents questions of how the 'scientific' space articulates with other spaces of public engagement, how these 'zones' are constituted as socio-geographical spaces and what this means for practice of communication. The idea of a trading zone also invokes, as shown above, questions about what kinds of knowledge and language constitute the 'currency' in use by actors in different trading zones and how trade is regulated and influenced by different actors and boundary objects. Moreover, whilst the focus on language and its various forms in the functioning of trading zone, it also allows to begin to consider how the trading zone continues to function in light of the increasing commodification of research where the value is placed on its instrumental impact in terms of industry, policy or practice more than for its intrinsic contribution to the breadth of human knowledge. This latter focus is addressed in further detail in the Chapter 7.

2.8 Theories of role identity and their relationship to science communication

Interactions amongst individuals occur in various socio-spatial contexts such as 'trading zones'. For each individual, these interactions contribute to the formation of the self. Individuals interact in a variety of groups and thus there can be a number of distinct selves that correspond to those groups of importance (James [1890] 1950 in Hogg et al 1995). This implies that the 'self' is a multi-dimensional social construct (as opposed to an autonomous psychological entity) whose emergence is contingent on the different roles that people occupy within society (this is responsible for the variation in the self-concept) (Hogg et al 1995, p.256). A ***role***, in turn, can be understood as a set of expectations that are associated with a social position which inform the attitude and behavior

of the person occupying the role (Merton [1957] 1968). Individuals can occupy a number of positions in organizations and more broadly in society. For example, the role of a student may involve the acquisition of new knowledge and skills; whilst the role of an academic scientist may involve fulfilling expectations concerning research and teaching. Robert Merton ([1942] 1973) outlined the principles ('norms') that should guide scientific research and the way scientists should behave. The scientific ethos should be governed by *Communalism*, *Universalism*, *Disinterestedness*, *Originality* and *Skepticism* (acronym CUDOS). *Communalism* refers to the notion that results of research are not the property of individual scientists and in fact belong to the wider world. The stipulation of wider ownership implies that scientific knowledge is public knowledge and should be communicated in a manner and through appropriate means to make it such. However, in practice, whilst dissemination of scientific results is common practice amongst researchers, until very recently it has favoured high-impact scientific journals which limit access for 'the public'[35]. *Universalism* refers to the notion that the laws of science are the same everywhere and as such, they are independent of the scientists that are involved. The contribution to science should then not be exclusive based on social status, race, religion or any other arbitrary criteria that has no bearing on the science itself. This postulate focuses on the persons rather than ideas. Therefore, the focus is on the social context of communication rather than the intellectual substance of the communication. *Disinterestedness* refers to the idea that a scientist is a vessel for representation of factual observation – a scientist is unbiased and does not have a stake in the acceptance or rejection of data or claims. The work conducted by a 'disinterested' scientist should be novel thereby continually adding to the body of knowledge, which refers to the last part of the ethos that is to do with *originality*. The continual work towards achievement of 'originality' is the driver of progress of science. However, each individual research does not possess the necessary expertise to decide which research claims are legitimate and which are suspect. Therefore, predicated on healthy *skepticism*, a systematic procedure for the scrutiny of scientific claims is an integral part of science. Together, CUDOS represents the ethos of science – a set of practices that are expected to be adhered to by academic scientists. The components of the ethos of science demonstrate that multiple expectations can be connected with a social position of a scientist (including research communication beyond academia).

However, not all scientists adhere stringently to CUDOS. These 'norms' do not apply to scientists in all aspects of life – 'being a scientist' and 'doing research' is a social role (Ziman [2000] 2002). The variation in expectations associated with being an academic scientist can be attributed to the interpretations that researchers apply to their roles. For example, an academic scientist's role

[35] It must be noted that since the field work was conducted, 'open access'(OA) has began to be strongly integrated within academia through online repositories hosted by universities (including the CSU) as well as emergence of a greater availability of funding for publication in open access journals.

identities may include the fact that she / he is a researcher, a teacher, an administrator (other examples may include a public communicator, policy advocate, entrepreneurial academic, etc.). ***Role identities*** are internalized meanings of a role that individuals apply to themselves (Burke & Stets 2009). In other words,

> "Role identities are self-conceptions, self-referent cognitions, or self-definitions that people apply to themselves as a consequence of the structural role positions they occupy, and through a process of labelling or self-definition as a member of a particular social category (Burke 1980; Thoits 1991)"(Hogg *et al.* 1995, p. 256).

The meanings of role identities are derivatives and in part come from culture and in part from individuals' distinctive interpretation of the role. Whilst society offers roles which provide the foundation for identity and self, the self also determines and carries out social behavior (Callero 1985; Hogg et al 1995). Therefore, the 'self' is a concept that links social structure with individual action.

Within the self-concept there is a hierarchy of role identities (encapsulated in the concept of *identity salience*) based on the probability that they will form the basis for action. *Identity salience* can be defined as the "probability that an identity will be invoked across a variety of situations, or alternatively across persons in a given situation" (Stryker & Burke 2000, p.286). Accordingly, people who have the same role identities will behave differently in particular contexts due to the differences in identity salience (e.g., Callero 1985; Thoits 1991). For example, presented with an opportunity to 'engage beyond academia' (e.g., participating in a weekend science festival), one academic may choose to do so while another may perform additional research, although both may have a 'researcher' role identity. The difference in behavior can be attributed to identity salience - the 'researcher' role identity is higher in salience than the 'engagement' role identity. Moreover, engagement in role-congruent behavior may also occur in situations that are not role relevant (Hogg *et al.* 1995). For example, considering that many academics do not consider research communication beyond academia as part of their role of being an academic, some academics may engage in public engagement activities (e.g., visiting a school) during working hours. However, Stryker (1968) has acknowledged that context, in certain circumstances, can overpower identity salience, so that even if a person does consider engagement to be salient to their academic role, they might not engage if the conditions do not seem to allow (and theoretically, vice versa).

Identity salience is determined by the individual's *commitment* to that role. Stryker & Stathan (1985) define commitment as the "degree to which the individual's relationships to particular others are dependent on being a given kind of person" (p. 345). Commitment reflects the extent to which significant others are judged to want the person to occupy a particular role position.

Therefore, the commitment to a particular role is high if individuals perceive that many of their important social relationships are dependent on occupying that role. According to Stryker (1980), there are two types of commitment. The first is *interactional commitment*, which mirrors the number of roles associated with a particular identity (extensivity of commitment). The second is *affective commitment*, which refers to the level of importance of those relationships (the affect that will result from the loss of those relationships). The strength of identity of identity salience is dependent on the commitment of an individual to a particular identity both in terms of interactional and affective commitment. Within the context of network relationships (e.g., an academic research network in a broader sense – university, faculty, department, institute), a particular identity will be more salient if the 'more important' relationships are dependent on the occupancy of a particular identity. For example, a 'researcher' identity will experience greater saliency in contrast to the 'public engagement' identity within the academic context. Accounting for the influence of social networks on the concept of the 'self' possessed by individuals, establishes a link between the wider social structure and individual's smaller social networks to the concept of the 'self'; whilst also connecting the social structure to the development and maintenance of social relationships (Serpe 1987; Hogg *et al*. 1995).

In summary, the self is a reflection of the social structure in terms of the role positions that the individual occupies, from which their sense of identity is derived. Through the form of role positions, society affords individuals a sense of self-meaning and influences behavior through components of the self which are role-related. However, individuals have internalized meanings of the role which mediate the impact of society on behavior. This accounts for the variation in individual's behavior. Identity theory, applied to the scientists' sense of his or her professional and personal 'scientific' role leads to questions (which also connect with geographical ideas about relational space) concerning how individual motivations and purpose interacts with spaces of scientific research communication. Scientist take on a number of roles in various contexts such as when dealing with broader public communication, dealing with policy or industry.

We can draw on three bodies of literature which have attempted to elaborate on the roles that scientists play in relation to engagement with policy processes, science communication as well as knowledge transfer / business engagement. These areas are explored further in the following sub-sections to highlight the plethora of roles taken on by academic scientists and to begin to highlight the identity work undertaken by researchers in relation to various spaces of scientific communication.

2.8.1 Scientists & Public Communication of Science

Horst (2013) has argued that "science communication should be considered as an activity intimately linked with perceptions of identity and organizational culture" (p. 758).

> "When scientists talk about science in public, they are doing more than just disseminating scientific knowledge to nonscientists. They are also representing science and its organizations in a very broad sense and enacting particular understandings of what science, scientific organizations, and scientists are and should be" (p. 760).

From her empirical study of scientists working in nanotechnology and biotechnology, three roles emerged: experts, research managers, guardians of science. Each role has associated with it notions of quality, audience, motivation and learning in science communication. The roles are summarized in Table 2.4.

Mode of Representation	**A Field of Expertise**	**A Professional Research Organization**	**A Societal Institution**
Scientists Role	Expert	Research Manager	Guardian of Science
Content of Communication	Factual Knowledge	Knowledge Products	Rationality and scientific method
Quality Criterion	Is it correct?	Is it good branding?	Does it enhance enlightenment?
Audience	Target Groups	Stakeholders	Citizens
Motivation	Obligation to make facts available	Integrated part of managerial role	Personal Commitment
Learning	Learning by doing as part of academic community	Acquisition of competences	Learning by example of role models

Table 2.4 - Three Ideal Types of Representing Science (Horst 2013).

As a part of each role, the audience and communication are conceived differently. For experts audiences are not necessarily part of the equation but the correctness of the communicated information is. Experts will often adopt a single model of communication with a view towards making expert knowledge available. For Research Managers the concern about communication is also about whether it is scientifically correct but it is also framed by the concern about how it reflects on the organization. As a result, for Research Managers audience consideration is of strategic importance. In contrast, for Guardians of Science the primary concern around communication is whether it will improve public understanding of science. Despite the different conceptualizations of the audience and communication, these are idealized roles. In practice, researchers can take on these roles in various combinations. Furthermore, we begin to see that individuals occupying the role of academic scientists also undertake multiple connected roles (expert, research manager, guardian of science) in various spaces of science communication. Juxtaposition of the ideals of science representation versus what Table 2.4, can be constituted in

terms of Merton's norms associated with science, begins to indicate the emergent nature of the roles undertaken by scientists and the necessary identity work associated with facilitating the performance of those roles.

The emergent and evolving nature of communicative representation through role adoption was also echoed by another empirical study of communicative roles of researchers. These findings come from a ten-year research project coordinated by the Institute for Development Studies - the Development Research Centre on Citizenship, Participation and Accountability (Citizenship DRC); and point to a much more diverse view of the role of researchers in research communication (Benquista & Wheeler 2012). This framework "approaches research communication not simply as an issue requiring 'capacity-building', but potentially as a site of conflict, and of personal change" (p. 46). Consequently, the framework is consistent with the *emergence framework of science communication* and emphasizes the roles that researchers adopt in the context of research communication. The four roles that were identified include: **engineers and cartographers; mediators and conciliators; critical friends and advocates; catalysts and leaders**[36].

The first group of researchers, '**engineers and cartographers**', using instrumental knowledge, can provide insight into problems through data that has been systematically collected and analyzed. As a result, in certain cases, in this role, the researchers provide their expertise to a previously recognized problem (e.g., when an engineer fixes faulty machinery). Their research communication is materialized through tools that are produced without a particular audience in mind (e.g., traffic lights need to be comprehensible to everyone using the road). The second group, '**mediators and conciliators**', are in possession of interactive knowledge, which allows them to function in between various groups. Their perspective on research as a process of finding out is flexible enough to be reformulated for these different groups in order to highlight the bigger picture and foster the creation of spaces of engagement(as mediators); or sometimes just by linking various groups who may not have known about each other (as conciliators). The third group, '**critical friends and advocates**', adopts a view on research from a normative perspective as in contributing to a particular agenda. "On the inside they are like a friend who dispenses advice that may not be comfortable, but that is welcomed and considered. On the outside, they must assume the role of advocate, pushing to change decision-makers who are often dismissive or hostile to their viewpoint" (Benquista & Wheeler 2012, p. 49). For the fourth group, '**catalysts and leaders**', research centers on co-construction or as action. For this group of researchers the aim is to "try to initiate or sustain

[36] This study adopts Park's (2001) typology of knowledge: Instrumental (knowledge that explains causal relationships, structures and functional relationships through the analysis of data); Interactive (knowledge that derives from how people interact with one another, including emotions, sharing daily experiences, and exchanging actions with a particular context); Critical (knowledge or theory that emerges from a combination of reflection and action that makes possible normative deliberations).

actions that would not happen otherwise, which in the context of research communication usually means helping a marginalized group to take their own communicative action" (Benquista & Wheeler 2012, p. 50). Moreover, the role of leader can also incorporate a full range of roles that include: engineering of solutions, mediation, criticism and facilitation. Similarly to the work by Horst (2013), this research demonstrates the emergent nature of the roles enacted by academic researchers and is affected by a number of factors including the communicative context, audience and motivations. However, what is emerging from the discussed work is that scientists undertake identity work in order to enact the variable roles in the spaces of research communication – role identities enacted within the context of role performance are contingent on their salience. Identity work is affected by factors such as motivation, context and audience. The interplay between these factors is prominent in events where science and policy interact and scientists are thrust into being a public communicator in the context of policy. The discussion is continued by considering some of the literature which has focused on the relationship between science and policy and the scientists' roles within these interactions.

2.8.2 Scientists & Policy

When considering the role of social scientists in relation to policymaking, Merton (1945) grouped intellectuals into two types: those situated within a government bureaucracy and those that are not attached to one (unattached academics are classified as 'neutral' intellectuals). For the unattached intellectual the "clientele is a public" (Merton 1945, p. 408). It is during periods of crisis that the unattached intellectual enters public bureaucracy. For Merton, there is a boundary between academia and society, which is subject to blurring in specific contexts (e.g., under conditions of crisis). However, whilst a helpful step forward toward considering the role of scientists in relation to policy, particularly the beginning to allude to the emergent nature of the 'public' role of an academic, Merton does fail to acknowledge that crisis conditions represent an extreme of the contextual spectrum across which researchers can take on other roles and engage with policy. Subsequently, a number of models developed to characterize the roles that scientists can play in relation to engagement with policy processes in wider society (Hisschemoller *et al*. 2001; Hoppe 2005; Pielke 2007; Turnhout *et al.* 2008, 2013). One of the more prominent contributions to the debate concerning scientists and government policy has come from Roger Pielke Jr. In his widely cited work, *The Honest Broker* (2007), he offers a theoretical basis for four idealized roles for scientists in dealing with policy: ***Pure Scientist***, ***Issue Advocate***, ***Science Arbiter***, ***Honest Broker of Policy Alternatives***.

The ***pure scientist*** focuses on research without consideration for its use or utility (e.g., Albert Einstein). This approach in the broad sense maintains the separation between science and policy;

between scientists and policy makers. In terms of communication, a pure scientist 'deposits' their research results into a reservoir of knowledge from which the decision makers can then draw from. Therefore, there is no targeting of communication. However, for the scientist, it allows her/him to maintain their claim to impartiality and objectivity. Consequently, any responsibility as to what is done with the information that is extracted from the knowledge base is placed in its entirety with the policymakers.

In contrast to the pure scientist, the ***Science Arbiter*** interacts with policy makers. This interaction is based on the recognition by the scientists that decision-makers may indeed have questions that require the input of experts. Thus, the Science Arbiter takes on the ('passive') role of a resource for the policymakers and remains removed from explicit consideration of policy and politics. Strategies for maintaining the separation from political milieu includes focusing on positive questions that can potentially be addressed through scientific query; and by analogy, through avoidance of normative questions. Science arbiters may also answer questions that are posed by the media. This role can be problematic for the researcher in as much as the process of a successful science question arbitrating has the potential to transition into issue advocacy.

An ***Issue Advocate*** focuses on implications of particular research within the context of a specific political agenda. Instead of maintaining a 'gap' between science and policy, as does the pure scientist, the issue advocate affiliates oneself with a particular group that is attempting to advance its interests through policy and politics. Here the perspective is different in that science is envisioned as an active participant in the decision-making process. Moreover, the issue advocate goes as far as to tell the decision makers what they should do (or 'prefer') through construction of a particular case over another thereby narrowing the scope for the decision-makers. In contrast, the ***Honest Broker*** **(of policy alternatives**) aims to engage with the decision making through clarification and, if required, expansion of the spectrum of choices available in relation to the agenda in question. Unlike the science arbiter, the honest broker integrates scientific knowledge with the stakeholder concerns in formation of possible courses of action.

For Pielke, the decision for scientists about how they are to engage with policy and politics is contingent on two criteria: value consensus on a particular issue and the degree of uncertainty in a particular context. Value consensus will fluctuate depending on the nature of the issue (e.g., if it is more controversial) result in variable dynamics across the different issues on the controversy scale. Moreover, the contexts within which decisions are to be made will be mediated by various degrees of uncertainty. In cases characterized by increased uncertainty (both scientific and political), it becomes more important for science to focus on policy options rather than just scientific results

(Pielke Jr. 2007, p.18). The application of these criteria in relation to the adoption of the appropriate roles is demonstrated in Figure 2.8.

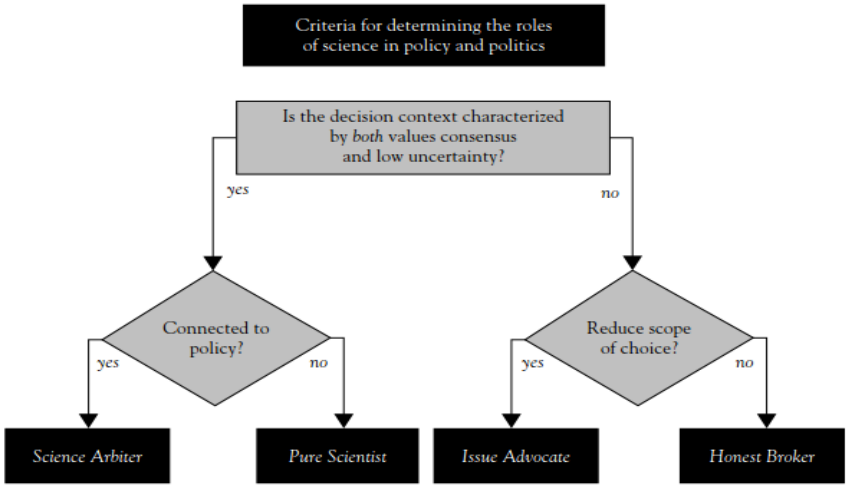

Figure 2.8 - Criteria for determining the roles of science in policy and politics (Pielke Jr.2007)

Turnhout *et al*. (2013) recognize the importance of Pielke's (2007) contribution to theory but point out some weaknesses in his proposed structure. Firstly, they highlight that "the role of the broker, which includes the most interaction with knowledge users, is still fairly distant, offering different knowledge-based alternatives to knowledge users, without actively engaging them in the production of these alternatives or in contributing to the solution of problems" (p. 355). Secondly, they suggest that this framework is oversimplified and static in terms of its representation of what scientists actually do within those roles. In order to provide a more dynamic model and account for situations where researchers and policymakers are part of the process which they seek to inform, they propose a spectrum based on Pielke's (2007) work that also includes the role of 'participatory knowledge producers' (see Figure 2.9).

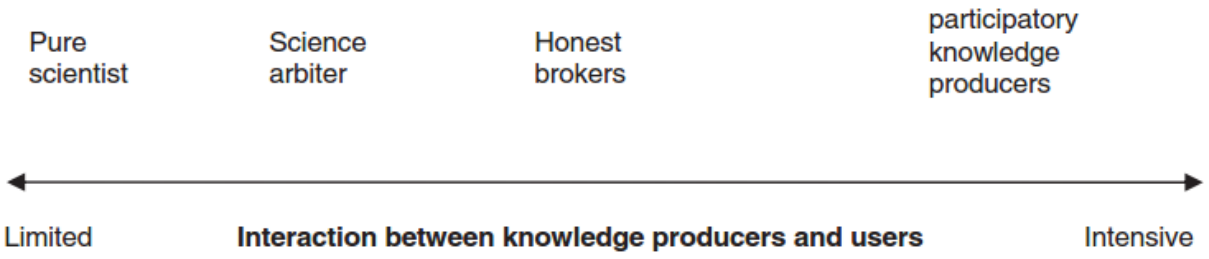

Figure 2.9- Spectrum of scientists' roles.

'Participatory knowledge producers' work in close proximity to knowledge users to such an extent that it leads to the blurring of the boundary between knowledge production and use. Moreover, this model also integrates the notion of the changing nature of the context and how juxtaposed against it

the role taken by researchers can fluidly evolve (instead of being situated within particularly framed contextual situations suggested by Pielke).

Similarly to Pielke (2007), Weiss (2003) also picks up on the idea that scientists adopt different expert roles depending upon a situation. The latter proposes a typology based on the position that a scientist can adopt in dealing with uncertainty. "Each position represents an attitude that is the result of a given level of uncertainty in combination with differences in the perceived necessity to take measures and the willingness to do so, given the associated (societal) costs" (Spruijt et al. 2013, pp. 1845-46). These positions are: *scientific absolutists*, *technological optimist*, *environmental centrist*, *cautious environmentalist*, *environmental absolutist*. "The scientific absolutist takes the stand that the Precautionary Principle was originally developed to oppose: make no precautionary intervention until the danger is scientifically proven. The environmental absolutist takes the opposite stand: take no action until it is proven that it will cause no harm. The "technological optimist," the "environmental centrist,"and the "cautious environmentalist" take intermediate positions" (Weiss 2003, p. 144).

The foregoing frameworks have been largely situated on the theoretical side of the spectrum and as such there has been a limited empirical evidence to substantiate either of the frameworks (Spruijt *et al* 2014). An exception to this is a study by Spruijt *et al*. (2014) that attempts to empirically test the theories concerning expert roles with participants from electromagnetic and particulate matter fields. Their research suggests that different expert roles exist amongst scientists who provide policy advice on environmental health risks. Specifically, the authors identified three different expert roles amongst each type of expert. Amongst the subfield of electromagnetic experts roles that were identified included: autonomous scientist, the pragmatist, action-oriented expert. Amongst the subfield of particulate matter experts roles that were identified included: the engaged expert, the instrumental expert, the deliberator. Across the two domains the roles were not identical, however there was some overlap. This study has demonstrated that there are some elements of the ideal-typical roles that have been distinguished previously by Pielke (2007) and Weiss (2003).

The work presented here and summarized in a recent literature review on the roles of scientists as policy advisors by Spruijt *et al*. (2014) has demonstrated the contingent nature of the roles performed by academic scientists with influences attributed to “the type of knowledge an expert has, the core values of an expert, the organization in which an expert works, the changing beliefs of experts and the context” (Spruijt *et al*. 2014, p. 22). Thus, this body of literature again indicates that academic scientists whilst maintaining the core norms associated with being a

scientist, engage in what appears to be modification of their academic role identity in order to perform within external contexts. To further elaborate on this process, we can draw on the final set of literature focusing on science, scientists and knowledge transfer.

2.8.3 Scientists & Knowledge Transfer

Academic scientists can also function at the university-industry interface. According to *Louis et al.* (1989) this boundary is negotiated through a number of different interactions: engagement in large scale science (externally funded research), earning of supplemental income, gaining of industry support for university research, obtaining patents of generating trade secrets or commercialization forming or holding equity in private companies that are based on faculty's own research. Jain *et al*. (2009) have investigated the role identity modification of university scientists who were involved in commercialization. They found that researchers adopt a hybrid role identity that comprises a focal academic self as well as a secondary commercial persona. Lam (2010) identifies different entrepreneurial roles that scientists adopts ranging from 'traditional' at one end of the spectrum to 'entrepreneurial' at the other end with hybrid roles of 'traditional hybrid' and 'entrepreneurial' hybrid in between. Adoption of hybrid roles allows researchers to map "out their own social spaces for strategic manipulation at the fuzzy boundaries between science and business." (Lam 2010, p. 309).

In order to maintain the saliency of their academic persona, scientists can perform identity work. Jain et al (2009) identify two mechanisms which academics used: delegating and buffering. The former term refers to academics focusing on "establishing appropriate interfaces with other actors - within the university and beyond - whom they viewed as possessing skills related to commercializing their technologies" (Jain *et al*., p. 929). Whilst this process requires establishing relationships with other actors, academics also can take steps to protect themselves from the norms that would normally be associated with commercialization through the process of buffering. This process enables researchers to continue as academics and entrepreneurs. These processes are fragile. "Delegating and buffering are sometimes not invoked or do not operate in practice, resulting in deviations from desired hybrid role identity and/or psychological strain. These dynamics attest to the negotiated and fluid nature of a hybrid role identity, requiring these individuals to constantly manage the contradictions that exist in their composite personas" (p. 2009). It is then clear that researchers respond in different manners to institutional pressures to engage beyond academia, in this case particularly through industry engagement. As a result, the researchers employ a plethora of adaptive strategies in order to maintain agency within the institutional structures (Jain *et al*. 2009; Lam 2010). Consequently, this opens up a set of questions about how researchers are meeting the needs of society in light of the diverse roles that are required to be taken up by them and the

adaptation strategies they employ, including identity work. This connects with the bigger question of, how are researchers engaging beyond academic context? The next three chapters, drawing on empirical material, attempt to address this question.

2.9 Conclusion

In conclusion, I offer a brief summary of the conceptual framework that is applied in this dissertation. This dissertation focuses especially on the relatively neglected experience of researchers and those within (or at the boundaries of) academic institutions supporting their research communication activities and the potential influence of the changing policy environment in regards to academic research. The work draws on ideas from geography to explore the socially as well as materially constituted spaces in which research communication takes place. Engagement events within which research communication takes place are understood to be emergent in nature. For researchers, this means undertaking 'identity work' for the purposes of engaging with non-academic publics. The interactions between human and non-human actor within the context of engagement events leads to the production of an atmosphere, which is in turn affected by the collective 'atmosphere of engagement' within the U.K. context thereby contributing to the engagement practices of academic researchers. Despite, being emergent in nature, engagement events can be understood as 'trading zones' whereby various actors engage in 'trading' using various currencies. The conceptual approach is explained in further detail in the rest of this section.

In order to understand the overall relationship between science and society, I draw on the work from human geography on 'space'. The relationship between science and society is understood as a multi-dimensional relational space. The multiple dimensions of this space are constituted through multi-level interactions: science and society (macro level), university and community (meso), researchers and publics (micro). This multi-dimensional space is constituted through multiple trajectories and as such represents a co-existence of heterogeneity. As such, this space is always under construction in light of the ever-changing relations between the parties at different levels.

Approaching the relationship between science and society from a perspective of a topological relational space blurs the supposed 'boundaries' between them. Therefore, research communication from the scientific domain into the public arena cannot be construed as a linear process. In fact, the engagement process can be initiated in either domain and the communication becomes a multi-directional. Moreover, publics do not necessarily receive information in a passive manner and contain in them the potential to affect scientific debates and research trajectories. Engagement

between parties is variable in intensity and is not viewed as a cause, but as a result of developments in both scientific and non-scientific domains.

Engagement between science and society on various levels occurs through the formation of trading zones. Trading zones, for the purposes of this thesis, are understood as “places where cultures meet, languages are learned and tacit knowledge [is] shared” (Collins et al. 2007, p.665). Since the trading zone is a relational space, it functions on multiple levels. At the level of science and society, trading zones enable engagement in the form of ‘cross-talk’ (Bucchi 2004) between specialist and public discourses under certain conditions. At the level of individuals, the model of emergence is adopted which views communication within the context of engagement as a "constitutive force in shaping entities such as science, publics and society" (Horst & Michael 2011, p.286). An engagement event and its constitutive entities (social and material, human and non-human, macro and micro, cognitive and affective, available and unavailable to consciousness) emerge through their coming together and engaging in the process of ‘trading’ through the production of novel relations and identities.

Identities are connected to roles that people occupy in societies. A role, in turn, can be understood as a set of expectations that are associated with a social position which inform the attitude and behavior of the person occupying the role (Merton [1957] 1968). Society affords meaning to individuals and influences behavior through the components of the self which are role-related. Role identities are understood as internalized meanings of a role that individuals apply to themselves (Burke & Stets 2009). Role identities mediate the impact of society on behavior, such as engagement practices. Participation in various engagement events is understood to require performance of identity work by the researcher in order to create a hybrid role identity by modification of the academic role identity.

Developing from the emergence of novel identities and relations are atmospheres. Atmospheres (in a non-meteorological sense) are understood as emergent from the processes of interrelations at multiple levels. They emerge from the encounters between various bodies including people, discourses, materials and other elements of the environments of which they are part in various everyday situations. As such, atmospheres include within their force field affects, sensations, materialities, emotions and meanings. The affective dimension of an atmosphere, ‘affective atmosphere’, is understood as a “relational potential for things to act or change in a particular space” (Bissell 2010, p. 273). The multitude and complexity of relations renders atmospheres as difficult to capture, as they emerge from relations and contribute to their constitution. However, it

also suggests that atmosphere is “a connective factor, linking people, places and things together in often unpredictable ways” (Bille *et al*. 2014, p.3).

3 Chapter 3: Methodology

3.1 Introduction

The focus of this chapter is the methodological approach used in the thesis. First, I explore the research strategy adopted. I then describe the main case study design followed by the analysis procedures. The chapter concludes with a discussion of ethical considerations.

3.2 Research Strategy

A research strategy should be sound, theoretically based, practical, efficient, feasible and ethically appropriate. It must reflect the wider aims of the research project and specific issues of the field of research. The project contains both descriptive and analytical parts. A number of strategies are associated with qualitative research: ethnographies, grounded theory, case studies, phenomenological research and narrative research. Case study research selects theoretically relevant examples of the phenomena of interest, using purposive (rather than statistical) sampling methods which may be refined in the course of the research. Case studies may be made up of information about individuals, communities, organizations or places. This approach can be detailed and intensive, allows for the phenomenon in question to be studied in context through the utilisation of multiple data collection methods.

This research is situated in the United Kingdom (U.K.). The U.K. presents an interesting case selection in light of the focus granted towards issues of 'science in society' over the last 35 years. Moreover, historically, scientists have occupied a prominent role in the U.K. society. More recently, issues concerning the ways that universities are evaluated in terms of their contributions to the relationship between science and society have been under scrutiny, in the public and academic spheres (Particularly, in the U.K., the emergence of the 'impact' agenda within the context of the national research evaluation framework has increased the focus on the science-society relationship). Therefore, the U.K. is provides a unique case within which to study how scientific knowledge is translated and transformed across the 'boundary' social and academic worlds.

The interviews were limited to a single higher education institution (referred to as the case study university [CSU]) in the U.K. The research was situated within a single university for a number of reasons. The focus was on researcher variability and diverse motivations for research communication, therefore it makes sense to talk to different people in the same institution, so that other factors such as institutional policies and practice are held relatively constant. The case study

university is a research oriented university with an international reputation and a member of the Russell Group[37] in the U.K. It submits to a range of Research Excellence Framework (REF) Units of Assessment (except medicine). The case study university includes full science and social science faculties with a range of different sciences and social sciences represented. Finally, the case study university is engaged in a range of research communication activities. Subsequently, the research was driven by a set of initial objectives:

1. to select a purposive sample of researchers from the case study university and engage this group in the discussion about communication of scientific research to non-academic audiences;

2. to explore how identified scientists approach communication of research to non-academic audiences, their views on communication, what works and what does not work;

3. to explore the types of communication outputs researchers are producing and what might be good ways to evaluate them;

4. to demonstrate through interpretation of the research findings the relevance of concepts outlined in the literature review for our understanding of research communication processes, viewed from the perspectives of researchers and of their colleagues in the case study university with whom the researchers work in order to communicate their research.

The foregoing objectives can be attained through adoption of a number of strategies. In the next section, I elaborate on the design of the case study.

3.3 Main Case Study Design

The inquiry process can adopt a number of strategies. For example, Creswell (1998) identifies 5 “traditions” of inquiry whilst Wolcott (2001) offers 19 types and Tesch (1990) suggests 28 approaches to qualitative inquiry. Thus, it is imperative to narrow down the available choices. Creswell (2003) suggests there is a choice between five possible strategies: narrative, phenomenology, ethnography, case study and grounded theory. “For example, researchers might study individuals (narrative, phenomenology); explore processes, activities and events (case study, grounded theory) or learn about broad culture-sharing behaviour of individuals or groups (ethnography)” (Creswell 2003, p. 183). This research explores the processes, activities and events corresponding to communication of scientific research to various non-academic audiences. As such,

[37] Russel Group “represents 24 leading UK universities which are committed to maintaining the very best research, an outstanding teaching and learning experience and unrivalled links with business and the public sector”(n.d.).

this work corresponds to a research strategy that combines a case study approach with elements from grounded theory, underpinned by a multi method approach which incorporated interviews, participant observation and document analysis.

3.4 Data Collection

The data collection process was undertaken using a multi methods approach. It consisted of interviews, limited participant observations through attendance at events, and document research.

In the final instance, 38 independent interviews were conducted with different parties in the case study university: 20 with researchers (in addition, 8 follow up interviews were conducted); 7 with members of the communications office (2 from strategic marketing; 2 from media relations; 2 from media relations connected specifically to research institutes; 1 from media relations connected to research communications); 1 with two members of science outreach; 2 with members of business engagement and knowledge transfer. Moreover, 5 communication events were attended in order to conduct participant observation and a number of documents were selected for analysis.

In what follows, I provide a detailed explanation of the interviewing process (numbers, recruitment, participants and data collection) for the various rounds; and offer a reflection on researching 'atmospheres' through interviews. Next, I move on to discuss participant observation at the events which were attended. Finally, I conclude the section with an overview of the documentary research that was undertaken.

3.4.1 Interviews

In its essential form, an interview is an event where an individual (researcher) encourages others to articulate their interests and experiences (Lindlof & Taylor 2003). Qualitative interviews are an adaptable approach and allow for exploration of a vast range of topics and issues (especially, useful for exploration of aspects that may not have necessarily apparent or focused upon through observational research). In other words, interviews are always open to the new and the emergent. However, there are some limitations associated with this method as well. Although, interviews are suited towards understanding social actors' experience and perspective, it must be considered that this information is framed through the views of the social actors and thus must be considered and analysed with this in mind. People are not neutral or mistake-free when they report on their own experience and can equally be affected by the presence of the researcher as well. Interviews may also not necessarily occur in the natural setting where for example ethnographic field work is conducted but rather in a particular 'place'. The malleability of interviews and their potential for a plethora of information cements their suitable for the purposes of this research.

Interviews were conducted within the case study university in several phases. In the first instance, interviews were conducted with 20 researchers across a number of disciplines across the CSU (see Figure 3.1; underlined disciplines represent interviewees' disciplines with numbers of interviewees in the brackets).

In light of emergent themes from the first round of interviews, 10 additional interviews were conducted with individuals from communications / marketing, science outreach as well as knowledge transfer / business engagement from the case study university.

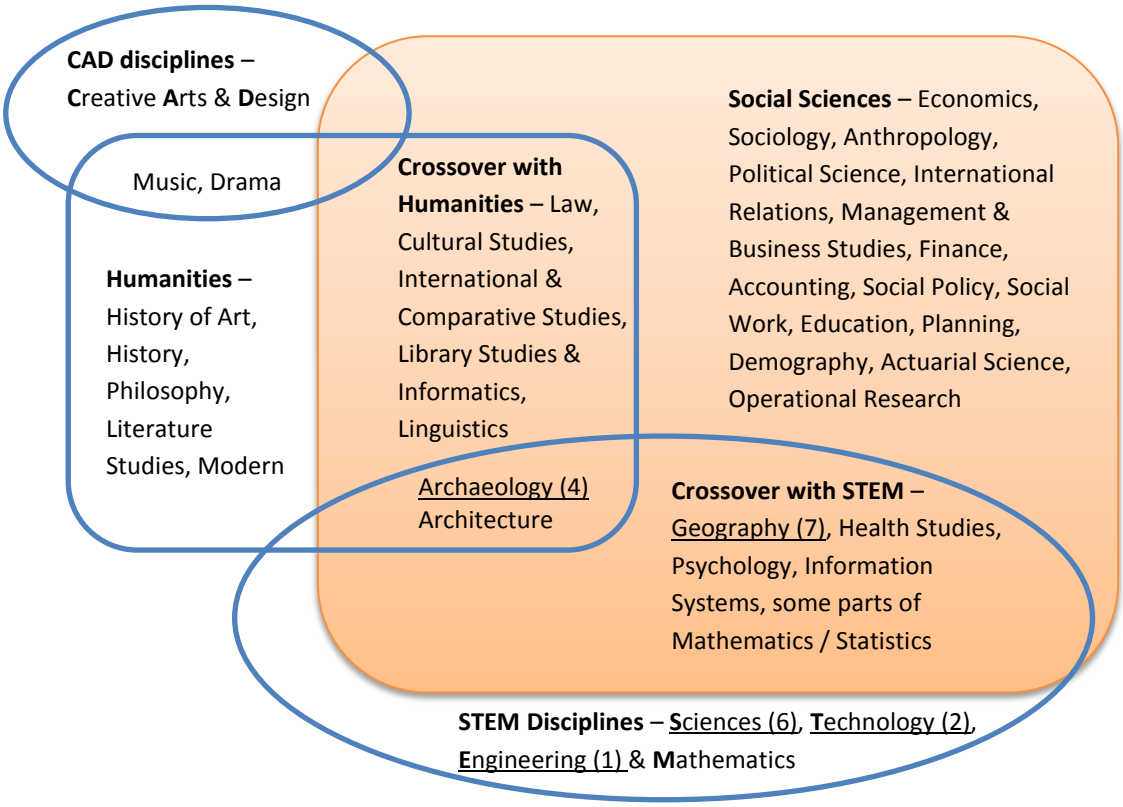

Figure 3.1 - Relationships between different disciplines (Adopted and modified from Bastow *et al*. 2014)

3.4.1.1 Interviews: Phase 1

Phase one of the interviews was driven by a number of purposes. These included: to begin establishing basic information on the types of research communication the interviewees were engaged in; understanding the types of research communication practices they were using; discovering the kinds of audiences with whom they sought to exchange knowledge about their research and the contexts in which research communication was taking place (both physical and social).

The recruitment process was guided by a combination of purposive and maximum variation sampling. On the one hand, participants were recruited against pre-set criteria that were devised to

reflect the objectives of the project. On the other hand, in consideration of the fact that the aim was to study the considerable variation in communication processes across the various scientific disciplines, maximum variation sampling was also adapted within the context of the first round of interviews.

In order to facilitate both sampling strategies, a list of names ('risk research register') of researchers from various departments/schools at case study university[38] with 'risk'-related research and interests[39] was obtained from administrative team in the 'The Research Institute'[40]. This 'risk research register' served as the initial sampling pool. The initial pool consisted of 148 researchers. Considering the focus of the research being on the 'traditional' sciences, researchers based in the departments/schools Music, Modern Languages & Cultures, Philosophy, Theology & Religion, History, Law, English and Education were excluded, giving a potentially eligible sample of 110 people. The remaining researchers in the list were checked against the following pre-set criteria. Selected participants were:

1. Conducting research at the case study university;
2. representative of the 'STEM' disciplines or the social sciences which cross over with 'STEM' disciplines or from humanities which cross over with 'STEM' disciplines
3. Their research must have associated societal implications of risk.

The first criterion essentially means that I focused on a single institution in order to be able to explore variation in researchers' practices within a similar institutional setting, since I was especially interested initially in how far different researchers exercised individual agency in the ways they communicated their research. The second criterion was applied because of the recent focus, in public debate over university policy, on the importance of communication for the science disciplines. However, for two reasons, I selected a more interdisciplinary group of researchers. First, I was a researcher based in an interdisciplinary department where there was crossover between science and other disciplines (in this case the social sciences). Secondly, the risk register indicated that because of the variety of disciplines represented by the researchers entered into it, and the proportional representation of each discipline on the list, that inclusion of cross-over disciplines would be suitable for the purposes of this research. Furthermore, focusing on research with social implications of risk enabled me to consider examples where the researcher in question would have a

[38] Anthropology, Archaeology, Biological & Biomedical Sciences, Business School, Chemistry, Earth Sciences, Engineering, Geography, Maths, Medicine & Health, Psychology and SASS as well as Music, Modern Languages & Cultures, Philosophy, Theology & Religion, History, Law, English and Education.

[39] This list was not a self-selecting list. The list has been kept on an ongoing basis since 2007 by IHRR administrative staff with the aim of maintaining institute's profile and fostering collaboration amongst researchers in various disciplines across the CSU. The list was populated via suggestions made by the management board based on their networks. Moreover, the list was also populated in a self-selecting manner by researchers attending various events run by the Institute.

[40] The name of the research centre has been anonymized.

potentially clear reason for engagement beyond academia to communicate findings likely to be relevant in wider society. Through the application of these criteria, the list was reduced from 110 to 65 eligible informants for this case study.[41]

All researchers were contacted with an introductory email (refer to Appendix I-A) and inquiry about whether they would be interested in participating. A large proportion of contacted individuals decided not to participate in the research. Table 3.1 presents a number of examples of the negative responses received. They are interesting in themselves – they reflect, *inter alia*, ideas about the need to have a degree of seniority and experience to be a knowledgeable source of information regarding research communication. There is also a sense in one response that this may be a 'marginal' activity for a busy academic.

Example Quote	**Example Quote**
"Sorry. I am not available."	"I have very little experience in communicating research to non-scientific/academic audiences so there would probably very little coming from me (or maybe this is exactly what you would like to know). My area is also not that directly risk related although I deal in the wider sense with sea-level risk in that I try to understand current rapid changes of ice sheets and their potential contribution to sea-level."
"…As my work is basic research involving no "risks", I would not be able to help you…"	"I have to say that given the junior nature of my post at Durham I haven't so far got the chance to interact with media and other non-academic audience. I am an expert on earthquake mechanics and my name is just getting across the University media office, so I would expect to start doing such kind of media related exchanges very soon, but I haven't yet done any."
"…I make no promises about finding time to complete this or to meet with you…"	"My work really has almost zero 'risk' dimension, and also my communication of my research to the public has been very limited. So not sure if I can be of any help."
"Sorry, but I am swamped with stuff to do."	

Table 3.1 - Examples of Negative responses.

Those researchers who replied expressing an interest in participating were sent an email with a Participant Information Sheet (Appendix I-B) and a Consent form (Appendix I-C). In light of these documents, the researchers were also asked to re-confirm their participation. Following the receipt of confirmation, interview times and dates were arranged via email (usually either directly with them or their personal assistant in cases of higher ranking researchers) that suited the convenience of the researchers.

[41] Criteria were applied by the author of the thesis. Although the selection was rechecked, additional individuals were not consulted in the selection of researchers from the list.

Initial interviews were conducted with 11 scientists out of the 65 in the sample list currently working at the case study university. Follow up interviews (round 1-1) were conducted with 8 of the initially interviewed 11 scientists (12.3% return rate from the originally contacted group of researchers; 72% return rate from the interviewed group of researchers). A list of participants, with non-identifying details, is presented in Table 3.2.[42] The ratio of female to male participants was 2:9. All the interviewees were actively engaged in research activities at the case study university and based upon the researcher's evaluation[43], their research had social implications of 'risk'. Due to the nature of the research conducted by 2 interviewed researchers and the content of the corresponding interviews, those interviews were eliminated from the included sample because they did not fit the selection criteria.

Gender	Position	Department	Date of Interview	Date of Follow up Interview	Code Name
M	Senior Lecturer	Archaeology	02-Mar-12	01-Nov-12	Archaeologist 1
M	Lecturer	Engineering & Computer Science	07-Mar-12	08-Oct-12	Computer Scientist 1
F	Reader	Geography	14-Mar-12	12-Oct-12	Physical Geographer 1
M	Professor	Geography	14-Mar-12	02-Nov-12	Physical Geographer 2
M	Senior Lecturer	Earth Sciences	16-Mar-12	15-Oct-12	Earth Scientist 1
M	Professor	Earth Sciences	21-Mar-12	10-Oct-12	Earth Scientist 2
M	Professor	Geography	23-Mar-12	15-Oct-12	Physical Geographer 3
M	Reader	Earth Sciences	27-Mar-12	06-Nov-12	Earth Scientist 3
M	Professor	Geography	29-Mar-12	Not Applicable	Physical Geographer 4

Table 3.2 - List of participants in the first round of interviews.

Initial interviews (Phase 1) were conducted in person during the period between February and March 2012[44] and follow-up interviews between October and November 2012 (Round 1-1). The interviews were conducted at the interviewee's place of work (their office at the case study university [CSU]) and lasted between 35 and 47 minutes. It is notable to mention that 2012 represented a 'midway' point for the overall process of the Research Evaluation Framework process for assessing the quality of research in the U.K. higher education institutions[45]. As discussed later in

[42] The sample did not include any research postgraduates or research assistants.
[43] No definitive list of criteria can be composed here. It is acknowledged that the decision was subjective in nature.
[44] 1 interview was conducted in February of 2012.

the thesis the focus in this REF round on 'research impact' brought issues of research communication to the fore in new ways.

With the permission of the interviewees, all interviews were recorded, transcribed verbatim and formatted. Transcripts were emailed to the interviewees inviting them to make any necessary corrections as appropriate. Interviewees returned the transcripts in due course with changes and any identifying information was removed from the returned transcripts. Due to the length of time it took for some participants to return the transcripts, the practice of sending the transcript for participant review was not undertaken after the follow up interviews nor in the subsequent rounds of fieldwork. The recordings were destroyed at the end of the study in order to protect the privacy of the participants.

The interviews were semi-structured. The initial set of interviews was guided by a 'conversational approach' (can be classified as a responsive approach) (Rubin & Rubin 2011) around a selected set of topics designed to understand researchers' involvement in research communication and their communication practices (see Appendix I-D). These topics included the experiences of scientists in communicating their research to non-academic audiences (e.g., 'lay' publics, policy makers, industry and others); views on communication of research to non-academic audiences (issues, obstacles, influences, approaches); development of communication and strategies and materials for various audiences. Whist these topics constituted the guide for the interview, the interview was allowed to unfold in an organic manner with the responses of the interviewee.

As indicated in Table 3.2, follow up interviews were conducted with 8 out of the 9 researchers. These interviews occurred after some time following the initial set of interviews in order to allow for transcription and analysis. Once the emergent themes and issues were identified a follow up round of interviews was arranged in order to explore those identified areas and ascertain whether they held credence amongst the researchers rather than being an interviewee's construct. In other words, this was a form of member-checking in order to "determine the accuracy of the qualitative findings through taking the final report or specific descriptions or themes back to participants and determining whether these participants feel that they are accurate"(Creswell 2003, p.196). For the follow up interviews in Phase 1, a list of prompts (I-D) in order to guide the discussion was prepared (see Appendix 1). This set of interviews adopted a more structured approach in order to address the previously identified themes and issues. However, interviewees were still able to raise issues for discussion that were outside and/or complimentary to the main foci of the discussion.

3.4.1.2 Interviews: Phase 2

The purpose of phase 2 of the research was based on two aims. First, the aim was to continue expanding the sample of interviewed researchers. Secondly, the initial interviews indicated that often researchers do not only engage beyond academia on their own but also through boundary spaces of the university, where a number of other key actors are involved. Consequently, in addition to snowballed researchers, phase 2 included interviews with representatives of these other groups of actors, so that communications/marketing professionals, knowledge transfer and business engagement professionals and science outreach professionals from the case study university were also interviewed.

Similar to phase 1 of the research, researchers and other identified actors were contacted with an introductory email (Appendix I-A) which enquired whether they would be interested in participating in the study. A Participant Information Sheet (Appendix I-B) and a Consent form (Appendix I-C) were sent to those individuals via email and a request for re-confirmation of their participation. After the receipt of the second confirmation, interview times and dates were arranged through exchanges over email.

Interviews were conducted with 5 researchers who were currently working at the case study university who had not taken part in Phase 1 interviews. They were identified by researchers who had taken part in Phase 1 interviews. A list of participants along with non-identifying details is presented in Table 3.3.

Gender	Position	Department	Date of Interview	Code Name
M	Reader	Archaeology	13-Dec-12	Archaeologist 2
M	Lecturer	Geography	13-Dec-12	Physical Geographer 5
M	Professor	Geography	14-Jan-13	Physical Geographer 6
M	Lecturer	Computer Science & Engineering	16-Jan-13	Computer Scientist 2
M	Lecturer	Archaeology	18-Jan-13	Archaeologist 3

Table 3.3 - List of scientist participants snowballed from initial set of interviews.

Interviews were also conducted with members of the communications office (encompassing marketing and communications) as well as the business and innovations office (encompassing business engagement and knowledge transfer). A list of these participants is presented in Table 3-4.

Gender	Position	Branch	Date of Interview

M	Communications Manager	Communications (Research Institutes[46])	04-Dec-12
M	Research Writer & Dissemination Officer	Communications (Research Institutes)	15-Jan-12
M	Media Relations Officer	Communications (Media Relations)	11-Dec-12
F	Deputy Director of Communications	Communications (Media Relations)	15-Jan-13
M	Deputy Director of Marketing & Communications	Communications (Marketing)	04-Feb-13
F	New Media Manager	Communications (Marketing)	15-Jan-13
M F	Senior Science Outreach Officer Science Outreach Officer	Science Outreach	14-Dec-12
M	Manager Research Communications Team	Communications (Research)	14-Dec-12
M	Senior Manager Business Engagement / Knowledge Transfer	Business Engagement / Knowledge Transfer	18-Feb-13
F	Senior Business Engagement Manager	Business Engagement	25-Feb-13

Table 3.4 - List of intermediaries and knowledge brokers interviewed. (Note some job titles were reworded to protect anonymity of the interviewee whilst conveying the essence of the post. They are indicated by an asterix.)

Phase 2 interviews with scientists were conducted in person in December 2012 and January 2013, at the interviewee's place of work (their office at Case Study University) and lasted between 31 and 74 minutes. Interviews with intermediaries and knowledge brokers were conducted in person in December 2012, January and February 2013. The interviews took place at the interviewee's place of work (their office at Case Study University) and lasted between 20 and 79 minutes

As in Phase 1, with the permission of the interviewees, all interviews were recorded, transcribed verbatim and formatted. The recordings were destroyed at the end of the study in order to protect the privacy of the participants.

The interviews were unstructured discussions framed by a list of prompts introduced at appropriate times during the discussion. On the whole, the topics were followed in order. However, the interviewer did ask questions to follow up on particular issues raised which may not have adhered to the structure set out in the prompt guide. This allowed the relevant issues to the researchers to emerge more organically. The orders as well as the manner in which the research themes got addressed and the attention allotted to each theme were determined to a certain extent

[46] This individual was employed directly by the research institute.

by the interviewee and the interviewer. Furthermore, interviewees were able to raise issues for discussion that are outside and/or complimentary to the main foci of the discussion.

3.4.1.3 A Note on Interviews and researching 'Atmospheres'

As indicated in the title of the thesis, one of the prominent ideas explored within this work is the idea of 'atmospheres'. In order to frame a reflection on researching atmospheres, the following quote provides a useful starting point.

> "Phenomenon of atmosphere is itself something extremely vague, indeterminate, intangible…atmospheres imbue everything, they tinge the whole of the world or a view, they bathe everything in a certain light, unify a diversity of impressions in a single emotive state….atmospheres are something entirely subjective: in order to say what they are or, better, to define their character, one must expose oneself to them, one must experience them in terms of one's own emotional state. Without the sentient subject, they are nothing" (Böhme 2013, p. 2).

The main point that one has to consider from the foregoing quote is the idea that in order to 'appreciate' an atmosphere one has to be 'exposed' to it. As a postgraduate researcher within the United Kingdom higher education system, I have been able to observe what I have termed as the 'atmosphere of engagement' (see Chapter 4). This is to say that I have been enveloped in this atmosphere in the overall timespan from 2009 to 2014 within the United Kingdom (across two higher education institutions). I sought to attend to the atmospheres of engagement through familiarization with the historical evolution of the bodies of discourses which have contributed to the formation of the overall engagement agenda within the context of science and society in the United Kingdom. Moreover, I sought to attend to these atmospheres through paying attention to the various interactions within the limited events which I was able to participate in and/or attend in person. In particular, casual conversations and various comments made by participants served to reflect the feeling of individuals that were enrolled within an 'atmosphere of engagement'; which also allowed for confirmation of my enrollment within the 'same' atmosphere. However, my own experience and interpretation of the 'atmosphere' may substantially differ from those of the researchers, due to my own positionality as a postgraduate researcher within a specific department in the case study university and not an employed academic researcher; but also in terms of my own background. I therefore decided to interview researchers. Interview data provided a sense of researchers' perceptions of the atmosphere at specific events but also the wider institutional / policy context of their research communication practices.

Atmospheres "cannot be passed down through representations, and that second-hand communication or inference of an atmosphere does not recreate the atmosphere but only produces its mediation" (Sørensen 2014, p. 1). This is referred to as the 'clause of subjectivity' (Sørensen 2014, p.1). The clause presents a difficulty in attainment of a level of apprehension of atmospheres which are situated "before memory and outside of subjective experience" (Sørensen 2014, p. 1). Research on atmospheres has been dominated by ethnographic approaches (e.g., Edensor, 2015; Hudson, 2015; Pink et al., 2015; Sumartojo, 2015; Turner and Peters, 2015). For example, in the special issue on 'designing atmospheres', the contributing authors utilize auto-ethnographies "that closely attend to their own and others' experiences of the sights, sounds, smells, temperatures and movements of other bodies that help comprise atmospheres. This is woven together with material gathered from museums, memorials, shopping malls, homes and art installations that form the empirical basis of the articles. This approach combines descriptions of how designers intend people to experience space with first-hand accounts of those atmospheres" (Edensor & Sumartojo 2015, p.261). There have been a number of studies that have also began to implement interviews as a method of ascertaining a characterization of atmospheres (e.g., Bille 2014; Finn 2016; Michels 2015). The present research contributes to this gradually emerging body of literature. The adoption of the interview method sought to attend to the experiences of the interviewed researchers within the atmosphere of engagement. In other words, by exploring the first-hand accounts of engagement practices of researchers, I sought to unravel their perceptions of the atmosphere of engagement. Each individual's experience, as captured through the interviews, becomes valuable and important despite the clause of subjectivity.

3.4.2 Participant Observation

Participant observation is usually described as the process of experiencing and recording events in social settings (Gans 1999). This approach permits the researcher to experience first-hand that which is also experienced by the participants. The information is recorded as it is revealed. During participant observation unique or unusual aspects may come to the forefront. However, within the context of participant observations researchers are dependent on themselves and their own attending and observational skills. Furthermore, researchers may also be seen by the participants as intrusive. Such a perception may alter the behaviour of the participants and the subsequent information that is revealed to the researcher. Moreover, the researcher may observe 'private' information that is not suitable for reporting purposes. Participant observation is a method which with appropriate consideration of corresponding limitations allows access to a reach variety of information at the research site via the activities engaged with- and behaviour practiced by- the participants.

Observational fieldwork was conducted at selected events (Appendix I-E) in the case study university. They were chosen because they would make explicit the rationale for different research communication practices that members of the university were being encouraged to undertake. Furthermore, they would give a sense of how the institutional setting influenced research communication. The process of selection of events to attend was also mediated by issues of access – there were several events that were not attended because they were not open for me to attend (for example, a course corresponding to the highest level of media training where an external consultant is brought in to conduct the training). In particular, the focus here is social settings that involve communicative engagements, training events and/or meetings. The training courses attended by the author are presented in Table 3.5.

Course Tittle	**Date of Course**	**Brief Description**
How to write a press release	31 January 2012	The media, print and broadcast, is a powerful, readily available vehicle for researchers to reach a wide audience. This half-day session for early stage researchers will provide an introduction to working with the media
REF Working Lunch	18 May 2012	Research Excellence Framework The policy is set out below but what does it mean for the individual researcher? You will be hearing much about REF in the coming months. Do you know what it is all about? University's REF Manager, will be providing an overview and answering questions.
REF briefing for researchers	25 May 2012	What are the implications of the Research Excellence Framework for the individual researcher? You will be hearing much about REF in the coming months. Do you know what it is all about? University's REF Manager, will be providing an overview and answering questions.
Level 1: An Intro to Media Relations: How to make the headlines	14 February 2013	Level 1 is for anyone at case study university who is not familiar with the Media Relations Office and wants to know more about how we engage as a leading University with the world's media and how we can publicise your work.
Newton's Apple – An Introduction to science policy	15 July 2013	These 'Introduction to Science Policy' Workshops will give you the chance to find out more about the policy processes and the methods by which you can contribute to it. The Workshop will also give you the chance to put your questions to the people who have worked regularly on science policy issues.

Table 3.5 - Training events attended.

3.4.3 Document Research

Documents can be found in a variety of forms. They can be classified as naturally occurring objects and therefore have not been produced for the purposes of social science research. Moreover, they possess a solid and semi-permanent existence, which provides indirect evidence about the social world of the people who created them. For example, articles published by scientists provide us with indirect information about the academic scientific world, its norms and rituals. Complimenting gathered evidence through documentary evidence renders documents of further value (Lindlof & Taylor 2002). In the first instance, documents can be linked to the social context which is being studied (Miller 1997). Moreover, documents can provide assistance in the reconstruction of past events or ongoing processes that may not be available for observation. Finally, documents are reflective of organizational rationality and thus can provide a glimpse into various organizations. In light of these considerations, documentary analysis was included as a part of a multi-methods approach within the context of this research project. . Documents were chosen on the basis of historical relevance in relation to science communication / public engagement within the U.K. context encompassing the range from 1985 (the year marking the publication of the Royal Society report on the Public Understanding of Science, commonly referred to as the Bodmer Report) through to and including 2012. A list of documents that was considered as a part of this analysis is presented in Appendix I-F

3.5 Data Analysis

Due to a vast corpus of material, for the most part in textual form, qualitative data presents a challenge for analysis. In a general sense, there is no one particular set of appropriate rules that must be adopted (Bryman and Burgess, 1994). The two most widely cited approaches are analytic induction (Znaniecki 1934) and grounded theory (Strauss & Corbin 1990; 1998). The analysis of data within the context of this thesis was a combination of grounded theory tools and thematic analysis. The tools of grounded theory that were utilised include theoretical sampling, coding and constant comparison. The aim was to produce the following during different phases of the research: concepts; categories; properties hypotheses and theory.

As is often the case in qualitative research, analysis was an ongoing process which incorporated continual reflection with regards to data, asking analytical questions as well as writing memos throughout the study. First, the gathered data were read through. This allowed establishing the scope of the gathered material in order to get the general sense of the data. Initial thoughts about the data were recorded. The data were then coded – a process whereby the material was organized into “chucks” (Rossman and Ralls 1998, p.171). When considering developing codes, the

following list of possible types of codes was considered (Bogdan and Bilken 1992, pp.16-172): setting and context codes; perspectives held by subjects; subjects' way of thinking about people and objects; process codes; activity codes; strategy codes; relationship and social structure. This process allowed for the initial identification of major themes that were emerging from the data that were relevant to the research. The data were then reviewed a second time in order to check further references and connections between the larger themes. These larger themes were then raised in a later round of interviews and communications with researchers in order to confirm their validity with the interviewees and in order to develop the themes further. Since some of the themes that initially emerged were unanticipated, the interviewees were also asked to expand on the unanticipated themes that were grounded in the data that appeared to have emerged from the initial analysis. Once the follow up interactions occurred, the larger chunks of data were further coded in order to develop the analysis to another level of complexity. The emerging framework was then constructed together through narrative in order to convey the findings of the thesis. These data were again checked in order to ascertain the coherence of the identified relationships between the themes. The data were then interpreted by comparing the findings with the information gathered in the literature (including previous theories). This allowed me to see which findings confirmed previously conducted work as well as identify where divergence occurred.

3.6 Ethical Considerations

Researchers in all disciplines have the responsibility to the pursuit of objective truth and search for knowledge as well as to the subjects of their research (Munhall, 1988; Robinson & Thorne, 1988). At various stages of social research, ethical considerations may potentially surface. A number of positions have been endorsed by various researchers in regards to ethics. Bryman (2008) has highlighted the different stances endorsed by various authors in social research: universalism (Erikson, 1967; Dingwall, 1980 Bulmer, 1982); situation ethics (Goode, 1996); ethical transgression (Gans, 1962; Punch 1998); anything goes (more or less) (Douglas, 1976). Diener and Crandall (1978) have sub-divided ethical considerations into four main areas: whether there is harm to the participants, whether there is lack of informed consent, whether there is an invasion of privacy and whether deception is involved.

Research that results in harm to its participants is widely considered unacceptable. Harm is a wide ranging concept that encompasses a whole spectrum of issues ranging from stress, physical harm, harm to participants' development, loss of self-esteem, as well as others. During the interviews I did not seek to obtain any sensitive information from my interviewees. However, the

topic of the research in conjunction with the timing of the interviews in the context of concurrently evolving Research Excellence Framework (REF) in the U.K. may have invoked a degree of stress amongst the contacted researchers. In order to ensure that the interviewees felt comfortable and confident in the interview process, three steps were implemented. Any identifiable information was anonymised. If at any point during the interview participants felt uncomfortable about taking part, they could ask to stop the interview and it would have finished (This did not occur in any of the interviews). Lastly, after the transcription of the interviews, the participants were sent a draft which they could amend. Overall, the conducted research has not resulted in any harm to any of the participants. As an additional step towards minimisation of harm, the recordings were destroyed following transcription.

The researchers and other individuals that did grant interviews all consented to be interviewed. During the initial recruitment stage, the participants were contacted with a participant information sheet (Appendix I-B) and a consent form for review (Appendix I-C). Participants who decided to take part were asked to sign a consent form to show that they agreed to join the study. If participants agreed to join the study and then changed mind at any time later, participants could stop taking part. Similarly, events where participant observations were conducted were attended with the permission of the organisers and (in the case of smaller events) participants were fully aware of my presence. In the case of documents, the majority of the documents were publicly available while those that were not were accessed through consenting sources (Appendix _).

Participants had a free choice to take part or not. If participants decided not to take part, they did not need to give a reason. As I indicated above, participants were thoroughly briefed about the research area (which was not an especially sensitive one). Participants were not compensated for taking part in the research. During the interviews there was always an option to not answer the questions or to cut the interview short (though this did not occur.). All information was kept on secure, password-protected computers in locked offices at Durham University. Any identifiable information about participants was only seen by the researcher.[47]

Every effort, as indicated above, was made to conduct the research project in a transparent manner in order to minimize any possibility of deception. Deception occurs when researchers provide a representation of their work as something other than what it is. Interviewees were comprehensively informed about the research: initial recruitment email, follow up email, right before the actual interview. Researchers who provided 'private' documents were also aware of the

[47] The only exception to this would be if participants gave information, which affected their health and safety, or someone else, or is a disclosure of a criminal act. This did not occur.

nature of the research. Attendance at smaller events was conducted with permission from organisers.

The presented findings are those of the research based on the made choices in topic selection, interviewee selection, document selection and data analysis.

Ethical clearance was obtained from the Ethics Review Committee, Department of Geography at Durham University (Appendix I-G).

4 Chapter 4: 'Science and Society' in the United Kingdom - Emergence of 'Atmosphere of Engagement'

4.1 Introduction

The focus of this chapter is the context within which the relationship between science and society in the U.K. has evolved over the last 35 years. Specifically, this chapter traces the emergence of what is termed as the collective 'atmosphere of engagement' within this context by highlighting the various institutional and government policies in the U.K. In order to demonstrate the proposed emergence, this chapter outlines the contemporary discussions around science communication and narratives of transitions from models of public understanding of science (PUS) to those of public engagement with science and technology (PEST). The move towards more dialogue based forms of engagement has evolved into an 'international phenomenon' (Davies 2013a, p. 688). Despite the prominence of a narrative latent with a sense of 'evolution' and 'progress' when describing the transition from 'deficit' to 'dialogue' modes of engagement, there is still skepticism towards this simplistic narrative(Trench 2008). Skepticism towards this account can be substantiated by considering that culture changes tend to occur at longer timescales, even at the level of sub-cultures (e.g., particular scientific disciplines). Moreover, dialogue was put on the agenda prior to it becoming a 'trendy' concept.

Through implementation of the concept of the 'atmosphere' in relation to the evolution of the relationship between science and society in the U.K., this chapter moves beyond attempting to re-tell the prominent narrative. Instead, in this chapter, I attempt to consider this relationship in more holistic terms thereby acknowledging re-appearances of the 'deficit' model in various forms (Wynne 2006) and the potential for various models of science communication to exist simultaneously (Trench 2008) and in various arrangements. In order to supplement the dominant narrative, this chapter also attempts to integrate the developments at the U.K. policy level in the context of the recently emergent 'impact' agenda; and at the European Union policy level in the context of the newly emerging agendas concerning responsible research and innovation (RRI). Overall, the collective 'atmosphere of engagement' can be traced historically across a timeline and through a number of phases characterized by their own unique atmosphere, in order to accentuate the variable degrees to which the overall atmosphere has been polarized. the concept of the collective 'atmosphere of engagement' allows consideration of new developments in the relationship between science and society whilst accounting for previous influences.

4.2 Public Understanding of Science

In 1979 the Thatcher government was elected to power in the United Kingdom. The government faced a shortage of funds. As a result, research funding was expected to suffer. Moreover, at the government level, science appeared to be fading into the background of priorities for the government. Budgets were being slashed with science being substantially affected.

> "… despite Margaret Thatcher's own background as a chemist, science remained low on her list of priorities. The Royal Society sent regular delegations to meet Sir Keith Joseph, then Minister for Education and Science, but were told that regrettably, Britain simply couldn't afford to spend more" (Wilsdon *et al*. 2005, p.15).

Subsequently, with limitations placed on science funding which persisted for 15 years, there emerged a steady brain drain to other countries (such as the United States) where science was more generously funded. Moreover, numbers of students pursing education in the sciences and mathematics was declining. These factors contributed to a perception that a hostile atmosphere had permeated society with a negative sentiment towards science being communicated in the relations between science and the U.K. society.

The rift between science and various publics was formally highlighted by the publication of the monumental Royal Society report in 1985, entitled *Public Understanding of Science* (This report is commonly referred to as the Bodmer Report). On one hand, the report can be situated within the perceived increase in anti-science sentiment in the U.K. spurred by the environmental and anti-nuclear protests that occurred throughout the 1970s. On the other hand, on a more practical level, the report was the result of a recommendation by the council of the Royal Society to set up a working group to investigate the potential ways in which public understanding of science could be enhanced, which was published by the Royal Society committee on Science Education 11-18 in England and Wales (chaired by Roger Blin-Stoyle) (Bodmer 2010). The report highlighted the link between the public understanding of science and the level of enthusiasm and support for scientific endeavors, within an overall framework that connected the public understanding of science to the economy and the nation. In general terms, this report highlighted the gap between the scientific community and various publics. Lack of social engagement in science was attributed to public deficit of knowledge (or in other words, lack of scientific literacy) and the onus was strongly placed on the scientific community to begin to work towards bridging that gap. Miller (2001) has suggested that to a certain extent, the Bodmer report reflected a concern that the withdrawal of scientists into 'their shell' reached a point where securing public funding for scientific research was undermined. Consequently, in its conclusion, the report made the recommendation that all scientists "must learn

to communicate with the public, be willing to do so, and indeed consider it their duty to do so" (Royal Society 1985, p.24). While the finger was sternly pointed at the scientists, various institutions making up the scientific community (including universities) were encouraged to provide support in the form of communications training which broadly focused on engaging the general public. This recommendation was indicative of the need to foster 'culture of engagement' within academic institutions, particularly universities. Overall, this report, created an 'atmosphere of legitimacy' for the popularisation of science by scientists (Miller 2001).

A direct consequence of this report was the establishment of the Committee for the Public Understanding of Science (CoPUS) in 1986. It was collaboration between the Royal Society, the Royal Institution and the British Association for the Advancement of Science. CoPUS became the driver for the development of the Public Understanding of Science (PUS) atmosphere. Concurrently, the U.K. government was beginning to integrate a similar impetus into its thinking. In 1993, the U.K. government published a white paper entitled *Realising Our Potential* (UK Cabinet Office 1993) which carried an overall message about the need to improve the communication, interaction and overall mutual understanding between the government, industry and the scientific community. These sentiments were echoed, with a re-emphasis on the need for scientists to be active communicators in the Wolfendale Report, published by the Committee to Review the Contribution of Scientists and Engineers to the Public Understanding of Science established by the Office of Science and Technology. The report highlighted the various contributions made by scientists, engineers, researchers and students across the U.K., including the U.K. universities sector. The recommendations of the report again emphasized the need for training in order to support PUS activities both within and outside of universities. Drawing from the Bodmer Report, the Wolfendale report stated that "scientists, engineers and research students in receipt of public funds have a duty to explain their work to the general public" (n.p.). It encouraged the U.K. Research Councils to integrate PUS as an important feature while also placing an emphasis on the acquisition of communication skills by scientists which was suggested would bring recognition for the scientists and the research institutions. Wolfendale report suggested that strong support at senior level in universities and other institutions was needed if they are to create an environment which is favourable to public understanding work" (Pearson *et al*. 1997, pp. 287-288).

The Bodmer Report legitimized public understanding of science activities. However, by the end of the 1990s, the PUS movement found itself at a 'crossroads' (Miller 2001). There was an acknowledgement that attempting to increase the public understanding of science was no longer enough to address the perceived problem in the relations between science and society. This line of

reasoning was substantiated by previous survey data (covering the years from 1988, shortly after COPUS was established, to 1996, when the follow up survey was conducted) that had indicated that there was little change in scientific literacy (Miller 2001).

4.3 Dialogue

Transition from the late 1990s into the new millennium also proved to be a contentious period for the relationship between science and society in the U.K. The recent BSE crisis rocked confidence in scientific advice to the government (as discussed below). The foundation was further shaken by scandals around GM crops (Lezaun & Soneryd 2007; Rowe *et al*. 2005)), MMR (Boyce 2007) and nuclear waste (Bickerstaff *et al*., 2008) which emerged in the U.K. during the 1990s. Moreover, there was uneasiness amongst publics due to rapid advances emanating from areas such as biotechnology and information technology (I.T.). National surveys (e.g., Office of Science & Technology and Wellcome Trust 2000) and large sales of popular science books were demonstrating that there was interest amongst publics in science. However, simultaneously, they were also becoming more critical of science and scientists. The emerging atmosphere precipitated the necessity to begin to move away from one-way communication with dialogue emerging as the preferred form of interaction as the 'deficit' between the two parties became characterised by levels of 'trust'.

The biggest impact on the relationship between science and society in the U.K. was the BSE crisis which rocked public confidence in scientific advice to the government (Frewer & Salter 2002; Jasanoff 1997; Millstone & Zwanenberg 2001; Smith *et al*. 1999). The U.K. government policies for disclosure (in this case lack thereof) were blamed for the consequent breakdown in consumer confidence. Instead of an open discussion about the uncertainties around science related to BSE transmission, the government shielded itself by presenting science as certain and apolitical (Jasanoff 1997). The summary of the inquiry into BSE and variant CJD were included in the report that was published in 2000.

> 'The Government did not lie to the public about BSE. It believed that the risks posed by BSE to humans were remote. The Government was pre-occupied with preventing an alarmist over-reaction to BSE because it believed that the risk was remote. It is now clear that this campaign of reassurance was a mistake. When on 20 March 1996 the Government announced that BSE had probably been transmitted to humans, the public felt that they had been betrayed. Confidence in government pronouncements about risk was a further casualty of BSE' (Phillips *et al*. 2000, Volume 1, section 1).

The case for greater transparency attained an even stronger degree of traction with the emergence of controversy around genetically modified (GM) crops in 1999. Again, issues of scientific

uncertainty, risk and best ways for communication with the public became the focal points of public debate. In 2000, the House of Lords Select Committee on Science and Technology published an influential report entitled '*Science and Society*'. The report diagnosed that the relationship between science and society was suffering from a lack of trust. The report suggested that the lack of trust had created a 'new mood for dialogue'. In order to address this 'deficit of trust' the report indicated that 'direct dialogue with the public should move from being an optional add-on to science-based policy making…and should become a normal and integral part of the process'. Whilst this House of Lords report is often credited with initiating the watershed moment, the erosion of public trust was beginning to be identified by other official bodies. For example, in 1998, the U.K. Royal Commission on Environmental Pollution (RCEP) published a report on *Setting Environmental Standards*, which noted an 'apparent erosion of public trust in environmental regulation'. Consequently, the publication of the 'Science and Society' report, advice from other bodies and contributions of social scientists precipitated the emergence of a series of initiatives that were meant to engage publics in dialogue on science and technology,.

> "Today's public expects not merely to know what is going on, but to be consulted; science is beginning to see the wisdom of this, and to move 'out of the laboratory and into the community' to engage in dialogue aimed a mutual understanding. Several of our witnesses agree that a shift along these lines is taking place" (House of Lords Select Committee on Science and Technology 2000, p.37)

Therefore, the report from House of Lords reframed the communicative relationship between science and society from one that was characterised by a 'deficit of knowledge' as elaborated in the Bodmer Report, to one that was characterised by a 'deficit of trust'. Within the context of the former relationship, the deficit was to be addressed through activities underpinned by educational goals characterised by one-way communication. In contrast, the new relationship called for greater 'engagement' between scientists and society; 'engagement' of publics in the policy making process was especially favourable. However, in both cases, the communication between the two parties was still aimed towards improvement of attitudes of publics towards science and technology.

The transition from 'deficit' to 'dialogue' became noticeablethrough the proliferation of a number of dialogue processes (Stilgoe, Lock & Wilsdon 2014, p. 5). In the U.K., the most extensive exercise in public consultation was the debate over the commercial growing of GM crops ('*GM Nation?)'*. The consultation implemented a number of avenues to receive feedback from publics. These included a survey which collected feedback from participants (there were 36 553 completed questionnaires), focus groups, a series of different kinds of public meetings, preliminary workshops and a dedicated website. A summary of the resulting report (GM Nation? 2003) can be encapsulated as before: "people are generally uneasy about GM crops; the more people engage in GM issues, the

harder their attitudes and the more intense their concerns; there is little support for early commercialisation; there is widespread mistrust of government and multi-national companies"(Irwin 2006, p.311). During the actual exercise, the government provided no indications that it would actually act upon the recommendations provided. Ultimately, the government decided to implement a 'case by case' approach to the development of GM. Irwin (2006) provides a critical evaluation:

> "On the one hand, the exercise can legitimately be presented as Britain's most thoroughgoing attempt to consult with the larger public and gain broad social consensus over the direction of technical change. On the other, the scale and timing of the debate (essentially, 5 weeks duration and with a budget of only 500,000), and the construction of 'firewalls' from both government and technical analysis restricted it in many ways" (Irwin 2006, p.314).

4.4 Shifting the 'Dialogue Landscape' - Moving Upstream?

Another key turning point in the evolution of science and society in the U.K. occurred in 2004 when the discourse around public engagement began to migrate 'upstream'. This emerged against the backdrop of consultation papers, focus groups, stakeholder dialogues and citizen juries that arose from within the context of the public engagement agenda. "Yet despite this progress, the link from public engagement back to the choices, priorities and everyday practices of science remains fuzzy and unclear" (Wilsdon & Willis 2004, p.18). Studies concerning engagement practices have demonstrated a number of limitations that are associated with various dialogue processes (Chilvers 2010; Lander *et al.* 2014). The case of GM controversy has starkly demonstrated that public involvement may come at too late of a stage to actually affect the developmental trajectory of the technology (Mayer 2003). Subsequently, recognition of these limitations has guided researchers, scientists and policymakers towards the notion that engagement needs to be moved to an earlier point in the innovation process, or 'upstream'. This idea was advocated in 2004 by the think tank Demos (Wilsdon & Willis 2004). The idea of 'upstream engagement' was then taken up in other prominent initiatives in the U.K. The Royal Society and Royal Academy of Engineering, in their report on nanotechnology, called for "constructive and proactive debate about the future of nanotechnologies [to] be undertaken now – at a stage when it can inform key decisions about their development and before deeply entrenched or polarised positions appear" (Royal Society & Royal Academy of Engineering 2004, p. xi). Moreover, the government, within the context of announcing its new ten year strategy for science and innovation in the U.K., stated its commitment "to enable [public] debate to take place 'upstream' in the scientific and technological development process"(HM Treasury 2004). As an example, which is often cited as the first British attempt at upstream engagement, was a consensus conference which was organised in 1994 by the Science

Museum and the Biotechnology and the Biological Sciences Research Council (BBSRC)[48] on plant biotechnology – a panel of ordinary citizens was tasked with the responsibility of taking evidence and cross-examining expert witness prior to making their conclusions (Durant 1995). More recently, an example of 'upstream' engagement was carried out by EPSRC in connection with the 'Grand Challenge' funding call in the research area of nanotechnology for healthcare where public engagement contributed to the framing of the call (Jones 2008).

4.5 Science for Society, with Society

4.5.1 Responsible Research and Innovation (RRI)

Despite the apparent support behind 'upstream' engagement, its momentum has begun to stagnate, "The rapid move from doing communication to doing dialogue has obscured an unfinished conversation about the broader meaning of this activity. It is not simply a matter of science providing a microphone as well as a megaphone. The need for institutional reflexivity (Wynne 1993) fundamentally challenges who should be doing engagement and why" (Stilgoe *et al.* 2014, p.8). Therefore, public engagement in the form of public dialogue has continued to exist as "a means that is in search of an end" (Stilgoe *et al*. 2014, p.7).

The idea of 'responsible innovation' (RI) or 'responsible research and innovation' (RRI)[49] (von Schomberg 2011) has emerged in "recognition of the need for scientists and innovators to take more care of the futures that they help create" (Stilgoe 2014, n.p.). Looking to the future, questions concerning what research can do for society and who gets to decide on those questions remains of importance not only more broadly in Europe (Danish Ministry of Science, Innovation & Higher Education, 2012; European Commission, 2012; Rome Declaration 2014) but also at the national level in the United Kingdom as well (Owen 2014; U.K. Synthetic Biology Roadmap Coordination Group, 2012).[50] "Responsible innovation is, in a way, a collective statement: an expression that gathers together a variety of communities, groups and viewpoints around a shared concern" (Callon & Lacoste 2011, p. 20). In the broadest sense, RRI means 'science policy should explicitly include society' (Alix, 2014). von Schomberg (2011) offers a more detailed definition

> "Responsible Research and Innovation is a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view on the (ethical) acceptability, sustainability and societal desirability of the innovation process and tis

[48] http://www.bbsrc.ac.uk/

[49] The idea of RI or RRI builds on anticipator governance, Real-Time Technology Assessment, Constructive Technology Assessment, value-sensitive design and open innovation (see Barben et al 2008; Chesbrough 2003, Guston & Sarewitz 2002; Rip et al 1995).

[50] Expectedly, RRI has also received extended attention from the academic community (e.g., Akrong, 2015).

> marketable products (in order to allow a proper embedding of scientific and technological advances in our society)" (p. 9).

Responsible research and innovation has begun to be embedded at various levels within appropriate funding bodies. At the level of the European Union, RRI is integrated into Horizon 2020 program through its 'Science with and for Society' branch (estimated budget €109m for 2014/5)[51]. Within this framework, RRI is centered around 6 keys: public engagement, gender equality, science education, ethics, open access and governance. At the national level, in the U.K., RRI has been incorporated into its strategic thinking and funding programs by EPSRC[52]. For the research council, an approach of responsible innovation involves continuous cycle of anticipation, reflection, engagement and acting (AREA). Although the RRI agenda has garnered a prominent place within the funding bodies at the EU and U.K. level, it has not become prescriptive at the university levels - as such, universities have been allowed to address this agenda in their own manner.

At the conference Science in Dialogue - Towards a European Model for Responsible Research and Innovation (Odense, Denmark; 23-25 April 2012), Máire Geoghegan-Quinn, European Commissioner for Research, Innovation and Science stated that

> "After ten years of action at EU level to develop and promote the role of science in society, at least one thing is very clear: we can only find the right answers to the challenges we face by involving as many stakeholders as possible in the research and innovation process. Research and innovation must respond to the needs and ambitions of society, reflect its values, and be responsible" (p.10).

The commissioner went on to set out a framework that is contingent on six keys which contribute to the practice of responsible research and innovation: engagement of all societal actors, gender equality, science education, open access, ethics and governance (see European Commission 2012). The first key refers to the necessity of including all societal actors (researchers, industry, policy makers and civil society) in the research and innovation process. Connected to this point is the need to ensure that there is gender equality that is incorporated as a part of the inclusivity process. The next key is to improve the science education process in Europe in order to empower the future generations of researchers and other societal actors. The next is establishing open access to results and data associated with publicly-funded research. Ethics refers to the necessity of adhering to the highest ethical standards in the conduct of research. Lastly, there should also be an onus on governance to ensure that policy makers prevent any harmful or unethical developments in research and innovation.

[51] For an investigation of whether the Horizon2020 program incorporates the concept of Responsible Research and Innovation, see Reinhardt (2014).

[52] EPSRC RRI framework https://www.epsrc.ac.U.K./research/framework/ [Accessed 10 June 2015]

Institutionalization of RRI has not only occurred at the European Level, it has also occurred in the United Kingdom as well. In October 2013, the U.K. Engineering and Physical Sciences Research Council (ESPRC) announced publicly its commitment to a framework of responsible innovation (EPSRC 2013a)[53]. The framework was developed over a four year-period since 2009. According to EPSRC, "as a public funder of research, we have a responsibility to ensure that our activities and the research we fund, are aligned with the principles of responsible innovation, creating value for society in an ethical and responsible way" (EPSRC 2013a, n.p.). Therefore, according to the EPSRC

> "Responsible Innovation is a process that seeks to promote creativity and opportunities for science and innovation that are socially desirable and undertaken in the public interest. Responsible Innovation acknowledges that innovation can raise questions and dilemmas, is often ambiguous in terms of purposes and motivations and unpredictable in terms of impacts, beneficial or otherwise. Responsible Innovation creates spaces and processes to explore these aspects of innovation in an open, inclusive and timely way. This is a collective responsibility, where funders, researchers, stakeholders and the public all have an important role to play. It includes, but goes beyond, considerations of risk and regulation, important though these are."(EPSRC 2013a, n.p.)

The approach to responsible innovation advocated by the research councils should seek to continuously anticipate, reflect, engage and act (AREA) (EPSRC 2013b). Anticipation requires the description and analysis of un/intended impacts (e.g., economic, social, environmental) that may arise. Reflection refers to the process of reflection on "the purposes of, motivations for and potential implications of the research, and the associated uncertainties, areas of ignorance, assumptions, framings, questions, dilemmas and social transformations these may bring"(EPSRC 2013b). Engagement is the process whereby the visions, impacts and questions are opened up to broader deliberation, dialogue and debate in an inclusive manner. Lastly, to 'act' is to implement the described procedures in order to influence the direction and trajectory of research and innovation process itself. The council recognizes that in order for this process to occur that the council and their researchers need to provide support[54] in order to nurture and develop partnerships not only with other disciplines but other 'spheres of expertise' (therefore, implicitly here is the suggestion that engagement with other parties outside of academia is important). Finally, it should be noted that at the time of writing Biotechnology and Biological Sciences Research Council (BBSRC) has not yet institutionalized RRI into its governance structures. However, RRI has been integrated into particular funding calls; for example, one for synthetic biology research centres (see Pearce 2014).

At the level of universities in the U.K., engagement with the idea of RRI has been left to be determined by the universities themselves. My research has not yielded any information concerning

[53] For a personal account of the development of this framework over a four year period since 2009 see Owen (2014).

[54] For further details, see EPSRC 2013c.

initiatives connected to RRI in the CSU[55]. In contrast, UCL appears to have demonstrated a strong commitment to exploring and developing the framework through the creation of a new hub focusing on RRI. According to the website, "the RRI Hub at UCL aims to build RRI in UCL and beyond through research collaboration and engagement" (UCL 2015). Another example is found at the University of Nottingham, where a project aimed by "using documentary analysis and interviews to investigate how RRI is being interpreted within a research-intensive, Russell Group university" (Pearce *et al*. 2014, p. 2). This project reported a set of findings including: the university did not address RRI within its governance framework; there were a number of existing research activities that explicitly engaged with RRI; there were diverse interpretations of RRI amongst staff and researchers within the university; researchers responded to funders' RRI requirements in an ad-hoc manner. Overall, this project identified a potential for an interdisciplinary conversation about RRI. This was followed up by a workshop (Pearce *et al*. 2015) in order to explore the meaning of the RRI agenda, sharing different understandings of RRI and to establish a network of researchers with interest in RRI across the university. The example from the University of Nottingham suggests that universities may already be doing work that can be classified within the parameters of RRI. Nevertheless, more broadly, it appears that wide scale appropriation of responsible research and innovation is yet to occur across the universities in the United Kingdom.

Overall, responsible research and innovation remains a concept that is open to interpretation by various parties. Most importantly, it requires co-operation and a migration of different parties towards mutual understandings and expectations as well as potential outcomes of research. In broad terms, it requires public engagement with a purpose. But the question still remains, what is the purpose of public engagement in its various forms? One potential answer is that public engagement should serve as a mechanism for articulation of societal impacts of academic research (Watermeyer 2012b).

4.5.2 Impact – Research Councils U.K.

In the U.K., the concern around societal impact of research has been considered at the level of Research Councils. The emergence of 'impact' as an indicator for research councils can be traced back to four milestones (Payne-Gifford, 2014): 1965 Science & Technology act; publication of Science White Paper, '*Realising our Potential*' (UK Cabinet Office 1993) in 1993; publication of the 2004-2014 *Science and Innovation Investment* Framework by the Treasure (HM Treasury 2004); publication of in 2006 of the Warry Report ('Increasing Economic Impact of Research Councils).

[55] This is not to say that there are no initiatives that are within the university that my fall into the parameters associated with RRI.

The Science & Technology Act of 1965 established the U.K. Research Councils, which at the time included the Science Research Council (this is now the EPSRC and STFC) as well as the Natural Environment Research Council (NERC). The purpose of the research councils was three fold: to fund high quality research; to advance knowledge and technology in order to meet the needs of the users; and contribute to U.K. economic competitiveness. It is important to note, as pointed out by Payne-Gifford (2014, p.14) that the original text of the Science & Technology Act stated that the purpose of the Research Councils was 'the dissemination of knowledge'.

The focus on knowledge transfer began to increase with the publication of the Science White paper *Realising our Potential* in 1993 (UK Cabinet Office 1993). Around this time, the EPSRC also introduced a statement on importance of beneficiaries (Payne-Gifford 2014). In 2004, HM Treasure published the 2004-2014 *Science and Innovation Investment Framework*. Important point from this framework was that it committed the research councils to goal of knowledge transfer rates. The framework included a 10-year reporting framework which enabled the monitoring of research council's contribution to the U.K. economy.

In 2006, The Warry Report, *Increasing the Economic Impact of Research Councils.* reiterated the importance of the research in mediating the relationship between science and society through knowledge transfer. The report identified three areas on which the research councils were to act: their leadership of the knowledge transfer agenda; their role in influencing knowledge transfer behaviour of universities and research council funded institutes; and increasing their engagement with user organisations. The recommendations heavily focused on improving the interactions between researchers and wider society. For example, under Recommendation 2 ('Influencing') the report suggest that "The research councils should influence the behaviour of universities, research institutes and Funding Councils in ways that will increase the economic impact of Research Council funding"(p. 3). Moreover, under Recommendation 3 ('Engagement'), the report suggest that "RCUK should engage Government, business and the public services in a wide-ranging dialogue to develop overarching, economically relevant 'research missions'"(p.4).

Therefore, the idea that research councils should contribute to the economy of the U.K. (in other words, achieve economic impact) was incarnated in the 1993 Science White Paper, the 2004-2014 Framework, Warry Report and eventual implementation at the Research Councils. In April 2009, Research Councils announced the inclusion of an 'impact plan' in new grant applications across all Research Councils. The purpose of the 'impact plan' was to get the researchers to consider the potential impacts that their research may have as well as routes that needed to be taken in order to increase the probability of impact achievement with the funds awarded for research. In

April 2010, 'impact' plans were replaced with a 'Pathways to Impact' section in order to provide greater clarity for researchers emphasizing the expectation for researchers to explore ways to promote potential for impact rather than simply predicting it. At the time of writing, all Research Council funding applications in the U.K. include an impact summary[56] and a 'Pathways to Impact' section. For example, Natural Environment Research Council (NERC), provides the following guidance on their website,

> "All researchers are required to submit a pathways to impact plan with their grant application. Funds are available to support activities identified in the plan which can help achieve societal and economic impacts; project-specific public engagement activities, which are relevant and appropriate to your proposed research, can be included as ways of generating impact in your Pathways to Impact plan" (NERC 2015).

The summary section is meant to answer two questions. The first question is: *Who will benefit from this research*? Beneficiaries may include such end-users such as government agencies, policymakers, public sector, industry, NGOs, schools, museums, associations, media as well as others. The second question is: *How will they benefit from this research*? Again, there may be a variety of benefits which include evidence-based policies, new technologies and equipment, better training, improved skills, wealth creation, improved environment, international development as well as a multitude of others. Therefore, researchers undertake dual consideration of various publics that may benefit from the research and all the potential benefits (academic, societal, economic) that may emerge from the research. The 'Pathways to Impact' section is complimentary to the summary in that it provides a description of how the impacts that have been summarised will be achieved. The focus of the pathways to impact should be on partners and other stakeholders beyond academia. The 'Pathways to impact' section is meant to answer the following question: *What will be done to ensure that potential beneficiaries have the opportunity to engage with this research?* A number of activities can be undertaken in order for various publics to engage with the research – publications, websites, on-line databases, conferences, public lectures, workshops, collaborative research. In order to address these questions, the research councils have provided extensive supporting materials on their websites[57]. Notably, the research proposals received by the councils continue to be assessed ranked on science excellence. The 'Pathways to Impact' sections are assessed but are not considered in the proposal ranking. However, if there is a lack of an 'acceptable' 'Pathways to Impact' statement, then the grants will not be allowed to commence.

[56] The impact summaries of the funded project are published on the RCUK website (http://www.rcuk.ac.uk.).

[57] Supporting materials can be found at http://www.nerc.ac.U.K./research/impact/communicating/help/

4.5.3 Impact – Research Excellence Framework (REF)

The contribution of research to the wider society is not only the concern of the Research Councils in the United Kingdom. Increased necessity for accountability of research (not just scientific) has led governments to implement a national evaluation system in order to assess the research being produced New Zealand's implemented the *Performance-Based Research Fund* initiative whilst in Australia a similar initiative has been implemented under the title *Excellence in Research for Australia*[58]. The most widely known evaluation system is conducted in the United Kingdom – the Research Assessment Exercise (RAE) has been carried out on a quinquennial basis since the 1980s. Prior to 2014, the last time an evaluation was conducted was in 2008 with the parameters of the Research Assessment Exercise (RAE), which has been internationally recognised as a standard for research evaluation (von Tunzelman & Kraemer Mhula 2003). In 2014, the RAE was succeeded by the Research Excellence Framework (REF). The transition from the former to the latter frameworks involved the integration of a new evaluation parameter to measure the economic and societal impact of academic research, under the broad term of 'impact' (the difference lies also in the removal of indicators of esteem from assessment).

The development of the current approach in the U.K. commenced when the Higher Education Council for England (HEFCE) commissioned RAND Europe to conduct a review the various approaches for the evaluation of research impact (Grant *et al*. 2009). Four frameworks were selected for an in-depth analysis: the Australian Research Quality and Accessibility Framework (RQF), the U.K. RAND/ARC Impact Scoring System (RAISS), Impact Scoring System, the US Program Assessment Rating Tool (PART) and the Dutch Evaluating Research in Context (ERiC). The recommendations provided in the report indicated the feasibility of quantifiably measuring impact with supplements coming from utilisation of case studies (or narratives), which can be supported by proxy indicators of impact. In particular, the report highlighted the work done as a part of the Australian Research Quality and Accessibility Framework (RFQ) as a basis for the development of the impact approach for the REF.

To ascertain whether impact can be integrated within the assessment exercise, HEFCE undertook a pilot study in 2009-2010. This pilot study involved 29 institutions. These institutions submitted evidence of impact across five units of assessment (in clinical medicine, physics, earth systems and environmental sciences, social work and social policy, and English language and literature) (REF2014 2010). The panels tasked with evaluation of the submissions were composed of researchers as well as users from public bodies as well as businesses and industry. The expert panels

[58] More information is available here: http://www.arc.gov.au/excellence-research-australia.

determined that it was possible to implement a case study approach in order to assess impact (REF2014 2010). The case study approach has been described as "the 'state of the art' to provide the necessary evidence-base for increased financial support of university research across all fields" (Donovan 2011, p. 178).

The Research Excellence Framework (REF) in 2014 assessed the following aspects of research: outputs; impact; and environment. Initially, impact was envisioned to be 25% of the total value of the REF, with outputs occupying 60% and environment 15%. However, the proportion allotted to impact was subjected to substantial criticism (LSE Blogs 2011; Russel Group 2009; Jump 2011). Consequently, HEFCE announced in March 2011 that impact will constitute 20% of the overall assessable units of the REF. The decrease in the proportion dedicated to 'impact' can also be attributed to the notion that a lower weighing would be appropriate in light of 'impact' being in the developmental phase as part of the REF and that the proportion would be increased in subsequent assessments (REF2014 2010).

Definitions of what impact counts as part of the REF have been criticised as "underdeveloped or ill-informed" (Watermeyer 2012b, p. 119). In 2011, HEFCE published a definition which defined impact as (HEFCE 2011 , p.48). However, it has been suggested that "… far from specifying or delimiting expressions of impact, this "guidance" revealed its plurality and non-conformity and that categories of impact are as multiple as receivers of impact are varied. Furthermore, many of these categories as abstract, emotive or cognitive qualifiers seem difficult to translate into measures or metrics of assessment" (Watermeyer 2012b,p. 119). HEFCE has proposed utilisation of "reach" and "significance" for the assessment of societal impact of academic research. Impacts are to be assessed within research disciplines. The range of impacts possible is substantial so, it may be questionable how one would compare impacts within and across disciplines (Penfield *et al* .2014).

4.6 Conclusion

This chapter has traced the evolution of the relationship between science and society in the United Kingdom. This evolution of the relationship can be traced through a path across a number of phases: a phase focussed on Public Understanding of Science (PUS), which transitioned to one concerned with Public Engagement (PE) and, increasingly, Public Dialogue (PD) whilst, more recently, Responsible Research and Innovation (RRI) with further extensions into the societal 'Impact' of research. In terms of research communication, this path reflects a change from a one-way, top-down approach where scientists disseminated their knowledge for the purposes of informing the public to two-way communication between government institutions and publics in order to foster a

more transparent relationship between the two, to dialogue between scientists and publics about science and its role and implications within society; to now migrating upstream where dialogue occurs at the beginning of the research process in order to integrate knowledge of various publics and inform the research process. This grand narrative suggests that the process of evolution has occurred and progress has been made in the relationship between science and society.

The evolution of the relationship between science and society across the identified phases (or more explicitly, within the context of the atmosphere of science and society in the U.K.) has contributed to the current constitution of the 'atmosphere of engagement', whose origins of emergence can be connected to the governmental and institutional levels in the United Kingdom. For example, this atmosphere has precipitated the emergence and development of the science communication sector on its own. Moreover, since the driving force for the formation of the atmosphere of engagement occurred at the governmental level, it too has enveloped the higher education sector in the U.K., which has been subjected to increasing calls from various publics for openness, transparency, and upstream engagement in relation to science and technology. Therefore, individual researchers are subject to experience the created collective 'atmosphere of engagement', whilst also being able to affect its constitution through their own individual engagement practices. The engagement practices of a sample of researchers within a case study university are the focus of the next chapter (Chapter 5).

5 Chapter 5: Constituting the 'Science-Society' Space: Exploring Researchers' Engagement Practices

5.1 Introduction

This chapter focuses on how academic researchers have 'mobilised' within the political and institutional 'atmosphere of engagement' and have contributed to its constitution through their engagement practices.

In chapter 4, I discussed the literature suggesting that there has been a transition (at least in the academic discourse and to a certain extent the institutional and social discourses as well) in the communicative relationship between science and society from a transmission model based on one way communication from scientists to public ('deficit') to a model based on two-way communication ('dialogue') between researchers and various publics. These models are often associated with different types of engagement activities but can often be found operating in unison complimentary manner. Despite the apparent diversity of activities connecting researchers and publics, theoretical 'framing' by researchers in the field has often been used to emphasize the deficit-dialogue models of communication dichotomy, particularly in discussions about the merits of each model of communication. Using this as a starting point, I argue that this approach is reductionist and leads to an over-simplified representation of the relationship between science and society (often used to support tacit agendas of the different groups involved). Instead, I argue that we need to move beyond focusing on the deficit/dialogue dichotomy and expand the focus to include all forms of 'engagement' in order to work towards a more nuanced understanding of the heterogeneous relationships between science and society; and ultimately recognizing the various outcomes ('impacts') of science on and in society. As a theoretical framework for this approach, I adopt a 'geographical perspective,' particularly grounded in the work on 'relational space' (Harvey 1996; Lefebre 1991; Massey 1992, 1998, 1999, 2005), to conceptualize the relationship between science and society as ('relational') 'space'. Using this approach and applying it in empirical research, I argue that the 'science-society' space is produced as a result of the interrelations between researchers, institutions in which they work, and various publics with whom they engage in various formats. It is a space of multiplicity and is in constant evolution, resulting in a heterogeneous science-society space. I argue that the overall science-society space is constituted through public engagement events (Horst & Michael 2011) where the events themselves as well as various actors (in this case particularly researchers and publics) that contribute, and the communicative frameworks which they adopt, are emergent. I argue that within the context of engagement events, researchers engage in

'identity work' by adopting a hybrid role identity which is constituted by the primary academic self and the secondary 'external' (commercial, outreach, policy) persona. Whilst an engagement event enables a researcher to adopt a hybrid role identity, it is also a 'context of publicness and of publics' (Hawkins 2011, p. 543). Here I suggest that researchers engage with 'potential' publics or 'infrapublics' (Hawkins 2011). In line with Hawkins (2011), I argue that for researchers, frequently, 'public(s)' are virtual entities which emerge in response to 'an affective modulation' (Hawkins 2011). The modulation occurs as a result of formation and dissipation of affective atmospheres. There is a reciprocal and dynamic relationship between the atmosphere in the social space of science communication and the ways that science communication is carried out in different settings. Furthermore, researchers adopt a set of strategies which involve interaction with other 'agents' deployed in the communication process which contribute to the formation of an affective atmosphere and the subsequent emergence of publics. Three types of strategies are identified here: media dissemination, dissemination via the mediating role of 'field experts', engagement mediated by materiality (the physical environments where communication is carried out and the devices and technologies applied in the process of engagement play a role in the communication process). I conclude the argument by suggesting that the interactions between the researchers and the various publics they communicate with, as well as the other agents involved, although temporary in nature, result in a formation of 'trading zones' (Galison 1998) which create 'specific' atmospheres for communication and affect the behaviour of the constituents (particularly researchers and publics); and contribute to the overall 'atmosphere of engagement'.

The rest of this chapter is structured in the following manner. First, I examine engagement practices of interviewed researchers. Next, I explore in detail the geographies of engagement. Specifically, I first consider the material and social spaces of engagement and continue the analysis by considering the types of communicative interactions researchers are involved in; the researchers' situation in relation to the knowledge production process; and finally, the underpinning models of communication. The chapter then focuses on the researchers and publics. In particular, I look at the roles that researchers adopt for the purposes of engagement, how they 'conceptualise' 'the public(s)' and the strategies implemented which enable the emergence of various publics within the context of engagement events. I conclude by introducing my interpretation of engagement events as 'trading zones'.

5.2 Engagement Practices

This section highlights the diversity of engagement practices that were reported by the interviewed researchers. In addition to emphasizing their multiplicity, I dissect these activities in

order to reveal the dynamics between researchers, research and publics and the associated complexity of the communicative process. Consequently, the aim of this section is to begin to advance the argument that the relationship between science and society is open and emergent; characterised by multiplicity and constant evolution.

The empirical findings reflect that the socio-geographical space formed by science and society in the U.K. context is constituted through a wide variety of engagement activities within which research communication occurs. They included giving public talks and lectures, writing for non-academic audiences, participating in an open day, working with industry (collaborative research, consulting, etc.), conducting participatory research, going into schools, using social media, volunteering and others. Table 5.1, which is included below, presents an overview of the different types of engagement activities that each interviewed researcher explicitly reported within the context of reflecting on their engagement practices as a part of the interview.

Researcher **Engagement Activity**	**Archaeologist 1**	**Computer Scientist 1**	**Physical Geographer 1**	**Physical Geographer 2**	**Earth Scientist 1**	**Earth Scientist 2**	**Physical Geographer 3**	**Earth Scientist 3**	**Physical Geographer 4**	**Archaeologist 2**	**Physical Geographer 5**	**Physical Geographer 6**	**Computer Scientist 2**	**Archaeologist 3**	**Physicist 1**	**Archaeologist 4**	**Engineer 1**	**Physical Geographer 7**	**Chemist 1**	**Biologist 1**
Giving a public talk or lecture	X		X			X	X	X	X			X		X	X	X			X	X
Going into a school (e.g. Researchers in Residence Program)															X			X		
Involvement in open day (university, department, lab, etc.)	X	X											X	X						
Doing a demonstration (not part of university open day)		X											X							
Writing for non-academic audiences	X		X			X	X	X					X	X						

Industry / Business Engagement		X			X			X				X	X	X	X					
Presenting at a science centre		X														X				
Media Engagement (Radio, Television, Newspapers)	X	X				X	X	X	X	X			X							X
Policy (makers) Engagement						X			X		X									
Volunteering activities				X	X															
Carrying out public consultation						X														
Carrying out community-informed research			X								X						X			
Carrying out community (public)-involved research	X													X						X
Participating in a dialogue event (or process)			X			X														
Webpage		X								X										
Social Media Engagement (Facebook, Twitter, blogs)							X			X				X						
Training or teaching public groups to carry out research					X							X	X	X		X			X	
Participating in a science cafe					X															
Engagement with Practitioners		X					X													
Involvement in Professional Organisations														X						

Table 5.1 - Interviewed researchers' engagement practices.

The typology strictly emerged out of the interviews. The most popular form of engagement was giving talks (From the interviewed researchers: 3 of the 4 Archaeologists; 4 of the 7 Physical Geographers and 2 of the 3 Earth Scientists discussed giving talks[59]). Giving talks is a mirror image of an activity that researchers consider to be a part of their academic role - presenting at academic events such as conferences and workshops. Another form of engagement that several of the interviewees discussed was communication through the traditional forms of media (television, radio, newspapers). Media engagement represents the most direct way for researchers to reach a wide audience (which includes other academics) and inform them about the work while also contributing to maintaining a positive image of the university in the public sphere. Notably, the utilisation of social media was mentioned by several interviewees, yet only two interviewees talked about using a blog for engagement beyond academia. Engagement with businesses and/or industry was also mentioned by some of the interviewed researchers. Similarly to utilisation of media, engagement with business (the term here also encompasses industry and other related organisations) also represents a favourable way to connect academia with society and demonstrate the value (economic, social) of academic research. Furthermore, this mode of engagement is closely aligned with university's goals in terms of knowledge transfer/exchange goals of the U.K. Research Councils and now makes a contribution to aims and objectives associated with the U.K. 'impact' agenda, which is discussed more in depth in Chapter 7. This research suggests that researchers can engage in a variety of practices that connect them with various publics (and more broadly connect universities and communities; as well as science and society). Moreover, consideration of individual engagement trajectories for researchers in different disciplines reveals substantial heterogeneity between and within disciplines, which is subject to temporal variation. Therefore, the constitution of the 'science-society' space is characterised by heterogeneity, which is constantly evolving.

Having provided an overview of the actual engagement practices discussed by the interviewees, in the rest of the section I begin to consider the geographies of engagement. First, the practices discussed by my interviewees are analysed from a socio-spatial perspective. A further layer of analysis is then added by considering the nature of engagement in terms of the relationship between the sender (researcher) and the receiver (publics), the positioning of the communicative process in relation to the knowledge production process as well as the models of communication that form the foundation of the communication process.

[59] It would not be unreasonable to assume that all researchers have engaged in giving talks/public lectures at one point or another in their careers as this is a rather common activity for academic researchers in general.

5.3 Geographies of Engagement

Whilst the foregoing section has emphasized the multiplicity of engagement practices, this section begins to look at the geographies of engagement. Just as science has a geography (in terms of the spaces of knowledge production), so does research communication ('geography of engagement'). The 'spaces of engagement' have material and social dimensions.

5.3.1 Material and Social Spaces of Engagement

In terms of **material spaces**, engagement is a localised practice and occurs in a variety of 'physical' locations. In the interviews scientist described a number of physical spaces within which engagement practices were carried out. Based on the interviews, these can be grouped into three categories: **'spaces of science', 'public spaces of science', and 'spaces of public(s)'** (Table 5.2).

Physical Spaces Of Engagement	Spaces of ***Science***	Laboratories Institutions Conferences Scientific Societies Field Sites
	Public Spaces of Science	Field Sites Science Centres
	Spaces of ***Public(s)***	Science Centres Schools Businesses Industry

Table 5.2 - Physical Spaces of Engagement.

The first category, '**spaces of science'**, refers to the more traditional spaces of scientific knowledge production: laboratory spaces, institutions, conferences, scientific societies, field sites. These spaces can be characterised by the variance in the degree of dominance of particular forms of scientific knowledge. Moreover, these spaces are source sites from which scientific knowledge is disseminated primarily to other academics. However, in all the listed spaces interaction between researchers and various members of publics can occur and scientific knowledge can be mobilised through a number of formats and representations. The second category, '**public spaces of science**', includes spaces that are still sites of scientific knowledge production but are situated beyond the traditional academic contexts and have a more ongoing interaction with various publics. Field sites are also included in this category as they can often be public spaces that become 'scientized' (characterised by the emergent dominance of scientific knowledge and its production) whilst still facilitating interaction

between researchers and publics. Examples include sites that are used for archaeological excavations. Another example that fits into this category of physical spaces of engagement is science centres[60]. The last category, '**spaces of publics**', refers to settings occupied by particular publics, such as schools, business premises and other industrial settings. These spaces are not necessarily dominated by academic scientific knowledge and its associated production processes. This is the primary reason for inclusion of industrial settings in this category, which may not necessarily be considered as public spaces with access available to particular groups of people (e.g., employees of the organisation). Moreover, the engagement between researchers and representatives of these publics occurs through a various formats that do not necessarily adhere to a one-way model of communication. Engagement can occur in numerous physical spaces dominated by science or hybrid spaces that can be 'scientised'. These spaces are characterised by variable degree of access granted to publics. Establishing a categorisation of physical spaces of engagement contributes to an understanding of the variability of physical environments and their potential impact on the communication between researchers and various publics. The physical spaces contribute to the interactions that develop between researchers and publics (formation of the social space of engagement), which can range from being based on a one-way model of communication to one based on dialogue. Furthermore, the coming of various publics and researchers in a number of physical spaces of engagement also suggests the need to consider of the relational geographies of science communication (social spaces of engagement).

'Social Spaces of Engagement' can be characterised by different kinds of social relations. Some spaces are dominated by scientific knowledge and the associated and mode of knowledge production (associated with Mode 1 knowledge production (Nowotny *et al*. 2001)). In such contexts, scientists are deemed to be in control of power due to the possession of knowledge whilst various publics are judged to be deficient of that knowledge. From the communications perspective, this distribution of power between researchers and publics translates into implementation of one way communication approaches by the researchers. Basing the interactions on this model of communication maintains a 'separation' between researchers and publics.

However, as have been argued that the modes of knowledge production have been changing to include heterogeneous practices, transdiciplinarity and reflexivity (Gibbons *et al*. 1994; Nowotny *et al*., 2001). These processes have enabled the transformation of reliable knowledge according to science to become 'socially robust knowledge' through contextualisation and inclusion

[60] According to Dairianathan and Lim (2014), "science centres and science museums are considered leisure attractions or edutainment centres that provide support for students, teachers and families with opportunities to experience and understand science in an enjoyable setting"(p.251). Not all science centres integrate the knowledge production element associated with; for example, universities. However, some can act as stages for demonstration of the research process

of numerous parties to speak back to science. In terms of communication, there is then a transition from one way model of communication to one based on dialogue. These processes occurred in the social space of the agora. In simple terms, as previously alluded to before, it is the space where 'science meets the public'. "Science and the public are … linked by a complex web of interactions which take place in what constitutes a manifold public space in which scientific and technological knowledge becomes increasingly distributed throughout society" (Nowotny 1993, p. 308). These interactions can be imagined at the macro, meso and micro levels, which may be complimentary or adversarial. The macro level refers to the relations between 'science and society'. The meso level refers to the relations between 'university and community'. The micro level refers to the relations between 'researchers and publics'. This latter category can be further broken down into the relations between researchers and particular sectors of society: researchers and schools (school children); researchers and stakeholders (e.g., NGOs, industry partners); researchers and policymakers; researchers and media; researchers and interest societies. Based on the interviews with the sample of researchers within the case study university, the interaction at the various levels between science and society can be distilled into a number of 'social spaces of engagement'. They are presented in Table 5-3.

Social Spaces Of Engagement	Hybrid Spaces of Public Discourses	Spaces of 'the public' discourse Spaces of 'a public' discourse
	Public Space of Market	
	Professional Knowledge	
	Lay Knowledge	

Table 5.3 - Social Spaces of Engagement.

The conceptualisation of these socially constructed spaces help us to understand how formal institutional and informal social processes can be important for science communication. The public space of the market is perhaps the most familiar and accessible social space for science. The presence of scientific research in this space can be attributed to the increased role of science in the innovation process. Science has enabled a continuous flow of products, processes and instruments which enable further innovations. This is a space that can be characterised by unprecedented input from public. This is to say that the mobilisation of scientific knowledge for transformation into products and process is dictated by demand. Therefore, publics of the market space have a direct effect on the knowledge production process. The public space of the market is further connected to the space of 'professional knowledge'. It refers to adoption and/or utilisation of scientific knowledge in particular professional domain such as health care (this point refers to the idea of practicing evidence-based medicine). One such example stands out from the conducted interviews – the

researcher worked in the area of landslides and as a result engaged with number of stakeholders for whom understanding the 'state of the art' of scientific research concerning landslides was of outmost importance.

> *The third community that I talk to are practitioners. Obviously there are a lot of people out there whose day to day job is working on landslides. I do collaborate with them and work with engineering consultancies, local government, national government and such like, in terms of trying to help them to understand the kind of state of the art about landslides.* (Physical Geographer 3, 2012)

In contrast, scientific knowledge can also be communicated in the context of lay knowledge. In broad terms this refers to the general engagement events that are meant for the general public; example of this would be science fairs which focus on the 'fun' of science but can often instil the basic principles of science through the appropriate demonstrations. In broader terms, the public space of lay knowledge is also reached via far reach modes such as via traditional and social media. It is through these means that also enable the emergence of various discourses around science as well as discourses which draw on the support of science. Hot topic issues such as genetic modification, climate change, nanotechnology, synthetic biology, all substantiate their utility/relevance on a scientific basis both within and outside of scientific circles and carry wide implications for various publics (which can be grouped under the more encompassing and definitive 'public'). However, not all scientific research is equal in its mass social pull and relevance. Therefore, this knowledge can enter the public space (for example, public-in-particular) but it will only reach a particular segment of 'the public' (for example, a public-in-particular). An example of this can be academic researchers publishing in professionals journals or specialty magazines (for example, one of the interviewees gave interviews to popular computer magazines about his research based on simulation software); writing entries across a number of blogs; giving interviews to particular tv and/or radio stations. This space of 'a public' discourse can thus be reached in a strategic manner or can be an outcome of a broader communication strategy.

In summary, communication of research across a number of social spaces within the broader social space constituted through the interactions of science and society, within which the environment has been constructed that has legitimised for publics to 'speak back' (Nowotny et al., 2001) to science. Research is communicated in a variety of contexts where scientific knowledge may possess importance but it is not necessarily the dominant form of knowledge. This necessitates a shift towards considering how to effectively communicate new scientific knowledge through appropriate strategies and in appropriate formats so that it doesn not just enter the social space but is then actually taken up, adopted and utilised. This places an emphasis the importance of intermediaries which are involved in the interactions between researchers and publics (for example,

science journalists (Brüggemann and Engesser, 2014; Fahy and Nisbet, 2011; Revkin, 2010) In order to advance towards more effective communication between researchers and publics, we need to further deconstruct engagement practices of academic scientists in order to understand the research communication process better. In the next set of sections, engagement practices are further considered in terms of the relationship between researchers and publics (in/direct nature); their integration in relation to the knowledge production process; and the communication models that underpin them.

5.3.2 Direct / Mediated

Researchers' reflections on their engagement practices revealed two types relations between them and various publics. Interaction between researchers and publics can either be 'direct' or 'mediated'. Direct engagement is when scientists deal directly with a public without the 'interference' of a third party. Mediated engagement occurs through involvement of a third party. A typical example of direct engagement is when a scientist speaks face to face with, or to their audience. A typical example of this is when researchers give public talks. Other formats of direct communication include open days and conducting consultancy work. While direct engagement appears to be the preferred choice for interaction with the general public, it is frequently the case that engagement occurs through mediators, a 'third' party between the researcher and publics. 'Mediation' is often performed by actors (e.g., communications officers, journalists) and/or organisations (e.g., Science Media Centre[61]). Furthermore, engagement can also be mediated by material objects, technologies, devices and physical settings. For example, the engagement process can be facilitated by artefacts such as archaeological finds that are used in the context of a 'finds handling session' or particular pieces of equipment (e.g., a microscope) in the case of laboratory demonstrations. Another example is when a research team works in collaboration with industry on developing a particular piece of technology (where the technology becomes a boundary object which facilitates the interaction between two 'different' parties). Similarly, a research laboratory or a field site can also facilitate the engagement process as in the case of laboratory / field site tours that are carried out during open days. Material features of the environment that contribute to engagement also include physical settings, such as a piece of land in the case for presentation of land remediation research, an excavation site for archaeological research, or a laboratory in the case of consultancy via analytical services whereby university equipment is rented out for analytical purposes. Overall, engagement practices of researchers can be grouped as being either direct and/or mediated. The examples derived from the interview data and reported here highlight how

[61] The U.K. Science Media Centre can be found at its website, http://www.smc.co.uk.

interviewees are able to interrelate with people and also with the physical environment around them in order to communicate research. This interaction can be direct or mediated thereby creating diverse temporal events and spatial geographies of engagement.

5.3.3 Upstream / Midstream / Downstream / Out-of-stream

Geographies of engagement can also be characterised in relation to researchers' core activity, knowledge production (original research). The interviews suggested that the process of production of 'science-public' space may be situated either 'upstream' or 'downstream' in relation to knowledge production undertaken by researchers. In the case of 'downstream' engagement, scientific knowledge is communicated to various publics after the research and the knowledge construction processes have concluded and subsequently disseminated through a journal article. An example of this is when universities communicate (through their media/communications offices) about their latest research findings in a press releases targeted towards various news outlets in order to encourage them to pick up the story. In contrast, 'upstream' engagement is situated prior to the knowledge production process and actually helps to frame and focus the research process and is closer to the co-production model of engagement. The majority of the engagement activities presented in Table 1 were situated 'downstream'. However, there were examples (e.g., public consultation where members of various publics raised issues that informed further research) of some activities that can be classified as 'upstream'. It is notable that 'upstream' engagement can be planned into the research process (For example, Engineer 1 worked with communities to identify a particular piece of land suitable for remediation). However, what can regularly be classified as 'downstream' engagement can also transform (or 'emerge') into 'upstream' engagement if the information provided or issues raised by publics are deemed to be necessary of further investigation or a researcher sees 'potential' in the information that is being provided to them by publics.

The prevalence of what can be classified as 'upstream' and 'downstream' modes of engagements reflects discussions around public engagement with science and technology that have been polarised through the creation of 'upstream' (associated with the dialogue model of communication) and 'downstream' (associated with the deficit model of communication) silos (Hilgartner 1990; Wilsdon & Willis, 2004). Under the condition of multiplicity, focus must be expanded beyond this dual distinction and recognition must be allotted to a larger spectrum of activities. Moreover, some of these activities can be classified as 'midstream' – occurring during the knowledge production process; in other words, during the overall research process. For example, researchers may present preliminary research findings to particular audiences with the aim of informing the consequent direction of research. However, a large proportion of engagement

processes used in the production of the 'science-public' space is not necessarily connected to a particular research paper, research project and/or research agenda. These 'out-of-stream' activities are 'organic'[62] in the sense that researchers engage in these opportunities as they present themselves. For example, a school may contact a researcher directly in order to invite them to give a talk to the students; or a company may approach a researcher directly to discuss consultancy work.

In summary, the interviews with the researchers suggested that the production of the 'science-society' space can occur in four positions in relation to the knowledge production process: upstream (before), midstream (during), downstream (after) or out-of-stream. What this suggest is that the emergence of engagement with different publics depends on how far engagement is built into the research process, and whether it is viewed as a part of research or as an 'additional' activity for the researcher. In turn, this points towards the importance of implementation of appropriate model of communication vis-à-vis the positioning of engagement within the context of the overall research process.

5.3.4 Models of Communication

The interviews with the researchers revealed that the engagement practices can be underpinned by various models of communication. The interviews revealed the continual prevalence of the deficit model of communication. However, in contrast to the often portrayed dichotomy of the deficit and dialogue communication models, the two models do not necessarily exist in opposition with each other and are often found in coexistence. I have identified the following models of communication based on the interviews**: *dissemination, consultation, participation and co-production***. The typology reflects the previously presented types of public engagement. Dissemination and represents a one-way flow of information from the scientist(s) to public(s), who are often assumed to have a 'deficit' of scientific knowledge. ***Consultation*** is when researchers engage in active listening to the views, concerns and insights of public(s). ***Participation*** is when there is a two-way flow of information between researcher(s) and public(s). ***Co*-production** (may be considered a sub-group of participation) is when researcher(s) and public(s) engage in a collaborative relationship in order to jointly address pressing issues. To reiterate, these models do not work in isolation. Any one public engagement activity is likely to incorporate these approaches (particularly the former three) in accordance with the nature of research as well as the needs of the public(s) and the researcher(s) involved with the context of an engagement event.

[62] They are not 'organic' in the sense that they are most appropriate activities for the researchers (Gehrke 2014), the audience and potentially the project.

While the impetus for public engagement with science and technology within the U.K. context is still being re-articulated (the last re-articulation is in the form of 'responsible research and innovation'), engagement activities undertaken by researchers have largely adhered to the one-way model of communication (transmission model). In this case, the flow of information process from the latter (scientific space) to the former (public space). Embedded in this model of communication is the implication that the two spaces are separate. (Although, if one assumes that scientists are also members of public, then the two are not separate and are thoroughly intercalated.). Dissemination then is performed with the aim of filling that knowledge deficit with public(s) remaining a passive recipient of the scientific knowledge. A typical example of this type of communication is when researchers engage in giving talks to various audiences drawn from the general public (e.g., school children, local interest societies).

In addition to engaging in one-way communication, the interviewed researchers also talked about engagement activities that were underpinned by dialogue-based communication models. One such example involves a researcher who participated in a *consultation.* Consultation involves a dialogue between researchers and various public whereby researcher listens to the various opinions, views and concerns of the aforementioned audiences. For example, Earth Scientist 2 participated in a number of public engagement events across Eastern Europe concerning the issue of shale gas extraction ('fracking'), where people had the opportunity to engage with the researcher by asking questions and/or raising various issues of concern. What is interesting to note is that some of the issues that were raised actually identified areas of research that were overlooked by the researcher, and thus to an extent informed the future direction of the research to be conducted by Earth Scientist 2. This transition exemplifies an evolution from what was initially aimed to be a public engagement / consultation event, to what became a quasi-form of community informed research. Another one of the interviewees, Engineer 1, actually engaged in community-informed research on land remediation projects where communities played a role in identification of land for the purposes of remediation as well as providing local knowledge for the researchers in preparation for the remediation process. Community-informed research represents a form of a co-production where researchers and public(s) contribute to the research process from the beginning and each party is assumed to have expert knowledge so that they are involved in engagement on an equal footing. In a lesser sense, co-production was achieved by Archaeologist 1 and people that participated in archaeological excavations (This latter case is an example of the 'participation model' of communication which involves the 'audience' taking an active part, though they are assumed to have a lower level of expertise than the researcher(s)). Therefore, apart from just communication as dissemination, researchers also reflected on examples that represented communication models of

participation, consultation and co-production; which actually do not always exist in isolation. These categories of coproduction of knowledge and participative research communication are important here because both acknowledge, to varying degrees, that the 'audience' has, or can acquire, expertise which is crucial to the process of research, making them active participants rather than passive recipients of information. This research showed that several researchers are aware of this aspect of communication and were incorporating it into their practices.

Whilst discussions often focus on the benefits of one model of communication over the others, often one-way transmission communication approaches and those that are based on a more dialogic model are found in co-existence. This dynamic has been pointed out in several previous studies (Davies 2008a; Davies 2008b; Watermeyer 2012a). In my interviews, there were several examples demonstrating this amicable dynamic between the different models of communication. For example, in and of themselves blog entries are representative of the transmission model of communication. A researcher writes a post which is then read by various audiences. However, blogs usually have the 'comments section' enabled[63], which allows users to comment on the what was written as well as engage in discussion with the author (researcher) as well as with other users. Therefore, within the digital space of a blog, one-way communication co-exists (and in fact to an extent supplemented) with dialogue. Another example of the two models existing together is found in the context of a café scientifique[64]. There are several formats that these cafes adhere to, including a UK model (the UK is the birthplace of this format of engagement between researchers and publics) as well as the French and Danish models (for an overview of international experiences with café scientifique, (see Grand 2009). The event usually begins with an introductory talk by an 'expert', traditionally a practicing scientist. The talk can last as little as 10 minutes or as much as an hour, which was the case with Earth Scientist 1. This is usually followed by a break and then a set period for discussion, questions, comments, thoughts and opinions between the speaker and the present audience. Considering the café scientifique example, it is possible to suggest that even the format of public talks embraces both models since the talks are usually followed by a discussion or a question/answer period. In each case, the two models exist in a complimentary relationship. Therefore, the relational space that is produced becomes heterogeneous as a result of variable communicative interactions rather than homogenised due to constant one-way communication. Moreover, we also see that the amicable dynamic between the different types of communication models is temporally situated but may emerge in different combinations and compositions (e.g., a

[63] Providers of popular blogging platforms such as *Wordpress* and *Blogger* provide the option of disabling the comments section for the individual's blog.

[64] A Café Scientique if "is a place where, for the price of a cup of coffees or a glass of wine, anyone can come to explore the latest ideas in science and technology" (www.cafescientifique.org).

question may be asked during a presentation rather than waiting until the end of the presentation). The amicability of the models and their emergent qualities raise issues around how to plan engagement events in such a manner that would allow multiple models of communication to co-exist in a complimentary manner and how then to maintain this unison in the context of emergent dynamics. When considering the various models of communication both the role of researchers and public with whom they are communicating with requires evaluation. These topics are considered in the next two sections.

5.4 Roles of Researchers in the Spaces of Science Communication

Merton (1968) has characterized the normative system of science: *universalism, communism, disinterestedness, organized skepticism*. Universalism refers to the notion that scientific findings should be verifiable and independent of the observer. Communism refers to the idea that scientists should share their work with their community for the common good. Disinterestedness refers to the notion that scientists have not emotional or financial attachment to their work. Organized skepticism refers to the necessity of waiting for all evidence to be admitted prior to making a judgment. For scientists acquisition of these 'norms' occurs through a prolonged training period until they become integrated within their role identity. As a part of the training, scientists learn to recognize that outcomes of this training can lead to academic prestige parameters such as publications, citations and peer status (Latour & Woolgar 1979).

The interviewees echoed the importance of scholarly publications[65]. As a part of being academic scientists, researchers are expected to publish, preferably in high impact journals. The journal article has been the most common publication format for hundreds of years. Even amidst the electronic revolution, the importance of the academic journal publication as a means of knowledge mobilisation has persisted. Recent large scale studies in the UK (e.g., Research Information Network 2010; Wilson *et al*, 2010) have reaffirmed the importance of publication in academic journals. In a 2010 report by the Research Information Network (RIN), 90% of respondents classified journal articles as 'very important'. The primary importance of journal articles to academic scientists is evident in the following quotes.

> *I will do the papers. And the papers are still the foundation, I suppose, of being a good academic. I don't think you can get away from that. (Physical Geographer 1, 2012)*

> *So the first thing, we wrote a paper, which was peer reviewed. That was the starting point.* (Earth Scientist 2, 2012)

[65] An overview of the interviewees' academic webpages yielded one common information section across all the profiles: academic journal publications.

More recently, the 2011 survey of UK-based principal investigators of publicly funded applied and public health research, revealed that the top two communication channels used by researchers were the academic journal and the conference presentation (Wilson *et al*. 2010). The following quote echoes the importance of the journals and conferences in the field of computer science.

> *I guess the normal way we do dissemination is publication. And so that's either, what I do is journals or conference proceedings.* (Computer Scientist 1, 2012)

The above quote speaks to the primacy of academic journals across academic disciplines whilst suggesting that there is variation within each discipline.

For academic researchers, the core activity of the profession is doing research, and dissemination through academic journals may be seen as the 'end-game' of academic research. Publication in peer-reviewed publications advances disciplinary and collective knowledge. Moreover, it is through peer-reviewed publications that researchers attain recognition and status. Consequently, there exists a 'pressure to publish' in academia, otherwise you will perish ('publish or perish' is the short phrase often used to describe this dynamic within academia). In addition to the traditional pressures of the academic profession, researchers are also faced with institutional pressures to publish.

> *In terms of disseminating our research, obviously the first medium is through publication. So, I publish in lots of different academic journals. That's very important, actually…Because, though the pressure on us as academics is, within the REF system is to publish in high impact international journals.* (Archaeologist 1, 2012)

The REF is the U.K. version of a performance-based research funding system (PRFS). Its significance lies in that it is responsible for not only for "mobilising competition for funding among academic coteries but competition for institutional prestige and esteem; and concentrating research and critical mass in specific locales, in turn influencing an institution's ranking within national and international league tables" (Watermeyer 2014, p. 360). In short, the REF is a determination of research excellence which then affects the distribution of resources to higher education institutions. This determination is largely (60%) based on academic journal publications. This further amplifies the importance of 'publishing' as a part of the job of an academic scientist and supports the usage of descriptors such as 'first medium', 'first thing' and 'normal way' in the interviews. Thus publishing in (preferably) high-impact academic journals is one of the normative expectations that is associated with the role of being an academic.

However, there are additional expectations that are linked with being an academic researcher. These are highlighted in the following quote.

> *Thou shalt bring in loads of research money. Thou shalt publish 4* papers. Thou shalt do fantastic teaching. Thou shalt administrate well and efficiently.* (Physical Geographer 1, 2012)

Academics (both in the physical and social sciences) are expected to take on the roles of researchers, writers (scholarly communication), teachers and increasingly of administrators. The tasks that can be associated with being an administrator are listed in the quote below.

> *So at the moment, as an academic, I must be a teacher, a researcher, financial manager, you know, an HR manager, all those other things.* (Physical Geographer 4, 2012)

The above examples have referred to the 'standard' expectations that are associated with the academic role. However, there are also unique meanings that individuals bring to their roles – an individual understands the roles as it applies to them. For example, the professorial role identity typically entails the one's status as "instructor" and "educator". Some may add to this an idiosyncratic dimension of "friend to students" or "protector of students". The potential variability of an individual's understanding of their role as it applies to them is demonstrated in the next quote.

> *....what are you expecting from an academic? A while ago I started making a list of the roles and skills that you need to have to be an academic; certainly an academic in geography. So you got to be a scientist, a teacher, administrator, accountant, project manager. I end up doing electronics; so programming. And I think I got to about twelve different things.* (Physical Geographer 5, 2013)

By extension, depending on the field of research as well as the researcher's own interpretation of their role, different lists of expectations associated with being an academic scientist could be compiled. What is noticeable, from the above quote is that 'engagement beyond academia', in any form, is absent from the list. As alluded to above, these are 'other' activities, which are not part of the 'core' role of academic researcher. The sentiment that public engagement is not part of an academic role is explicitly summarised in the following quote.

> *Things that are in the job description take up all my time and a lot more of it. My self-obsession with research, which I'm sure I share with all of us, and then teaching and all those sorts of those things. So there is not a huge amount of time left over for public engagement.* (Archaeologist 4, 2013)

In the above quote Archaeologist 4 again alludes to the core activities that dominate the academic role. While he does somewhat suggest that doing public engagement might in fact figure in the hierarchy of role identities for a researcher, he seems to consider this as a secondary activity to do if one has time to spare for it. Whilst emphasizing the importance of academic publication, the above quotes also suggest that there are other ways through which scientists can accomplish dissemination. If there is a first medium, then there are other media as well. The 'normal' way can be contrasted with the 'other' (non-normal or deviant) ways. The discourse exemplified in the

quotes reported here reflects how dissemination serves as a form of boundary work performed in a demarcation zone between science and society, between researchers and non-academic publics, between academic role identity and the external role identity. Thus, the implication here is that participation in engagement events requires the researcher to carry out work formally identified as the researcher's role and also adopt a hybrid identity that is still dominated by the academic identity but also incorporates an external persona. The next quote provides a good example of the expectations that are associated with the academic role positioned together with the expectations of associated with an academic that is supposed to engage beyond academia.

> *And the idea of my [academic] post is particularly to kind of work with industry. I'm very interested in working both commercial archaeology units and also working with local community groups. So, most of my work is facing outwards at different outside constituencies. But also being in a university department, I also have to do my academic work for academia as well. So I'm kind of facing three different ways.* (Archaeologist 3, 2013)

The implication in the above quote is that despite the bulk of the emphasis being placed on maintaining an external persona, the academic identity still implicitly requires protection and maintenance even under polarised conditions. In the next example, we clearly see the tension conveyed by the researcher concerning protecting the academic identity whilst also engaging in modification in order to enable engagement beyond academia through collaborators.

> *More recently I've been interested in how I can get more exposure of my work, because I want to attract external interest, particularly if I can get industrial collaborators. And that's part of getting your research out there so that people might be contacting you and saying, 'Well, you do this. Can we work together?' Trying to get collaborators is extremely difficult. I have the usual things, a webpage and stuff… I have a staff one in the department, which has the usual stuff on it. But I also have a personal webpage, which is linked to the university, which I then add more details on my research. And then if its something particularly of interest, I'll then give it its own project page* (Computer Scientist 1, 2012)

> *… why are you here? Are we here to…It's like when I get my parents asking me, you know, it's a great idea you've got it published, when are you going to start making money from it? It's like, well, to do that, to commercialise something, that's a different job. You know, to start a spin out company, become a developer of commercial software to actually make money, that's different than being a researcher.* (Computer Scientist 1, 2012)

The above example again suggests that engagement beyond academia in its various forms presents a form of identity work. This is to say that researchers end up adopting a hybrid role identity that involves the dominant academic persona and the 'inferior' external facing persona (see Jain *et al*. 2009). This process of identity work is in part contingent on various publics with whom researchers engage. The next section considers how researchers conceptualise the various publics and how those publics emerge in the context of engagement events.

5.5 Diverse Publics in Research Communication Space

The foregoing sections situated the engagement practices of researchers in terms of their geographies (material and social), and we see that they vary in terms of models of communication, direct/mediated character and positioning in relation to scientific knowledge production. I have suggested that the relational space can be developed topologically at various levels: macro (science and society), meso (university and the community) and micro (researchers and publics). In this section, I focus on the latter category and ask, 'who are these publics?' and 'how do they emerge?'

As discussed previously, the relationship between science-technology in the U.K. has provided a fertile ground for engagement of various publics with science. I have termed this to be the 'atmosphere of engagement'. Within the context of various engagement events, which spatialize the overall potential created by science, technology scientific knowledge and the corresponding institutions with which engagement may emerge. Subsequently, this follows by the emergence of publics, who to that point are potential or 'infrapublics' (Hawkins 2011). Drawing on the work of Michael (2009), I have suggested that these infrapublics emerge through performance that is dictated by various patterns of publics that emerge during an engagement event. The emergent publics can be conceptualized as 'publics-in general'(PiGs) or 'publics-in-particular' (PiPs). As previously explained (see Chapter 2) "PiG is emergent not least through its complex relations to science-in-general" (Michael 2009, p. 621). In comparison to PiG, PiPs are emergent in relation to technoscientific issues; this is to say that they are "associated with specific projects, programs of research or technoscientific enterprises" (Michael 2009, p. 623). Participants enact these categories through processes of identification or differentiation. Therefore, technoscientific assemblages (such as science projects, programs of research and enterprises), which are constituted through actors, discourse and actants, contribute to the formation of an affective atmosphere as a result of which publics emerge and subsequently contribute to its constitution. Whilst they are not necessarily intentionally exercising audience segmentation, I suggest that researchers engage in mediated communication that facilitates the emergence of various publics (e.g., PiPs and PiGs). In particular, I identify three strategies that are used: using technologies of circulation (e.g., traditional media outlets, social media); mediated communication via field experts (e.g., graduate students, media professionals and members of public); and utilisation of materiality.

The interviews with the sampled researchers demonstrated two tendencies with regard to researchers and audiences in an engagement context. First, some reported that their engagement practices involved the identification of audiences that were involved. The specificity concerning audience identification and conceptualisation varied across the interviews, ranging from very

particular to a broader characterisation. Second, for a large proportion of the researchers that I interviewed, particular publics did not exist prior to the engagement event. Thus, in practical terms, they represented virtual actors ('potential or infrapublics') that emerge during an engagement event through enactment. What was interesting to observe in the interviews is that the potential field (of 'publics') was often characterised based on two criteria, 'interest' and 'knowledge'. It became apparent from the interviews that in contexts where there were multiple audiences involved, researchers did not exercise audience segmentation as a part of their communication strategies and consequently attempted to address multiple audiences (general and particular) simultaneously. In order to substantiate this point, I present three examples where researchers are addressing multiple audiences without attempting to implement audience segmentation for communicative purposes - researchers are communicating via the traditional popular media (e.g., television), using the 'newer' social media and participating in a public engagement event.

Media outlets, such as television, represent a traditional way to reach a variety of audiences ranging from journalists (Friedman *et al*. 1986; Nelkin 1995), other scientists (Nelkin 1995), to policymakers (Fisher & Kordupleski 2000), to the general public (Phillips *et al*. 1991). Amongst researchers that I interviewed, the perception was that using the media remains the dominant form of engagement beyond academia. In the next quote, Physical Geographer 3 discusses how engagement with the media allows for communication to both general and particular audiences, with the latter being policy makers.

> *…apart from occasionally meeting very junior politicians at events or more likely senior civil servants, most of my work in communicating science has been with media or lay public. But I do it at quite a high level with the media; so, you know, press conferences with BBC and ITV and things like that on sub-glacial lakes and on the ice sheets. The BBC and ITN have both filmed my work in the field and done things like that. So, that indirectly feeds into policy makers. And I know it does, because policymakers see it. They watch the news more than anybody else. So that's an indirect route into that.* (Physical Geographer 3, 2012)

The above quote is an example of utilisation of a mass medium to reach a wide audience. While attempting to reach a plethora of individuals across the social topology of pubic discourse, the respondent does appear to be discriminating between media outlets and choosing interviews and programmes with the focus on his research field, through which his expert view is most likely to communicate to PiPs such as policy makers. The researcher suggests that policymakers perform being a PiP through more copious amount of hours of television watched in comparison to other publics. Whilst, to a certain extent that may be true, it is a large over simplification of the process through which PiP perform themselves with the view towards differentiation from other PiPs in relation to the research that is being communicated. However, there is a degree of uncertainty as it

is difficult to assume that all policymakers (and in particular the relevant policymakers) watch television in order to obtain scientific information and more so have the interest in that particular research topic. For example, Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO) conducted a study about how Members of Parliament (MPs) obtain information and how they use it (Fisher & Kordupleski 2000). A focus group of federal MPs returned a list of nine sources of scientific information that they used; one of the nine was media. This implies that the affective atmosphere generated by the interaction of the medium (in this case it is the television) and the research in question can be of variable intensity. Therefore, ultimately, though the communicative event does reach a wide audience by conveying information into the space of public discourse, whether a PiP emerges in response is questionable.

More recently, another prominent medium through which it is possible to reach multiple audiences is social media platforms such as blogs. Utilisation of social media by academic researchers has been reported to be limited (Lupton, 2014; Research Information Network 2009). However, academic blogging, which is shorter and faster (Dunleavy 2014), and, more importantly, are dictated by the researchers themselves, provide a platform where even the most niche topics can 'find an audience'. Therefore, it is possible to communicate very specialised research to broader and particular audiences simultaneously (The challenge is in the writing to be able to reach both audiences.). The next quote from an interviewed researcher with a prominent blog demonstrates the lack of consideration allotted to audience segmentation by the researcher, in part driven by the 'self-indulgent' purpose of the blog.

> *I consider the blog to be very self-indulgent. I mean I just really write about things that I think are interesting. I don't sit down and think, 'What's the audience out there? You know. What it might be?' Whatever on that morning, I think, 'That's kind of interesting topic! There is that landslide going on or whatever.' And I just sit and write about it. And it's just really nice that there is a group of people out there who find it interesting.* (Physical Geographer 3, 2012)

In this case, as indicated by the approach to writing which is centred on 'the self 'rather than an audience, the public exists as a social totality rather than something that emerges in relation to science and technology. In other words, publics are morphed into 'the public'. However, numerous particular publics do emerge in relation to the topics covered in the blog posts. To extend, publics emerge in relation to the affective atmosphere ('atmosphere of interest') generated through the interactions between the research area, corresponding discourses with it, researcher's interest, the communication medium (blog) and the topic of the blog post. Publics can then perform being publics in relation to each other either through participation in the comments section or subsequent interactions with the researcher (e.g., via email or telephone). However, for the researcher these PiP

can also be morphed into a mini PiP through the metrics[66] that are provided on the blog hosting website. This is highlighted in the following quote.

> *That [blog] sort of communicates to a very, very wide audience, which spans from quite a lot of people who are landslide researchers, lots of people in industry or government organisations read it thought to sort of interested members of the public. Truly international. It gets around about on average about 1000 individual visitors per day. So, it has quite a decent reach. I think sometimes the people who read it forget that it is talking to such a wide audience. So, you know, when I write on there I do have to bear in mind that sometimes you're talking to people who know a lot about landslides and as well as people who know nothing about landslides*. (Physical Geographer 3, 2012)

The above quote provides an explicit acknowledgement by Physical Geographer 3 concerning attempting to communicate across a diverse social topology in order to reach multiple audiences. The audience is made up of publics in general (e.g., 'interested members of the public) as well as publics in particular (e.g., landslide researchers, people in industry, government organisations). This segmentation of the audience is grounded in the researcher's assessment of their knowledge levels about landslides along a spectrum between 'a lot' versus 'nothing'. This constitutes a guiding criterion that informs the blog post composition practices of Physical Geographer 3. Thus, the initial engagement event of a blog post is guided by the 'deficit' model of communication whilst the subsequent interaction 'in the comments' section (and beyond) can be said to be guided by a participation model of communication. The complicated combination of the researcher, the topic of choice, the communicative style and the communication platform contribute to the formation of an affective atmosphere that creates a potential for diverse sets of publics to emerge in relation to the blog post and subsequently potentially engage further either through posting a comment or contacting the researcher via Twitter (through an individualised tweet or a direct message).

Thus far, the provided examples focused on reaching multiple audiences through spaces of public discourse, which may be general or more particular. These spaces are flexible enough to sustain researchers' potential attempts to exercise audience segmentation whilst also enabling the emergence of various publics. However, due to the nature of the mediums in the examples, avoiding reaching a 'broader audience' is essentially impossible. As such, the social landscape served by the communicative approach may not be enabling for audience segmentation. In contrast, the **physical location** of engagement practices may contribute towards enabling audience segmentation. This is particularly notable in what I have termed 'public spaces of science'. Good examples of this type of

[66] 'Metrics' Parameters or measures of quantitative assessment used for measurement, comparison or to track performance or production.

space are science centres such as the Centre for Life in Newcastle (UK)[67] or the Royal Society[68] in London. Engagement events at these venues are specifically designed to facilitate the emergence of diverse publics; or in more specifically, the PiG. The following quote from an Archaeologist who conducted a series of practicals at the Centre for Life in Newcastle exemplifies the 'general' nature of the social space that is mediated within the physical space of the centre.

> *So for example, in the Centre for Life, you have no idea who is going to walk in. All they've done is sign up to do a course in archaeology. And that can be absolutely anybody.* (Archaeologist 4, 2013)

Here 'the public' is an 'unknown' entity and only becomes 'known' at the time when the individuals making up this group enact the process of participation in the engagement event. Prior to this, 'the public' is materialised only as a set of registration entries on paper and/or in a computer database. At this point, a mini PiG distinguished itself from the PiG. This dynamic creates favourable conditions for the implementation of the 'deficit' model of communication since it is difficult to tailor an engagement activity to a particular audience when there is no information available about them and no prior knowledge of the science can be presumed. And yet simultaneously, the course offered as was explained by the interviewee was very much hands and involved a substantial participative element (e.g., finds handling). This demonstrates that despite the socio-spatial context creating the suitable conditions for a particular model of communication to emerge, it does not guarantee the emergence of that particular model of communication. The adoption of model that is more participatory in nature (doing the finds handling) then becomes the method that allows PiPs to perform themselves in relation to each other, as well as science knowledge and scientific institutions.

In the above discussion, I elaborate the emergence of a PiP from a PiG and then the emergence of mini PiPs. The emergence of a mini PiG from a 'total public' is also alluded to in the next quote.

> *And then in terms of the general public we've done a number of big demonstrations, with cosmologists, of the 3D films. [pause] Royal Society ones tend to stand out because we get thousands of people coming through to see the films in one day.* (Computer Scientist 2, 2013)

Spaces such as the Royal Society and science centres are what I termed as 'public spaces of science'. In the context of a physical space such as the Royal Society a large sample of the public is granted access (the sample size is decreased when we compare this to the Centre for Life in Newcastle, for

[67] International Centre for Life in Newcastle upon Tyne is a science village based in the heart of Newcastle upon Tyne where scientists, clinicians, educationalists and business people work to promote the advancement of the life sciences. (http://www.life.org.uk)

[68] The Royal Society is a Fellowship of the world's most eminent scientists and is the oldest scientific academy in continuous existence. (http://royalsociety.org)

example). Therefore, there is a greater potential for the emergence of a more diverse sets of publics in comparison to physically smaller spaces. Other spaces, such as 'spaces of public(s)' such as a science café, are held in a bar or a café which are physically only able to fit in a specific number of people. The ability of publics to perform 'publics' can in part be mediated by the physical space of the engagement event.

Despite the potential constraints of the physical space that limit the possibility of segmenting the audience, there are strategies that researchers do utilise in order to facilitate the emergence of publics. Through the foregoing discussion concerning the emergence of publics, I have demonstrated the role of popular media and social media in facilitating this emergence. In what follows, I focus on the roles of mediated engagement via field experts (e.g., graduate students, media professionals and members of public) and the role of material features as actors in science communication (materiality of research communication).

5.5.1 Relationships with Field Experts

In addition to the use of mass communication technologies, as discussed above, the process of mediation of scientific knowledge (where the knowledge is transposed in identical form or is translated) also frequently occurs through individuals. In a case study of an anti-fat campaign in Finland, Setälä and Väliverronen (2014) demonstrate that 'field experts' have become important mediators of scientific expertise. In comparison with scientific experts, "field experts do not appear so much as sources of scientific information, but instead as authorized users of that information..."(p. 18). Their importance is enhanced through direct working with targeted groups. The experts' proximity to various target groups ensures a greater probability of reaching an 'appropriate target group' thereby foregoing communicating to the public-in-general. Thus, this increases the probability that PiPs can then enact themselves in relation to each other. There were several examples of 'field experts' with varying levels of expertise mediating the interaction between researchers and publics. These included graduate students, media professionals (presents, researchers) as well as members of a (the) public themselves. However, somewhat in contrast to the conceptualization of 'field experts' offered by Finland, Setälä and Väliverronen (defined as being in existence independent of the communicative process), the examples from the interviews demonstrate the 'creation' of 'field experts' with various degrees of 'expertise' by the researchers themselves (The level of expertise can be interpreted as related to the social distance between researchers and the 'field experts').

The first example of ‘field experts’ that emerged from the interviews is that of graduate students. The quote below demonstrates graduate students undertaking the role of 'field experts' within the context of archaeological site tours.

> *And importantly, in terms of teaching, if we have got students on the site, we usually get students to run the tours because that gives them a lot of training about how to talk to the public. You know, people like talking to eighteen, nineteen, twenty year-olds rather than men with beards. That’s generally our experience. ‘Cause the students have an enthusiasm for the subject that is infectious actually. Especially in some of these areas; Atlantic Scotland can be a little bit windy and a bit wet. So if you’re trying to give a tour, and it’s all a bit cold and miserable, if you’ve got someone who is really enthusiastic, it works very well.* (Archaeologist 1, 2012)

By virtue of their education, students become 'authorized users of scientific information', which provides them with legitimacy and authority as bestowed on them by senior researchers, to convey that information to non-academic audiences. While not being the primary archaeologists, they do possess a degree of authority and scientific expertise within the socio-spatial context of an archaeological site. They are then instilled with the responsibility of communicating to people what the archaeologists are doing, the finds and move further by discussing the wider context. They do so partly by communicating ‘youthful’ enthusiasm, as well as through their expert knowledge. Here we see illustrated the creation of an atmosphere of interest in the science which is emotional as well as ‘knowledge based’; and the subsequent ‘infection’ of publics. There are parallels here with situations like that described by Bissel (2010) writing about passenger trains where atmospheres work through contagion – “students’ enthusiasm is infectious”. Here, atmospheres are the actual environment (‘cold and windy’), feelings and moods that circulate broadly within the physical space of an archaeological site as well as more closely within the relational space between the ‘field experts’ and a public attending the tour. Individuals can sense the body language, facial expressions, tone of voice and other factors, which can then in turn amplify collective emotions such as ‘enthusiasm’. Moreover, the implication in the above quote is that researchers themselves are unable to generate the same atmosphere in comparison to the graduate students. This backdrop of multiple interacting atmospheres contributes to the constitution of the communicative practices and is in turn affected by them. Within the communicative context, 'field experts' attempt to balance competing / complimentary representations of research - as a set of methods, as a material assemblage (archaeological finds, tools, space, etc.), as well as a socially-embedded practice.

Another example of ‘field experts’ emerging from researcher-public(s) interaction is the role of media professionals. The field experts described by Setälä and Väliverronen (2014), "gave advice, encouraged citizens to record their weight, and offered quite detailed prescriptions in their interviews of the sort of lifestyles people should lead in order to achieve their ideal weight"(p.

9). Similarly, 'media people' (media professionals such as presenters, researchers) can also engage in the role of 'advising' (informing) programs and/or program development as a part of their jobs. Engagement with researchers allows this group to become 'field experts' in the sense that they can become authorised users of the information provided to them by the researcher. This is demonstrated in the quote below.

> *A range of interactions from just talking to various media people on the phone, either in terms of advising people; lots sort of independent presenters who would then go on and do something with the BBC; or researchers for BBC or independent companies who are trying to build ideas for programmes.* (Biologist 1, 2013)

'Field experts' can emerge in relation to specific or nebulous contexts. In the case of the former, it can be in relation to particular projects or as in the case of the latter, it can be in relation to idea development. In a way similar to the case of graduate students discussed above, 'media professionals' may also attain varying levels of expertise, depending on their interactions with the researchers. For example, if a scientist engages briefly as an advisor to the media representative, the depth of the expertise attained will not be comprehensive. However, prolonged (continuous or intermittent) interaction can potentially ensure a greater depth of acquired expertise on the part of the media representative. This also contributes to establishing a greater degree of legitimacy for the media officer, who becomes a 'field expert' (in the making) as an 'authorized user of the science based information'. Theoretically, this should then translate into a constitution of a stronger field of potential from which publics-in-particular can then emerge.

The foregoing examples of field experts demonstrated how scientists facilitate the emergence of publics through the use of mediators who work directly with specific groups of people. The example of the graduate students demonstrated that field experts can emerge from within the scientific community, whilst the example of media workers demonstrated that field experts can emerge from groups beyond academia that engage within particular publics. Furthermore, as the next quote indicates, 'field experts' can also emerge directly from the broader public.

> *There is also quite a lot of community involvement nowadays… if people are interested in doing excavation, or, for example, pot washing or something like that. I've been involved with projects where locals have been involved with processing and actually doing some of the archaeological work. Not specialist stuff. Generally, pretty basic stuff: trawling, basic kind of finds washing. Things like that. Sometimes sample washing. But then sometimes if you go back to place year on year on year, you start getting people who live in the local area, volunteer for a week, and actually their skill sets begin to increase. And when they go back into the local community, they actually then discuss what they've learned and then they kind of spread the word.* (Archaeologist 1, 2012)

The foregoing quote is interesting because it demonstrates that the emergence of a PiP occurs from a pre-existing potential field that is characterised by people's 'interest' in doing hands-on archaeology. Subsequently, the difference in intensity from the proposed engagement event enables the emergence of representatives of PiPs who end up participating in the excavation process. Here, within the context of community involvement (versus open days), the public is able to adopt the role that was occupied by the postgraduate students within the context of an open day. While the public does become a 'field expert', their expertise is deemed inferior to the students running the open day tours. Therefore the quote suggests that there is potential for attainment of various degrees of 'field expertise' over an extended period of time and a hierarchy of science communicators becomes evident defined in terms of their proximity to the academic 'science space' identified above, and in relation to the amount of time that they spend engaged with the science space in 'apprentice roles'. We also see how from among the group defined as 'the public' with a knowledge deficit can emerge a set of 'field experts' with varying degrees of expertise who can then communicate their acquired knowledge to other members of the public and 'spread' the atmosphere of enthusiasm within their community.

5.5.2 Material features as actors in the science communication process

Material objects can play a role in making publics 'visible' - objects can facilitate the emergence of a public. Absence as well as presence of the material object may have an influence. An example of the former is lack of PowerPoint technology in the context of a science café as explained in the following quote.

> *But the actual talk had to be conveyed verbally, with no visual aid support, which I found actually quite, well obviously it was quite a challenge because as a, sort of an academic, you get so used to leaning on sort of PowerPoint. You have your main, the things that you're presenting actually on the PowerPoint slide and then you talk to the PowerPoint slide. Without that prop, you know, it was quite an interesting experience to try and convey some quite complex scientific ideas across, which I think I did successfully.* (Earth Scientist 1, 2012)

The space that was 'dominated' by the researcher and their science now becomes redefined through the dematerialisation of the familiar academic 'prop' of a PowerPoint presentation in combination with the materialisation of 'a public' in the form of a physically present audience. Consequently, instead of 'talking to the slide', the researchers talks (directly) to the audience (In other words, the audience is made more 'visible' and prominent by the absence of PowerPoint). Moreover, the shift from 'talking to the slide' to 'talking to the public' reconstitutes the atmosphere generated by the researcher, altering the communication process as well as the broader atmosphere generated in the relational space between the researcher and the present audience.

Technologies of visual (re)presentation such as PowerPoint slides, pictures and posters all convey a representation of science, according to the researcher. However, it is not always the case that the object facilitates the uptake of the representation envisioned by the researchers. In the following quote, facilitation by an object results in the audience misconceptualising the research.

> *So I took my set-up over there. And that was interesting: talking to the parents and to the kids. You know, they just wanted to play games. And at the time I had it hooked up to an Xbox Controller for Windows. And then it was really funny because you're talking about what you've done to the kids and they're interested in it because it's a game. And then you say, 'Well, you know, it's built on a Half-life 2 engine.' And they look at you blankly because Half-life 2 is a 15 [year age appropriate] certificate game and these were all like 8, 9 year olds.* (Computer Scientist 1, 2012)

The above quote demonstrates that material mediation can also alter the intended aim of the engagement (and therefore the intended atmosphere). In the first instance the introduction of a physical controller (from the Xbox gaming console) identifies a particular audience – individuals who are familiar with video games (those that play on a regular basis and those that have previously played. In the event that Computer Scientist 1 discussed, the PiP that emerged was kids. For them, the introduction of a games controller generated an atmosphere that reflected a computer game rather than one that was consistent with research visualization. Therefore, this is an example where the materiality of an object while coordinating the emergence of an audience does not facilitate appropriate engagement as envisioned by researchers between the audience and the research.

The materiality of an object does not necessarily have to impede the engagement process between research and publics. In fact, it is often the case that the materiality of the object (or device, setting, etc.) facilitates the engagement process.

> *I did have the fortune for one thing I did in the schools, I took two microscopes and demonstrated the techniques that I use as a scientist. But that's something I do and a few other people as well. And also, in reality, it was looking down a microscope at a diatom. You could have done the same thing with a piece of algae or insect to demonstrate the microscope skills. And of course the kids thought it was exciting because they were looking down a microscope.* (Physical Geographer 7, 2013)

In this example, the microscope does not need to mobilize a public around it. This is already accomplished as engagement is situated in a classroom setting within which microscopes are used. It does facilitate engagement in terms of 'visually materialising' the subjects (diatom; algae; insect) within which 'science' is embedded. The microscope in and of itself is a materialisation of the research that led to its design. Moreover, the microscope is also a representation of the research that incorporates the utilisation of the device as part of the research process. Furthermore, the microscope enables the formation of an atmosphere of excitement amongst the children.

A similar example of material devices facilitating engagement was ‘Spectroscopy in a suitcase’ and was provided by one of the interviewees. 'Spectroscopy in a Suitcase' is a project which was a part of the Royal Society of Chemistry (RSC)-led ‘Chemistry for our future’ (CFOF) initiative; and was funded by the Higher Education Council for England (HEFCE). The aim of the project was to provide local schools (in the North east) with "state-of-the-art" equipment designed to help teachers demonstrate the principles of optical spectroscopy and provide hands-on experiments for Key Stages 3-5" (Berresem 2008, p. 36). Overall, this is not a direct engagement between researchers (that made the equipment) and the students, but rather between the 'science' (spectroscopy) and the students. The equipment represents a materialisation of many years’ worth of research (research reservoir). Simultaneously, it is also meant to act as a device that materialises the research process through engagement in experiments.

Through this engagement, teachers, in the role of 'field experts', give students demonstrations in order to illustrate the principles of spectrosocopy. Engagement can attain a more 'involving' nature, if students are provided with ‘hands on’ time with the apparatus in order to conduct their own experiments within the context of a classroom. In both instances, the toolkit used to conduct demonstrations acts as a participatory object in the engagement event. Moreover, it is important to stress that here the mediation process does not alter the 'science' (in other words, creates a 'mediation' as there is no actual involvement with the process of research), but rather materializes it.

The examples of a microscope and the spectroscopy toolkit demonstrate that the spatial-material composition of a device could be deployed in engagement in order for a variety of public audiences to emerge. Whilst these were material artefacts situated in a material setting, the physical setting itself (e.g., the spatial-physical composition of a specific setting) can contribute to the emergence of a particular public. Engineer 1 works on the remediation of contaminated land (resulting from industrial pollution).

> *We try and work with communities to identify a piece of land that is a problem for them, possibly contaminated, and improve it by digging in these minerals...it's essential to take their point of view into account because often the public actually know more about that piece of land than any official documentation in regulatory authorities or local councils. Maybe their grandfather worked in the factory and knew exactly where the waste was actually dumped, you know. It might have been recorded as being taken away every week but maybe it's actually in the ground. That information doesn't always come out but there is a lot of knowledge there.* (Engineer 1, 2013)

Here we see a ‘public’ space become what can be described as a ‘liminal’ space, where both researchers and a public in particular co-exist. This space is defined by a communicative relationship

that can be characterised as one of co-production. Initially, members of the public decide on the piece of land that ends up being the target of remediation. Subsequently, representatives of the public in particular contribute 'local knowledge', which then informs the 'treatment' that is developed by researchers. Consequently, researchers contribute the scientific knowledge and the selected land undergoes the treatment process. Also crucial in this sequence is the materiality of the land, which could also be considered to be an 'actor' in the science communication process. This then is similar to an archaeological excavation site. The material composition of the site first facilitates the emergence of researchers who develop an interest in excavating a particular piece of land. Subsequently, the combination of the presence of the researchers and the land itself creates an atmosphere that enables the emergence of various publics from the local area, for example. Analogous comparison can be extended to when universities hold open days. The university reputation that is based on research conducted by researchers enabled by the infrastructure of the university, in combination with the various public discourses surrounding higher education, enable emergence of various publics in the context of an open day. Engagement events such as open days, can be imagined as spaces, where a number of actors and actants come together. This space can be interpreted as a 'trading zone' and is explored in the next section.

5.6 Engagement interpreted as a 'Trading Zone'

The above discussion emphasizes the emergent nature of engagement events, requiring adoption of a hybrid role identity for researchers in order to then engage with various emergent publics. Ultimately, the majority of these engagement practices are not altruistically motivated and represent events where the actors involved come together to form a 'trading zone', leading to various outcomes which are discussed below.

One motive or benefit of research communication mentioned across the interviews was that engagement beyond academia presented researchers with the opportunity to ***take action for the public good***, to 'help' or 'change things' through acting on a society as a whole. This theme was apparent across a number of different contexts. One example is through informing public debate that is significant for society. For example, Earth Scientist 2 at the time of the interviews adopted a prominent role in the debate around shale gas extraction in the UK and more widely in Europe (see the quote below).

> *For me, part of the reason I wanted to get involved, part of the reason, only part, one percentage of the reason was actually because I had research that I knew could have impact. And I, in my portfolio of activity in the university, I actually for the first time in my career, saw a gap and realized, 'Wow. This may lead to some good impact.'* (Earth Scientist 2, 2012)

Other activities include participation in steering group committees or advisory boards (e.g., Physical Geographer 1), sitting on a board of a research trust[69] (e.g., Physical Geographer 2), being involved in political activism through a society (e.g, Earth Scientist 1), or working with local community to conduct 'useful' research (e.g., Physical Geographer 1, Archaeologist 3, Engineer 1).

Engagement beyond academia can result in particular groups of people becoming ***empowered and/or equipped*** with the emphasis on abilities of particular individuals and groups to act or have agency within the society. A state of empowerment or the feeling of being equipped to do something can be realized in a number of ways. For example, communication by researchers may enable lay members of the public to perform their own research, as indicated in the first quote below. Another illustration is the acquisition of confidence in approaching the findings from research through the acquisition of knowledge.

> *And one of the things we're trying to do in our latest initiative is we've had a series of training workshops for local groups in the region. And we're training them in research skills so they can then go off and run their own projects. That's what we're really keen on is actually, kind of giving people stuff so they can go off and do their own work.* (Archaeologist 3, 2013)

> *So they [scientists] have a working knowledge of the data and a working knowledge of the technique. What they want to know is; you're on the periphery of the method. They have knowledge up to a certain limit. They have been trained and they have a sort of an expectation, this is what they're going to see and when they see something that doesn't fit that expectation, then what you got to do is use what they know, which is a fair deal, and say, 'When we have a model that looks like this, can you imagine what that's gonna to look like when we've actually gone away and done our experiments? How's that going to look?' And then you try and get them to think about models or scenarios they're not used to, but you use the basic knowledge, the basic physics that they've got to make them think through the problem in a way that, in a way that I suppose I think through the problem…So you just sort of take them through. Obviously you don't need to go back to the basics because they got that already.* (Earth Scientist 1, 2012)

The foregoing quotes demonstrate a trade of scientific knowledge that the public audience involved can make use of themselves. The trade is conducted through the adoption of the deficit model of communication. In both examples, the knowledge of the researcher is passed to a representative of a public(s) with the power balance of the trading zone firmly on the side of the researcher. Nevertheless, the quotes suggest that for the members of public(s) there is potential to then engage in a more dialogic interaction with the researchers thereby somewhat redressing the balance in the trading zone. Ultimately, the outcome of empowerment or 'feeling equipped' is contingent on the acquisition of a certain level of knowledge.

[69] A research trust is a charity which awards for research, with one of the sectors being academic.

Another product of the trading zone between science, publics and research was the ***generation of excitement or inspiration*** amongst particular groups in regards to research and/or science more broadly. The aim here was not so much a trade of knowledge but rather a trade of affect, changing the ways that members of the public *feel* about the scientific research. A particular subset of public audiences that was mentioned in relation to this outcome were the school children. For A-level students, the focus was also careers oriented in the sense of encouraging aspirations to work in scientific fields. The quotes presented here are reflective of this.

> *So, I approach that (giving school talks) as basically inspire them more generally about science.* (Physical Geographer 4, 2012)
>
> *It's about trying to provide something which is useful to them in terms of their A-levels course, which is kind of inspiring in terms of things that they might do with a geography degree. So in other words, trying to encourage them to think about a geography degree.* (Physical Geographer 3, 2012)
>
> *It's not blatantly careers focused, but with them [A-level students], it's starting to say, 'Look if you got into a science degree and then go on to do further study, you can be doing that sort of work …* (Physical Geographer 4, 2012)

Whilst outcomes for members of various publics were therefore part of what motivates researchers to take part in communication activities, trading within engagement events also present ***benefits and opportunities for researchers*** themselves both on ephemeral and practical levels. On an emotional level, engagement events offer researchers enjoyment, despite in some cases being challenging. In many cases, interviewed researchers explicitly indicated or conveyed a sense that engagement can be 'fun'. In broad terms, all the interviews conveyed a sense of enjoyment in regards to the engagement activities that they were reflecting on, whilst in some cases acknowledging and/or highlighting the challenges that were associated with those activities or emerged during them. Within the context of these activities researchers are able to acquire practical knowledge in terms of communication and presentation skills in non-academic environments. Moreover, they acquire tacit knowledge necessary for engagement with various non-academic publics. The acquisition of tacit knowledge is in part achieved through linguistic socialization. In the case of the latter, the language is not so much a specific language of a domain, but more so about how to adapt the scientific language to appropriately communicative to various publics. The next set of quotes provides a good illustration of the necessity to communicate using appropriate language (The quote is from Earth Scientist 2 talking about public engagement events he was presenting at that concerned shale gas extraction in Eastern Europe).

> **[Earth Scientist 2, 2012]** *You talk about the results. You just, perhaps, discuss them in a different way in a different language. So I would describe it differently to a non-academic audience*.

[Boris Popov, 2012] *So it's just the translation of it is different?*

[Earth Scientist 2, 2012] *Yeah. But I do discuss the results. In fact, I've spent the last 8 months discussing the results; what we know and what we don't know. But I tend to shy away from giving terribly scientific-type explanations because you're wasting your time and to some extent because people won't understand them.*

The above exchange highlights the differentiation made between when the researcher is communicating to fellow scientists or when he is communicating to a non-academic audience. The justification of the elimination of scientific detail from the conveyed content is grounded in two reasons. The first reason draws on the time-constrained nature of the engagement event. The second reason evokes the assumed 'deficit' of understanding of the scientific details if they were to be communicated. Thus, the approach adopted here is one based on a one-way, 'deficit'-based model of science communication. Despite, the utilization of a 'simplified' language, immersion in the engagement process can result in acquisition of interactional expertise (see next quote).

> *In fact, I've now realized how important it is to give the detail, as much detail as you can, cause it shows you're being open. It shows that we're not hiding anything. We can sit here for days if you want. We'll go through it in detail. And it's very powerful.* (Earth Scientist 2, 2012)

The above quote demonstrates the realignment of researcher's approach to the same one-way model of communication to include comprehensive details as one would do when communicating to other scientists. This realignment ensures the effectiveness of the communication by conveying a representation of openness and transparency for the public to whom the information is being conveyed. It is further interesting to note that in this approach, the time factor is also explicitly reframed from being a constraint to being an enabling factor in the communicative process.

Moreover, depending on the context, engagement events can offer an opportunity for researchers to network with members of publics as well as other academics. In particular circumstances, this networking can be used for advancement of research as in the cases where the information provided by publics informs the future direction of research. Whilst, preferably this process of advancement of research through communication with publics beyond academia is to be planned and integrated into the research process right from the beginning, it can also occur in a more serendipitous manner, as illustrated, for example, in the next quote.

> *I've used the communities to identify the gaps. They've asked questions which sometimes you brush over as a scientist. You think, 'Wait a minute! Perhaps we don't know the answer to that.' I've effectively gone around Romania, Bulgaria, Poland, Ukraine and London, UK and collected ideas. They've been a fantastic resource in pointing out the obvious unknowns…The known unknowns and I've drifted over stuff. It's funny, as a scientist you do tend to take stuff for granted in some ways and then someone asks you and you think, 'That is a good question! If I can't answer it, perhaps it has not been published.'* (Earth Scientist 2, 2012)

The above quote demonstrates a trade between a public and the researcher. The researcher receives public knowledge whilst the public involved receive a sense of agency in that they have potentially influenced the direction of future scientific research by enacting being a public. However, it is notable that this 'public knowledge' already existed as scientifically relevant knowledge, but was 'overlooked' by the researcher. This points towards the implicit importance of 'framing' that the researchers place on what is known and what is unknown and the corresponding relevance within a scientific frame. Therefore, the above example is suggestive of the potential for engagement to be a space for publics through performing being a public, they can identify visible gaps in knowledge that may have been previously overlooked by researchers.

In other cases, the process of ***'bettering' the research*** by drawing on the knowledge of publics may be more intentionally integrated into the overall research process. For example, Engineer 1, who worked on contaminated land remediation, engaged publics early on in the research process in order to learn from local knowledge and in order to legitimate the overall research project by creating affinity between the publics and the to-be-remediated piece of land.

> *… it's essential to take their point of view into account because often the public actually know more about that piece of land than any official documentation in regulatory authorities or local councils….That information doesn't always come out but there is a lot of knowledge there. So that's one practical reason you have to engage with the community. Another reason to engage with them is of course that unless you do engage with them and ask them what they would like done or tell them what the options are for regeneration, they're not going to feel attached in any way to that piece of land. They'll feel that 'Council or somebody just came in and just did it. They didn't talk to us about it.' For that reason; it's to make success of the project really.* (Engineer 1, 2013)

Here the researcher begins to invoke the idea of an atmosphere that is associated with conducting the remediation research. Engineer 1 stresses the importance of incorporating the public knowledge and creating an atmosphere of attachment in order to maintain the bond between the land and associated publics. In turn, the engagement process creates legitimation for the research to proceed. This is demonstrated in the next quote.

> *…that's actually incredibly important because the last thing you want to do is look like, you know, kind of colonial, kind of research outfit that just kind of lands in a place with a couple of mini buses full of students for two weeks and then leaves really quickly. You've got to be very careful about that, especially in the foreign countries. So, we're acutely aware that community involvement and being seen to be embracing the community and importantly spending money in the community as well. That's a very important aspect is that. You know, you go to the local shops. You don't turn up with a container full of food which you bought for frankly much cheaper back where, you know where, in terms of the big conurbations in Britain. You actually go there and you spend money in the shops and things like that. And by doing that, what you find is all the kind of local logistics which you need in place: a tractor to pull something out of a ditch; sometimes, someone, you know, is ill and you need to get to a*

> *doctor quickly. All of that becomes much easier if you've done the ground work, spoken to the local community and really kind of engaged the local community with the research that we do.* (Archaeologist 1, 2012)

Despite these positive benefits of public engagement, public engagement can be somewhat of a ***risky activity***. Several interviewed researchers, also identified 'risks' that arise within the context of engagement beyond academia. For example, in the case of engagement with external partners such as those in the industrial sector, these partners may place constraints on what can and cannot be published. This is exemplified in the next quote.

> *I've witnessed, particular for PhD students, research students, where it's a crucial part in an academic's development is getting that first group of pieces of academic research done that allow you to demonstrate your own independence and take the step up into progressing up the ladder. I've seen instances of companies turning around and saying, 'That can't be published,' or 'You can't use that data.' And you know, suddenly, a crucial part of the argument drops out of an academic work and the whole thing essentially is diminished by it. I've see it have a significant impact on students…It's demoralizing as much as anything when it happens to an academic, when you feel you invested a lot of time and your intellectual energy, then that is very frustrating*. (Earth Scientist 3, 2012)

In this case the gains from the trade of research knowledge with a partner in a position to apply the findings is not very profitable for the researcher because of the high cost in terms of loss of academic recognition. This dynamic manifests itself in the generation of an atmosphere of engagement that may potentially 'demoralize' the academic involved. Ultimately then, engagement with industry is a process whereby there is a necessity to negotiate the interests of the parties involved.

> *… it's played against the background of the interests. And I suppose it does center on intellectual property rights of who is going to be responsible for doing what and how you're going to do that in a constructive way that allows everyone to get out of it what they want. So, for academics, to get the material that can be published in a public forum, well, in journals if you can call those a public forum... So that's really where the difficulty in communication I think lies with industry is making sure that there is very clear framework for what data is going to be used, how it can be used and how it can be dealt with at the end. So what's appropriate to publish and what's not appropriate to publish.* (Earth Scientist 3, 2012)

The management of the risks involved in communication is seen here to lie in the framework that negotiates the inherent tension and guides the scholarly output by the academic whilst satisfying the intellectual claims of the industry partner. The risk highlighted here is situated on the pre-publication side of the spectrum. Engagement which occurs post publication may also result in risky outcomes. In particular, engagement can be risky in that it may lead to necessity for researchers to establish or lose their authority over the process. In the first instance, the next quote demonstrates the necessity for researchers to establish authority in order to avoid losing it.

> *We're just about to get the publication for Science. We've actually found an earlier site that has never been found in the [Scandinavian Islands] before. And this will push back, the kind of founding of the [Scandinavian Islands, as in the settlement, the human settlement of the [Scandinavian Islands] by a good 500 years. Now that's going to have a big impact. Those people cannot be Vikings. But the popular conception and the cultural identity of the [Scandinavian Islands] are that they're Vikings…So we have to be very careful about how we going to disseminate that. What I want to do is actually I want to create; when the paper comes out I want to create a kind of media release at the same time in the [Scandinavian Islands] with my colleagues at the national museum of the [Scandinavian Islands] to actually try and get our point across before anybody starts saying, 'Who are these people to tell us?' sort of thing. 'Who are people are?' So we're working out a strategy for that at the moment. It's not completely formulated yet but it will be. Sometimes there are sensitivities that we need to bear in mind.* (Archaeologist 1, 2012)

The quote demonstrates that the management of risks involved in engagement events can be in part addressed through the process of staging, of the engagement event in order to create an atmosphere that will facilitate effective communication of research. Therefore, when considering engagement instances, the trading practices within them can emerge to a large extent 'organically' or can be staged (or planned) to various degrees.

5.7 Conclusion

The trading zone therefore operates as a space for the coming together of different actors involved in the communication process. In the preceding discussion, I have demonstrated that rather than just being 'altruistically' motivated, intrinsically justifiable acts, of 'good will', engagement events can be envisioned as spaces within which exchanges are carried out in a way that is partly motivated by more instrumental gains that are made from the exchange for all those involved, including the researchers themselves. This view of engagement suggests that it can be considered as a form of 'trading' and that the process of 'trading' information depends on: a range of interactions between the different animate and inanimate actors involved. Atmospheres that build around the process are important determinants and outcomes of communication of scientific research. In the next chapter, I explore further how these trading zones operate and the roles of some key actors in these spaces.

6 Chapter 6: Organisational Boundary Spaces for Research Communication

6.1 Introduction

Chapters 4 and 5 highlighted the problem of communication between science and society. Chapter 4 traced the emergence of a collective 'atmosphere of engagement' in the U.K. at the policy level, which enveloped the academic sector amidst concerns about the need to improve the relationship between science and society. Chapter 5 focused on how individual researchers from a case study university experience this atmosphere and contribute to its constitution through their engagement practices. By considering instances of engagement as 'events', the chapter demonstrated how researchers adopt hybrid identities within the context of their engagement activities with 'potential' publics. Moreover, I examined how engagement activities function as 'trading zones' driven by research communication. In this chapter, I explore further how these trading zones have become increasingly institutionalised and formal, and how researchers are increasingly interacting with a wider range of actors involved, including professionals whose role is focused on creating and facilitating the trading zone.

In the first instance, I argue that these 'boundary' spaces act as coordination sites for the creation of trading zones where problems of communication are resolved between the university, researchers and various publics. Specifically, I demonstrate that these problems are resolved through the exchange of knowledge, expertise and resources. Secondly, I argue that these sites, whilst facilitating specific types of engagement for a particular group of researchers, induce the emergence of intentional engagement practices amongst the other larger proportion of university academics. The formation of different engagement trajectories (independent or boundary space-mediated) amongst the researchers is a result of- and contributes to- the formation of an 'atmosphere of engagement' within the case study university that is in a liminal state. Lastly, I argue that this dynamic (within the case study university) can be attributed to the ways that these boundary spaces are attempting to negotiate their identity, which incorporates an 'external' focus on the 'business' of research communication and an 'internal' focus on contributing to the development of university's research base.

6.2 Overview of Formalised Boundary Spaces

Universities have a number of spaces that function at the boundary between the university and society. In this chapter, I focus especially on three formalised boundary spaces, set up and

operated according to the institutional strategy of the University where this research was carried out: the *Marketing & Communications Office*; the *Business & Innovation Services Office*, the *Science Outreach Unit*. The aim of this section is to outline the functions of each of these formalised boundary spaces in order to demonstrate their positioning at boundary of the university-society relationship and more specifically at the science-society boundary. This description relates to the institution as it was when the author carried out the research (refer to chapter three for specific dates), although the system is constantly developing so may have changed since.

6.2.1 Marketing and Communications Office

In the 'Case Study University' (CSU), one space that acts at the university/society interface is the 'Marketing and Communications office'. The Marketing and Communications Office (MarComms) is a professional services department, situated within the Registrar's division. It is connected to various marketing and communications projects as well as other ongoing operations and processes across the university. The office is made up of two 'distinct' teams of 'qualified marketing professionals' with "over 200 years of collective professional experience not only in Higher Education but in the public and private sectors in the UK and Europe, bringing skills and expertise from the worlds of national media, publishing, marketing and brand consultancy, business analysis and corporate affairs" (CSU MarComms 2014). The Communications Office works "in partnership with staff and student colleagues to raise the University's profile and engage with a vast cross-section of audiences in the markets in which we operate, from prospective undergraduate and postgraduate students and those who influence them, to the global academic community, funding councils and policy makers. We are also passionate about managing the University's reputation by disseminating good news and engaging the media, policy groups and the general public to manage and mitigate reputational risk" (CSU MarComms 2014). The Communications Office consists of two units: 'strategic marketing' (SM) and 'media relations' (MR).

'Media relations' is a strategic unit that is a part of the 'Communications Office'. The staff consists of 6 professionals (deputy director of communications, 3 media relations officers [MROs] and 2 communications co-ordinators[70]) with expertise in print and broadcast journalism, including BBC TV and radio, and media and public relations. One of the MROs is the media contact for the Faculty of Social Sciences & Health. Another MRO oversees the faculties of Science and Arts & Humanities. A third MRO is responsible for maintaining a positive profile of the university across a number of communication channels. The aim of the media relations team is to promote the

[70] At the time of writing.

university's profile and manage its reputation at the international, national and regional levels in accordance with the university's strategy. The work of media relations focuses on five areas:

- *Proactive media relations* (providing journalist with positive news and expert commentary);
- *Reactive media relations* (management of incoming inquiries from the media);
- *Crisis media relations* (management of media during a crisis; management of sensitive issues that attract media attention);
- *Media Training*[71] (preparation of staff and students to talk to the media);
- *Horizon scanning* (Identifying and preparing for media opportunities / interest).

The areas of focus for media relations are centred primarily on relations between researchers and the media (Although, it must be noted that for MROs it is also equivalently important to maintain contacts in the media with journalists, and other various representatives).

6.2.2 Business Engagement / Knowledge Transfer (BEKT)

The CSU's other interface for engagement beyond academia is situated under the 'Business & Innovation Services' umbrella. This unit was created in 2010 as an amalgamation of the 'technology transfer office' and the 'regional development office'. The overall unit is comprised of 4 teams of professionals who focus on four areas of activity: business engagement, commercialisation of research, consultancy and analytical services. The 'Business Engagement' (BE) team focuses on developing new business activity and partnerships with business and industry. It includes 'Consultancy' and 'Analytical Services'. The 'Research Commercialisation' (RC) team is tasked with the commercialization of research outputs and is responsible for handling patents, licensing and spin out companies. A more detailed account of each team's responsibilities is presented in Table 6.1.

Business Engagement (BE)	**Research Commercialisation (RC)**
Development of industrial collaborative research projects	Disclosure of research findings with commercial potential
Contract Research	Identification of funding technology development resources
Impact Acceleration Accounts (IAA)	Protection of intellectual property through patents, trade marks and design rights
Knowledge Transfer Partnerships (KTP)	Development of appropriate strategies to exploit intellectual property and the preparation of the requisite business plans
Knowledge Transfer Secondments (KTS)	Establishment of university spinout companies
Consultancy	Agreements
Analytical Services	Negotiation of intellectual property terms to

[71] The 'Media Relations' team offers the following courses for staff in order to develop skills and knowledge in order to successfully deal with the media. There are three levels: level 1 ('An Introduction to Media Relations: How to make the Headlines'); level 2 ('Intermediate Media Skills: Practical media Interview Skills'); level 3 ('Advanced Media Skills: Advanced Broadcast Interview Skills'.)

	research contracts
Higher skills and Engagement	Negotiation of licenses to university patents, software, etc.

Table 6.1 - Business Engagement & Research Commercialization responsibilities.

The *Business Engagement (BE) Team* works "closely with the research base to develop and engage in substantive business and industrial research collaborations and partnerships" (CSU Business & Innovation Services 2013). Business engagement works in two streams: business development and business partnerships. These sections support academic staff in accomplishing the university's aims and objectives for: business relations/networking; research coordination; knowledge transfer partnerships (KTPs); knowledge transfer secondments (KTSs); consultancy; analytical services and equipment; research commercialisation; student placements and projects. Another branch of the BEKT focuses on *Commercialisation of Research and Technologies* which arise from the research conducted at the case study institution. Here work is conducted around intellectual property, licensing and spinouts. *Consultancy* constitutes a third arm of BEKT. The work of the university is supported through multiple avenues. Alongside research and teaching activities, consultancy is represented as an opportunity for the university to undertake work that can generate income (both for the university and for the individual researcher). Within the CSU, consultancy is defined as,

> "…the provision of expert advice and work which, while it may involve a degree of analysis, measurement or testing, is crucially dependent on a high degree of intellectual input from the HEI to business. Such work is usually paid for at a market rate, and may deliver stronger IP rights to the business client than would apply in a collaborative research relationship." (Case Study University 2011, p.4)

The case study university provides consultancy to various sectors (such as business, industry and public sector partners) through a number of consultancy units. These include units which provide consultancy services relating to archaeology, managerial skills and services, chemical analyses, statistics and mathematics, nuclear magnetic resonance equipment, administrative processes such as government data distribution, education, and a range of engineering and technology services[72].

There are other types of consultancy activities that are recognised by the university but which take place largely outside the 'boundary zone' constituted by this central Consultancy Unit; these may be *departmental, individual,* or *private***.** Departmental consultancy is led by the department and is geared around its interests. In this instance, the head of the department must approve the work; however, direct engagement with the central consultancy unit is not required. Individual consultancy projects are not led by the department, but the Consultancy Unit encourages

[72] The names of units have been generalized in order to protect the anonymity of the units and the case study university.

contact within in order to develop the project and gain internal approval. This type of consultancy is carried out by staff within their 'normal working' hours and is conducted within their 'consultancy allowance' (normally 24 days per year). Private consultancy is conducted outside the parameters of the process provided by the university. This requires approval from the Head of the Department as well as the client and is not part of the 'consultancy allowance', so it would be conducted 'outside working hours'. The Consultancy Unit supports the university by creating 'boundary spaces' offering a number of services, such as: project management; advice and support in responding to tenders; costing and pricing of projects, including negotiation; providing approval for projects; risk assessments; contract preparation and negotiation (in conjunction with legal support); and advice on how to get involved in consultancy.

The case study university has a vast range of state-of-the-art research equipment and facilities. These are situated across a range of disciplines including Anthropology, Archaeology, Biological Sciences, Chemistry, Computer Science, Earth Sciences, Engineering, Geography, Health, Physics, Psychology and Medicine[73]. The analytical equipment and facilities are primarily available in support of the university-based research at the national and international levels. However, access to these services and facilities is also available more widely to academic or non-academic partners outside the institution for a fee.

6.2.3 Science Outreach

Lastly, at the CSU, there is a centralised space that is dedicated to organising and carrying out science outreach activities as well as facilitating activities for various researchers across the university. *"The [CSU] Science Outreach team provides inspirational, fun, hands-on science activities for schools and colleges..."* (Senior Science Outreach Officer 2013). These aims are accomplished through a number of activities, which are primarily externally situated; although some do take place on the university premises. They include initiatives such as Science Festivals (some targeting general audiences and others for school children); Student Placements (under the University's Science into Schools programme); Science Teaching Consultants; as well as a range of Special Projects / Unique Events and other activities 'supporting others' (within and outside the university such as organisation of smaller satellite science festivals). The activities can be considered in terms of the dominant purpose of the communication that takes place: 'science into society' or 'society into science'. An example of the 'science into society' category is the *Celebrate Science* festival which "includes a wide range of fun and fascinating science-themed events and activities…at various

[73] Note that in order to maintain complete anonymity (particularly of the case study university) a table listing the available equipment and facilities has been omitted.

University locations around the city" (CSU Science Outreach 2013a). Also the *Science Teaching Consultants* scheme "aims to alleviate a shortage of subject-specific science teachers through engagement of PhD students in science, technology and mathematics" (CSU Science Outreach 2013b). These are aiming to extend access to science into the 'public space' of the wider community beyond the university. Examples of 'society into science' activities include the *Schools Science Festival* which enables school students to "follow a demanding programme of engineering projects including design, building and testing, and a range of hands-on science and technology activities "(CSU Science Outreach 2013c). These focus on drawing publics into spaces of engagement which are more academic in nature.

The aforementioned activities are facilitated through the centralised science outreach space within the university. The main science outreach team is composed of the director of science outreach, two science outreach coordinators, and a science outreach officer. In addition, my interviews with staff of the outreach service indicated that there is also a network of 'science outreach representatives' across the various departments within the university who are associated with the central science outreach unit. These representatives carry out their own initiatives and activities whilst also engaging with the centrally organised events. The departments and research institutes that engage in science outreach include: biological and biomedical sciences, chemistry, earth sciences, engineering, geography, physics, mathematical sciences, earth sciences, research institute 1 (interdisciplinary), research institute 2 (physics), computing sciences, mathematical sciences and psychology. The degree to which this network is embedded across the university varies across the individual departments / research institutes. For example, within the Department of Geography at the time this research was carried out, science outreach was not listed on the departmental website and was associated with a particular research area (Ice Sheets and Sea Level), which corresponded to 8 researchers in physical geography. In other departments, science outreach is referred to on the main departmental website and represented as activity involving the entire academic body of the department rather than being affiliated with particular research area and a limited number of individuals. Despite the somewhat uneven distribution and inegration of the science outreach 'network' across the case study university, it is administratively formalised through a university administrative committee, which oversees science outreach.

In summary, this section provided an overview of three spaces which function at the boundary between university and society, and more specifically science and publics. In particular, the aim was to outline the 'formalised' functionality of each space with the aim of juxtaposing the boundary space-mediated engagement practices versus the engagement practices outlined in the

previous chapter. The next section builds on this outline in order to explore how the aforementioned spaces function as trading zones.

6.3 Communications Office as a Trading Zone

The competition amongst publicly-funded research institutes and universities to attract students, staff, and funding has created an environment in which communication activities have acquired an important status. This has corresponded with an increase in the number of public relations practitioners employed in scientific organisations since the late 1980s (Bauer & Gregory 2007). In the context of the higher education sector in the U.K., science communication has become a part of the wider efforts to raise the public profile of universities and emphasize the importance and quality of the work that they do across their research portfolio. Thus, as science communication received greater importance it has been increasingly managed by a dedicated staff of public relations practitioners and/or communications advisors, rather than being left to academic staff to undertake in the diverse, more informal ways summarised in Chapter 5.

In a recent issue of the *Journal of Science Communication (JCOM)*[74], an editorial on public communication from research institutes asked the question, 'Is it science communication or public relations?' (Carver 2014). This question encapsulates the tension that permeates science communication carried through media/communications offices especially across the Russell Group of universities (as well as other higher education institutions in the UK). According to Shipman (2014), public communication from research institutions often incorporates both science communication and public relations. He argues that successful science communication as a form of public relations is based on 'finding a shared language and disseminating findings in context' (p. 1). This process occurs through the formation of what Galison (1997) has described as a 'trade zone' (see chapter 2). Claessens (2014) makes a contrasting argument in suggesting that scientific institutions are neither engaged in science communication nor in developing public relations (in the traditional sense); a press release is not 'genuine communication', since real communication requires dialogue. Similarly, Marcinkowski & Kohring (2014) argue that public communication from research institutes, such as in press releases, has become the dominant form of public science communication and has resulted in other forms of science communication being relegated into a less prominent position in the 'background'. They suggest that this 'journalistic' form of communication represents a potential threat to the autonomy of scientific research because it focuses too much on gaining public attention and is actually not necessary for the functioning of science. However, for Autzen (2014), the press release represents a genuine form of science

[74] Journal of Science Communication can be found at: http://jcom.sissa.it/

communication[75] which can potentially evolve into a normative means of doing things (There is already a high reliance on public relations sources and means to disseminate scientific knowledge [Weitkamp 2014]). Despite the disagreement over the usefulness of the press release, it has still maintained a high level of popularity as a science communication and PR tool within Russel Group of Universities in the U.K. (Figure 6.1).

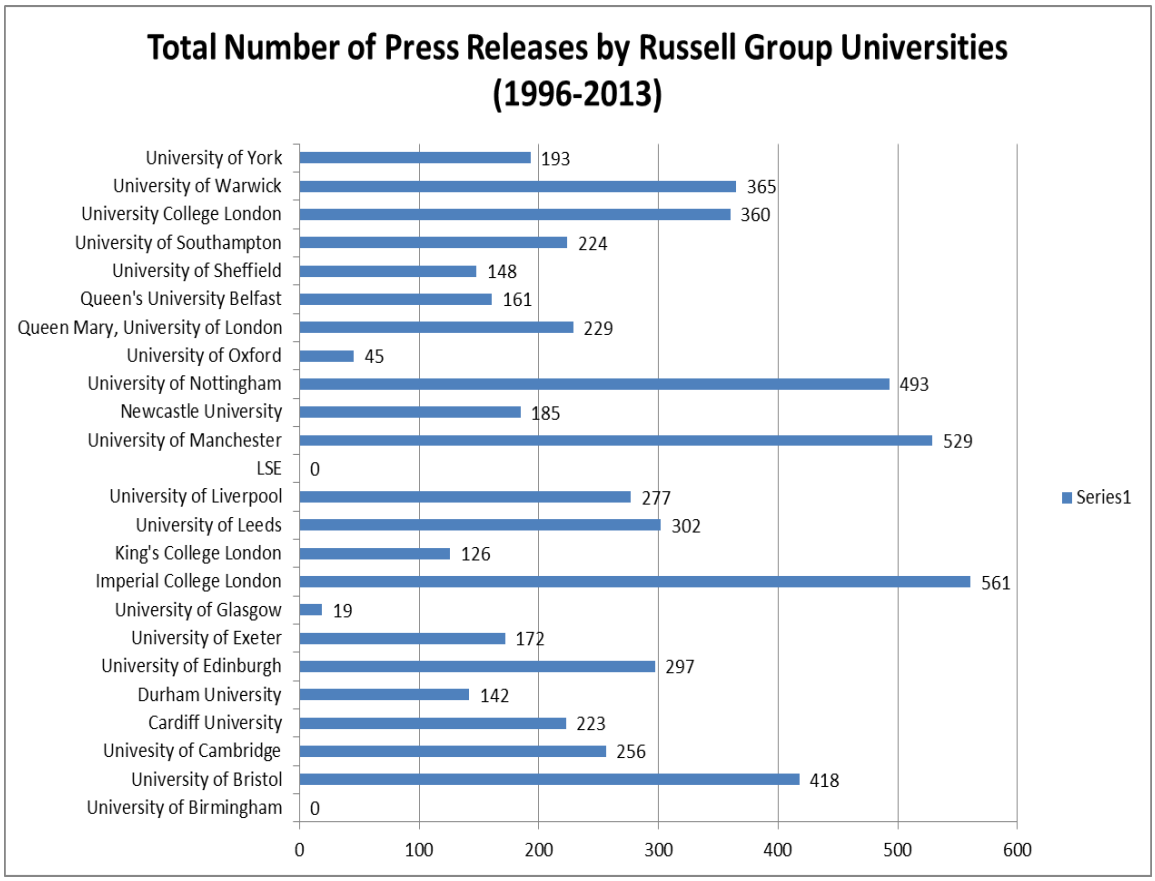

Figure 6.1 - Total Number of Press Releases from Russel Group Universities on EurekaAlert! (1996 - 2013).[76]

Within the universities in the U.K., the press release has become a dominant 'hard currency' in a fractionated trading zone (boundary object / interactional expertise) that is formed between the researchers and the university press officers (and implicitly the journalists as well as various publics). For the universities, the press release 'procures' enhanced public profile for the university's research activity as well as communicating some of the findings of the science. For journalists, press releases can be converted to news items which are essential commodities for their business in public media distribution. For scientists, the press releases communicate some of the findings of the

[75] However, she does emphasize that there is a need to recognise that press officers are perfectly capable of writing stories for public consumption which would allow journalists to pursue more contentious issues.

[76] Criteria for attaining press releases for each individual university: Search terms – not applicable; related research journals – not applicable; related scientific meeting – not applicable; Region – all locations; category – agriculture, archaeology, atmospheric science, biology, chemistry/physics, earth sciences, mathematics, medicine and health, space/planetary, technology / engineering; sort search results by – date.

science simultaneously to academic and non-academic audiences thereby increasing their public and scientific profiles.

6.3.1 Creating the Trading Zone

In order to bring the various actors (especially researchers and journalists) together to form a trading zone, media relations officers engage in a networking process. With the case study university, media relations officers circulate around the departments (and attend various events that are held across their university) and encourage researchers to inform them about any potential research projects and or papers that may be suitable for dissemination. The following exchange from an interview with a media relations officer demonstrates this dynamic.

> **[Boris Popov]** *The stories that you cover - do the scientists come to you or you actively seek out stories or it's a bit of both?*
>
> **[Media Relations Officer 1]** *Both.*
>
> **[Boris Popov]** *What would you say are the proportions?*
>
> **[Media Relations Officer 1]** *50-50. I can't say. We meet people regularly. We do a lot of face to face contact. So I like to think that in the departments, most people would know who I am.*

In 'push' networking media communications officers push out a 'net' in order to enrol the media relations representatives distributed across the university and encourage them to engage in dissemination of research. The networking process may be planned in the sense that the officers make arrangements to meet with a particular researcher; for example, one with a 'high profile' project likely to garner a lot of public interest and prestige. Alternatively, networking may also occur in a more 'serendipitous' manner through chance contacts between the two parties. The next quote demonstrates both the planned ('push') and the 'serendipitous' types of networking.

> *And at the time, I think one of them* [media relations officers] *was visiting a Professor about her projects. They said, 'Have you got anything interesting? Send us a copy.' So when I finished the project, I wrote the journal article. And as I submitted to the journal article, I sent it to them and said, 'Well, this is under consideration. What do you think?' And they got interested and they then prepared a press release.* (Computer Scientist 1, 2012)

The two types of networking processes contribute to the constitution of an 'atmosphere of engagement' within the university through formation of 'engagement trajectories' amongst the researchers and the staff in dedicated university offices. Enrolment of the researcher into engagement via the communications office space can occur at an affective level. In the above quote, the chance encounter between Computer Scientist 1 and a media relations officer occurred in such a manner that conveyed a level of 'interest' from the media relations office to the researcher that he felt encouraged to get in touch with them about composing a press release to be circulated as he

was publishing the article about his research. The interaction imbued the researcher with a feeling that the proposed exchanged with communications office is valued and 'worthwhile'.

Following the initial contact, the ***selection*** process occurs. This is a twofold system – positive selection, whereby a piece of research is selected for dissemination; negative selection, whereby a piece of research is not selected for dissemination. The previous quote provides an example of positive selection. The research paper pitched by the computer scientist was evaluated to be meeting the criteria required for dissemination via the media office. The specific criteria are to a large extent black boxed. According to the case study university's communications office webpage, "There are so many positive news stories to tell about 'Case Study University' that the team cannot publicise them all but concentrates on disseminating those that will have the most impact on the media, usually at international or national level" (2014). Therefore, from a public relations perspective, the broader selection criteria are based on whether publicity of a particular piece of research will contribute to maintaining a favourable image of the university in the public sphere at the national and international scales. For example, in light of this broad objective, 'interdisciplinary' research may be viewed favourably for dissemination purposes, since it enables the University to broadcast positive information about research activity across several research areas and a number of research institutes.

> *But also, where the skill of my job came into it was that I thought, 'Bing Bang. Right!' Somebody came up with this idea in the year 1200. That's a new story.' So that worked. But it's good for me because it's not just the Research Institute 1 but it's the Research Institute 2, working together. So it also shows – very important word - the 'interdisciplinarity' of research at [Case Study University], because you've got the physicists and the medievalists working together and that's great. That makes it invaluable in terms of coverage. They're doing the interviews with the guys at the Research Institute 1 and the guys at the Research Institute 2 this week. So, it's all very positive.* (Research Institutes Communications Manager, 2012)

Just as there may be a positive bias towards the selection of 'interdisciplinary research for dissemination, there is equivalently a negative selection, or elimination of other research from dissemination. In addition, the research topic may also be one of the selection criteria for external dissemination. This is exemplified in the next quote.

> *Well, with my other projects, I try to go down the same routes. So I did a paper, must be nearly a year ago, on antisocial behaviour and training police. I sent that to the media people. They said, 'Public aren't interested in that. So we're not going to do a release.' And I thought that's weird because, you know, antisocial behaviour is all over the news. But they do what they do.* (Computer Scientist 1, 2012).

The foregoing quote suggests that the process of selection is to an extent predicated on the public interest in the area of research as perceived by the media officer. In the case of Computer Scientist

1, research that dealt with fire safety was taken up by the media office whereas research that dealt with antisocial behaviour was not. Potentially, a stronger consideration is how the research will affect the public perceptions of the research institution that is disseminating the research and its 'ranking' in reputational league tables of academic institutions nationally and internationally[77]. The following quote suggests that the actual expert knowledge communicated from research is less significant than the potential to promote this kind of general recognition of the institution.

> *The other media, and other methods, speak to a specialist audience but we have to think of the mainstream audience first, because public perception of an institution like [Case Study University] can actually play an important part …perhaps not formally to the REF or to impact, but certainly in people's perception of an institution, which can help to push it up the top 50 universities list, which is important to people.* (Research Institutes Communications Manager, 2012)

Selection for dissemination via the media office is 'framed' in terms of maintaining a positive image of the university and its researchers amongst the general public. Moreover, maintenance of a positive representation has been linked with affecting various ranking systems of universities nationally and internationally.

Before the media relations officers are able to apply their selection criteria, researchers also undergo a ***self-selection*** process, whereby they apply their own set of selection criteria to their research in order to decide what to promote through the media versus other methods. This is demonstrated in the next quote.

> *I have talked to the media office. Someone from the media office came a couple of years ago and had a discussion about where my interests lay just so they could find out what I did and where my interest lay. And, having done that with a number of people in this department, they were very well prepared when the Icelandic event [78] happened. But, they made it clear at the time that if there were any papers that I felt were going to be of significant impact to let them know in advance and they could help determine whether that would be suitable. I haven't in the interim felt there's been anything [that] really warranted going down that route. There is now. There is a project that we're working on that perhaps by the middle or end of the summer, we're submitting two manuscripts and the latter of those has the potential to have a very significant impact scientifically.* (Earth Scientist 3, 2012)

In contrast to media officer's criteria (two of which include, general public interest and the maintenance of a positive image of the research institution), for this researcher the criterion for dissemination of their research appears to be grounded in the scientific merit rather than in the appeal to the public sentiment. The next quote within which a researcher reflects on his experience

[77] University rankings are rankings of institutions in higher education order by a combination of various factors. Some of the prominent rankings include: Academic Ranking of World Universities, Times Higher Education World University Rankings, QS World University Rankings.

[78] In 2010, volcano Eyjafjallajökull erupted in Iceland. Although it was relatively small for volcanic eruptions, it resulted in an extensive disruption in air travel across Western and Northern Europe over an initial period of six days in April 2010.

disseminating via press releases, there is recognition that potential for media dissemination capacity is derived both from scientific importance and the popular appeal of the subject matter.

> *I mean the fact is that we had a nice story. It was climate change. It was cuddly arctic foxes. Arctic foxes are nice. You could have a picture of an arctic fox and people go, 'Ooh. Isn't that nice,' sort of thing. It's a nice little story and it makes sense… You can see that if the story is kind of scientific but light enough, then you can hit certain places*. (Archaeologist 1, 2013)

Moreover, the above quote appears to suggest that the researcher has adopted or 'internalised' the selection criteria that he observes being applied by media officers. Thus, the suggestion here is that the values of the media communications trading zone are permeating out to the wider body of the CSU research staff.

In summary, the media communications 'trading zone' has been created as a space for communicating scientific research in particular ways which focus on the 'market' for popular news stories (the commodity being traded by the university) and the resulting gains for the university in terms of public profile and enhanced reputation as an institution carrying out scientific research which is of public interest and relevance (transaction-focused interaction). Overall, this trading zone is negotiated via two sets of practices: relations-focused (e.g., university-society; media relations officers – journalists, media relations offices – university researchers) and transactions-focused. The relations-focused practices are 'affective' practices in that their aim is to try to create potential ('affective atmosphere') from which transactions can emerge. The key commodities being traded here are not detailed expert knowledge and the selection processes determining which research science information is traded do not necessarily match with the views of researchers about the significance of their findings. Those researchers who are able to function most successfully in this kind of trading zone are those who are able to relate (sometimes self-consciously and in a strategic way) to the affective atmosphere of popular media debate. The comments above raise questions about how emotional and affective aspects enter into the process of science communication (including sensationalism, or emotional appeal of the topic) and the importance of these aspects of science communication for interactions with actors in the popular media. Some researchers appear to embrace these with enthusiasm, but others seem more sceptical and find that this trading zone does not offer the space they are seeking to channel the communications they would like to offer to a wider audience.

The tensions between the self-selection process implemented by researchers and the selection criteria exercised by media relations officers (and the fact that media officers do not have capacity to cover all the possible news stories arising from research with potential public interest), has therefore left a space for researchers to create other trading zones through more autonomous

initiatives. This space has been in part occupied by the emergence of social media platforms which have become power tools for communication beyond academia (Lupton 2014; Powell *et al.,* 2012)[79]. However, adoption of social media platforms for research dissemination within the case study university and more broadly amongst scientists in the U.K. has been limited (Lupton 2014; Mewburn and Thompson 2013; Wilson *et al*., 2010). A more traditional way that researchers can bypass direct involvement with the media relations trading zone at the university is to use the already prepared media templates in order to make their own media releases for distribution. However, stories with potential major impact for the national/international and regional media will continue to be managed by the Media Relations Team. Alternatively, researchers have the option to engage with media relations representatives from a journal which will be publishing their work. The next quote provides an example of a researcher going beyond working with media relations team in the communication office at the CSU and instead engaging with the press officers working for the journal in which his article is to be published.

> *But for me, that's just one because most journals, a lot of the journals in which I'll be publishing will have their own press and so I'll work with them on a press release. For PNAS, you always have to give them, … [a] 150 word press summary. We pore over that very carefully to try and ensure that if you're a journalist looking through all the 150 word summaries of all the papers that are coming out in PNAS, ours is going to stick out ... We keep the sentences short. We keep it popping very fast. We try and hit some buzz words pretty quickly. We shy away from any overly obtuse language, which even though it might be accurate in a scientific sense, that's not your audience.* (Archaeologist 2, 2012)

This approach represents another path for dissemination of scientific research from a university to a wider audience. Previous research has demonstrated that press releases issued by journals lead to increased press coverage in newspapers (Bartlett *et al*. 2002; de Semir V *et al*. 1998; Entwistle, 1995; Woloshin & Schwartz 2002)[80]. In comparison to the other alternatives such as using social media, this may represent a relatively 'efficient' option simply in terms of the multitude of publics that can be potentially reached, since the media briefings are likely to be known and scanned by journalists looking for news-worthy material about research findings[81].

6.3.2 Communications Office as a Fractionated Trading Zone

As shown above and in the wider literature (Dunwoody 1999; Logan 2001; Nelkin 1995; Weigold 2001), media relations officers facilitate the relationship between scientists and journalists. In terms of research communication, the press release plays a role as a focal point for the interaction

[79] Over the course of this research, the prominence of social media amongst academics has substantially increased.

[80] Most of these studies have focused on medical journal press releases; the trend may potentially vary coming from other types of journals.

[81] For example, EurekAlert! (http://www.eurekalert.org/) is an online science news service featuring health, medicine, science and technology news from leading research institutions and universities.

between media relations officers and the researchers, and may be considered to be acting as a 'boundary object'. Together, the actants form a *fractionated trading zone* which carries elements of both cultures (media relations and researchers). In the case of this trading zone mediated by a boundary object, the object itself (in this case the press release) is the operative medium. Boundary objects are 'plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites' (Star and Griesemer 1989, p.393). In the case of a press release, for both the media relations officers and researchers, the press release is dissemination medium for university research. However, the composition of the press release (e.g., to what extent to include the nuances of the conducted research) and the intended outcomes of its dissemination may differ between the two parties. The complimentary (linguistic) dimension to the 'boundary object' is interactional expertise. Media relations professionals require interactional expertise in order to engage in the construction of press releases by engaging with researchers and their research from across a variety of disciplines. Conversely, for a scientist to contribute to the construction of a press release requires the acquisition of interactional expertise in media communication and/or public relations. Thus both parties rely on partial interactional expertise in order to function within the trading zone. The example of Researcher 11 clearly demonstrates the process of acquisition of this interactional expertise through a process of 'linguistic socialisation', (via 'physical contiguity' and professional interaction with medial officers in the medial communication space) and though 'physical immersion' ('hands on experience'). This then enables researchers to contribute towards construction of the press release.

> *When I did my PhD I was in a lab where the PI [Principal Investigator] was very media-savvy and he knew exactly how to manipulate the media and how to put out press releases. We already had press releases working up before we submitted the paper because we already were thinking about the best way to position it. And that often informed the paper because you're not just thinking, 'Okay, what's the primary result of this paper and how we're going to handle this paper?' It's also, 'How will that play in the public,' and maybe we should go with this [alternative] angle instead, because that will get us more PR. We never made a decision on that basis but it was always part of the calculation.* (Archaeologist 2, 2012).

> *And so, given that was my first experience with it, I've just carried that through. And now, what I always do. I've got templates now. I've got contacts for press.* (Archaeologist 2, 2012).

It is interesting, however, that the comments from the researcher quoted above suggests that when constructing a media briefing, their interactional expertise regarding the public relations potential of the briefing is viewed as a secondary consideration, and not the only criterion determining what material to include. This may reflect a residual tension and challenges in reconciling the requirements of the media trading zone with the perceived priorities of research communication. Consequently, within the process of working on a press release, three idealised phases can be

identified: **contestation, reconciliation and reconstruction**. The three phases are referred to in the following quote,

> *So, [Media Relations Officer],...for the last couple of years, he's been assigned to archaeology. And he and I have this working relationship where I send him the paper. We have a conversation on the phone and I send him an email with a couple of bullet point saying, 'This is kind of what we'd like to do.' In some cases I'll even send him a first draft of the press release of how I think it should read, depending on how busy I am and how important I think the overall story is. And then, he comes up with the release .... It's an iterative process. We go back and forth. Sometimes I'll insist upon a line staying and sometimes I can see that he's got a better idea of how to pitch it and what might make more sense. Sometimes some of the science that he's talked about was nuanced; they simplify it but then it looks like it's kind of wrong. So we play with that a little bit. Then he puts it out there as part of CSU's approach. (*Archaeologist 2, 2013).

The initial contestation phase occurs following the selection of the research by the media relations office for dissemination and the researcher and a particular media relations officer engage in a process of negotiation over the context of the press release. Following the 'contestation' and 'reconciliation' phases the 'reconstruction' phase occurs whereby the final press release is constructed. The phases of the process of constructing a press release are iterative, and can feedback into one another. However, there may be instances whereby both parties 'insist' on particular elements being present in the press release. There are also reconciliation phases ("...sometimes I can see that he's got a better idea of how to pitch it and what might make more sense") whereby both parties concede to the wishes of the other. Moreover, it is interesting to note that this process occurs between individuals who already have a pre-established 'working relationship', which implicitly speaks to both parties being in the possession of a common degree of interactional expertise.

Overall, the fractionated trading zone of the communications office is a dynamic entity. When this trading zone is populated by media relations officers and researchers who have a degree of interactional expertise in relation to their respective domains, the work undertaken may meet the aims of both science communication and public relations (Shipman 2014). As a part of this process the boundary object (press release) is exchanged and negotiated through interactions imbued with variable degrees of expertise. In its final form, which is an ideal state of equilibrium, the press release is a shared representation of science / publicity. However, this equilibrium state is relatively seldom achieved (see Brechman *et al*. 2009; Lynch *et al*. 2014; Maat 2007; Schwartz *et al*. 2012; Woloshin *et al*. 2009).

At one end of the spectrum, for an individual who has never engaged in dissemination of research via the media office (and perhaps is not very keen on doing this), research communication

seem to be an 'institutionalised' trading zone where the power balance is tipped in favour of the media relations professionals. Lacking the interactional expertise to engage in the development of the press release, the researcher may submit to the dominance of the 'public relations language' in comparison to the 'science language'.

> *And they then wrote their own pieces which they then published on their own online websites, and whatever. That was quite neat because they kind of did the 'lay' persons' summary for the research or put a particular angle on it. The media press release picked a topic; well, picked a title that was deliberately provocative.* (Computer Scientist 1, 2012)

The researcher seems to surrender their role in the interactional process and accepts that this is taken over by the institutionally appointed experts in media communication, and that what is produced is different from what, as a scientist, one might disseminate particularly in terms of language. Subsequently, the resulting press release may be more a form of representation of science as envisioned by media communications officers rather than a representation envisioned by the researcher.

However, it seems that this process may also serve as one which allows for the acquisition of interactional expertise on the part of the researcher, giving insights about this different way of presenting their research. Consequently, if there is a next time when the researcher engages in dissemination via the communications office, the interaction in the trading zone may (if the researcher is able to learn from the first experience) be based more on the degree of interactional expertise gained by the researcher through the previous interactions; who will now be more adept at understanding the language of public relations and applying it in relation to the research that is to be communicated. However, it is notable that this trading zone would not migrate towards a dynamic where the power was more in the possession of the researchers. For example, whilst the communications office offers media release templates for researchers to use independently of the communications office, they do reserve the right to manage the process if they deem the research to have a potential impact at the national and/or international scale. This suggests that the researchers do not always have a dominant and deterministic role in the science dissemination process through the 'communications office' boundary space of the university.

6.3.3 Conclusion

The communications office represents another boundary space that enables the formation of a trading zone between university, science, researchers and journalists. This particular trading zone focuses on research communication through the public market that deals with popular news stories (which act as commodities traded by the university). For the university, the resulting gains

contribute to maintaining and building its public profile, enhancing its reputation as an institution carrying out scientific research which is of public interest and relevance. Not every researcher is able to engage with this trading zone, in part based on selection criteria exercised by themselves as well as the communications office. Over time, this trading zone can evolve from one that is dominated by the media relations professionals to one where there is an equal contribution included from the researchers. This evolving dynamic of the trading zone, as a fractioned trading zone, is evidenced by the ways that a press release can constitute both a representation of science and a form of public relations.

6.4 Business Engagement and Knowledge Transfer as Trading Zone

Universities have always been at the forefront of new technological developments (Barker 1985; Hall *et al*. 2003). New technological developments have been amalgamated into the broader innovation agenda, which has emerged as one of importance in the UK (HM Treasury 2014). The understanding is that achievement of smooth interactions between science (in this case academic science) and industry will be beneficial for these purposes. At the organisational (the university), establishing a specialised technology transfer office (TTO) can be vital in fostering relations with industry. The TTO enables the provision of specialised support such as searching for partners, intellectual property management, licensing as well as business development (Lee, 1996; Sharma et al., 2006). In the United States of America, the surge in the creation of TTOs for the purposes of marketing and management of patentable inventions coming out of universities can be attributed to the successful enactment of the Bayh-Doyle act[82] (Allan 2001; Hsu & Bernstein 1997; Rogers *et al*. 2000). In contrast, the United Kingdom has not been as advanced in university technology transfer (Chappele *et al*. 2005). Consequently, the emergence of TTOs (and analogous spaces) is a fairly recent phenomenon in the United Kingdom – as an example, the business engagement and knowledge transfer (BEKT) unit within the case study university was only created in 2010.

6.4.1 Creating a Trading Zone

BEKT enables the formation of the trading zone by bringing the research base into close proximity with various sectors of the business world. This functionality of the space is enabled through its positioning at the interface between the university and the various businesses.

> *… an office that acts at the interface between business and the university.* (Senior Business Engagement Manager 2013)

[82] In the USA, Bayh-Dole act of 1980 gave institutions (universities) the right to claim title to inventions made with federal funding.

The focus of the BEKT unit is on working "closely with the research base to develop and engage in substantial business and industrial research collaborations and partnerships" (CSU Business Engagement / Knowledge Transfer 2014). The practices of the unit can be characterised into two types: research commercialisation and business engagement. In the next quote, a senior member of staff in the BEKT first elaborates on research commercialisation and then discusses business engagement.

> *Two main things that the office engages with; the* first *is research commercialisation. Another word for that is 'technology transfer'. That's very much about dealing with the research push; that is the ideas that are coming out of the university's research base and engaging with business and industry with respect to potential, whether it be licensing or whether it be new company formation or whether it be collaborative research that's based on ideas coming out of the research base…Second aspect of what the office deals with is what I call 'business engagement,' and in particular we're dealing with strategic relations with business; so engaging with business from the perspective of, understanding business needs and matching business needs to capabilities and building partnerships; in particular substantive partnerships with business.* (Senior Business Engagement/Knowledge Transfer Manager 2012)

The above quotes demonstrate two approaches to research communication through BEKT. The first approach is dominated by *relations-focused practices*, aimed at the development of three-way relationships between researchers, the professionals employed in the boundary space, and industrial partners. The premise here is that research communication via business engagement is underpinned by the development of appropriate relationships. The outcome of these practices is the creation of the relationships with various partners. In other words, the relations-focused practices are affective practices in that they attempt to create 'potential' for future interactions that may be more transactions-focused. The second approach within this boundary space was described as dominated by *transactions-focused practices*. These practices are underpinned by an understanding that research communication via commercialisation treats research outputs as tradable commodities (achieved through sales, licenses and other fees).

The coming together of the actors is facilitated by professionals who occupy this space through the process of **networking**. Networking is a dual process which consists both of **internal-** and **external-oriented** networking. Internal-networking focuses on identification of potential researchers and or projects that may benefit from engagement with an external partner, while external-networking focuses on identification of suitable partners in the business and/or industry sector. The two types of networking are exemplified in the following quotes.

> *I spend a fair bit of my time meeting companies who are interested in talking to Case Study University about their needs and interests. And then I will bring academics who meet those needs and arrange those joint meetings.* (Business Engagement Manager 2013)

In the BEKT, the networking processes that facilitate exchange are especially focused on fostering these internal and external relationships between actors involved in the application of research in commercial activity and industry, underlining the role of this 'trading zone' as a relational space.

6.4.2 Business Engagement / Knowledge Transfer as Fractionated Trading Zone

Being situated at the interface between the university and the business world requires that the professionals in these positions are able to relate to actors in each sector. This requires an understanding of both the research at the university as well as the potential 'needs' of a prospective external partner.

> *It's a job that is very much about understanding what universities are delivering. So it's very much about understanding about the research base. But also, in articulating what the university is delivering into a language which is relevant to business and which is accessible to business. And equally understanding what business needs and, you know, articulating that in a message which is understandable to the scientists as well. ....it's translation between business needs and research drivers and hopefully marrying a match between the two as part of what we're trying to do.* (Senior Business Engagement Manager 2013)

The quote explains that in order to successfully network (that is in order to successfully create a trading zone) professionals from DBIS require linguistic socialisation. Linguistic socialisation enables the professionals of the boundary space to translate between the two parties. Successful linguistic socialisation leads to interactional expertise. This type of expertise enables the professionals to navigate across boundaries between those entities in order to facilitate the development of the relationships. The competence of the professionals may be increased through 'physical immersion' ('hands on experience') which would lead to a level of 'contributory expertise' (''what you need to do an activity with competence' [Collins 2004; Collins & Evans 2007]).

> *In terms of the background of people that are within the office, most … will have had a period actually outside of the university sector prior to coming into this area… generally speaking, working within commerce or industry, and they would have arrived at this sort of job usually via quite a circuitous route. So it's not a job you generally train for. It's something that you migrate into at some stage in your career.* (Senior Business Engagement/Knowledge Transfer Manager 2013)

The next quote provides a further example of the background of the Business Engagement Manager that enables this professional to transverse the boundary between industry and the university.

> *I've always been interested in keeping abreast of scientific discovery. So, obviously, I did a PhD myself in physics, and throughout my career I've always maintained an interest in general scientific discovery… I joined the university three and a half years ago from industry. So in industry, I was working as a technical consultant. So I was delivering consultancy projects, managing consultancy teams in the pharmaceutical industry. So I was doing everything from negotiating with the clients, scoping out the project, then organising the pricing, putting contracts in place, delivering the work and then invoicing the clients. So that*

> *made me ideally suited to the role of consultancy manager when I came into the university.* (Senior Business Engagement Manager 2013).

Undergoing immersion in both social worlds (academic and business/industry), enables these professionals to work in the boundary space to coordinate the formation and development of trading zones between these two institutionally and socially different spaces. The interactional expertise gained from working both with business and the academic community is geared towards overcoming competing perceptions.

> *I guess before they start to interact there may be some stereotypical views, i.e., that academics are slow and working in many theoretical areas and industrialists are less bright and want narrow results immediately. I think when individuals start to work together, I think there is mutual respect, once they've started to work together. And that mutual respect has developed from the fact that the industrialists are dealing with difficult research questions and that they're working in areas which are relevant to academics. And the converse is that the industrialists appreciate the breadth of knowledge and insights that the academic researchers can bring to the problems which maybe they've been dealing with for many years and can be very insightful in terms of the ability to take things forward. So I think, there are some, from both directions, stereotypical views which are potentially dispelled*. (Senior Business Engagement/Knowledge Transfer Manager 2013)

The foregoing quotes suggest that a trading zone is created in part through process of overcoming competing perceptions. This is accomplished through the acquisition of interactional expertise for all parties involved. The operation of this trading zone is not purely based on interactional expertise, but can also be mediated by boundary objects. In particular, this can occur when collaborative projects are developed, meeting the requirements of both the industry partner for proprietary intellectual property and of the researcher for published scientific papers.

> *So a lot of the work that we will be doing with a business is similar to the work that their own researchers might do. But it might be driven by a manufacturing problem or a product problem. But it's usually the search for new knowledge. So for example, looking at particular chemical systems or investigating certain product failures, but which requires underpinning knowledge. So we're developing the underpinning knowledge. In that case, usually they're comfortable for us to publish. And it often gives them credibility because they then can point to this and say, 'We are doing this. Our products and our research are based on this scientific research'.* (Senior Business Engagement Manager 2013)

This quote illustrates an example of collaborative research based on a shared 'search for new knowledge'. This represents a trade for each party where an equivalent commodity is being traded in the form of the new knowledge that is to be attained. This represents a boundary object between the researchers and the company. The common understanding is that attainment of that knowledge can be translated into benefit for both parties; this enables the communicative process. The benefit for the researchers is to be able to publish the results of the research in academic journals which contributes to their reputation an academic scientist. For the company, the prestige associated with

published knowledge in academic journals can be used as reputational capital for reinforcement of their own research and products. However, not all collaborative research is as simple and straightforward. The negotiation process in the trading zone may be more contentious, as discussed in the next quote.

> *In some cases there is a conflict but in many cases there isn't a conflict and you can find a space where you can meet the needs of the university to publish and you can meet the needs of the company. Now the company is usually very much more interested in who owns the IP. So it's more about the timing of when you publish rather than if you can publish. Obviously you would need to make sure that any intellectual property had been secured before you published. So it's about the order in which you do things. It's about having the conversation to find a way that works. And if it doesn't, if it really doesn't work, then it's not a collaborative project. It's a contract research project. And we have processes in place in the university which mean, for example, that a PhD thesis can be put in the library and not let out for five years, ten years. Yeah. So we have processes to protect confidentiality, if we need them. But we very rarely use them.* (Senior Business Engagement Manager 2013)

In this case, the researcher would be interested in the scientific recognition associated with the publication of research, whilst the company is interested from a commercial perspective in the intellectual property rights to knowledge arising from the research. It is interesting to note that there are two solutions proposed to facilitate the functioning of the trading zone. In the first instance, it is an agreement about the order of who benefits from the trade first. For the company to agree for researcher to publish, intellectual property associated with the research must first be secured by the industrial partner. The second strategy involves the academic partner restricting access to the findings and limiting the audience to whom research is communicated in the period before the commercial benefits are realised, for example, by placing an embargo on a thesis. Therefore, the trading zone does not function in an identical manner across the various projects and is instead as socially diverse space whose functionality can be facilitated through a number of strategies.

6.4.3 Conclusion

This section has focused on the boundary space of the university that engages with various industrial partners through business engagement and knowledge transfer activities. This space is dominated by two types of practices: *relations-focused* and *transactions-focused*. In the first instance, research communication is enabled through establishment of potential through various relations between researchers, the BEKT professionals and businesses. Transaction-focused processes involve research findings being utilised as tradable products and are geared towards licensing and intellectual property transactions. Thus, research is communicated in variety different

formats (expertise, knowledge, research findings) across a number of socio-spatial contexts through the mediation of the BEKT boundary space.

6.5 Science Outreach as a Trading Zone

Another boundary space that is situated within the case study university focuses on 'science outreach'. 'Outreach' is perceived as important to a democratic society and the economy (Boyer 1996; Kezar 2000). Its importance has been framed, for example, in the context of the general decline of students pursuing science and engineering degrees (Cech 2013). To address this challenge for society, the aim of science outreach has become to inspire, inform and address public understanding issues amongst various publics, especially school children, with the longer term view of encouraging them to work in science and technology. Consequently, there has been a 'shift in gears' (Saab 2010) amongst the scientific community in order to address the perceived disconnect (a 'gap') that exists between academic scientists and public. Accordingly 'science outreach' definitions, rationales and best practices are growing (Merenstein *et al*. 2001). Science outreach "may include tutoring, mentoring, giving presentations or facilitating inquiry, supporting teachers, judging science fairs, developing resources and curricula, interacting with children or teachers in summer or after-school programs, and so forth" (Andrews *et al.* 2005, p.281). This definition focuses primarily focuses on two audiences: children and teachers within the context of a number of activities with a strong connection to education. 'Science Outreach' does not have to be limited to particular audiences or specific activities. Johnson *et al.* (2014) defines science outreach as "any activity such as public lectures, interactive forums, or popular press articles in which scientists communicate their research or broader scientific concepts to those outside the scientific community" (p. 82). Within this definition the audience is larger and more amorphous, as individuals are characterised as those who are 'outside the scientific community'. These definitions of 'science outreach' begin to provide an example of the diversity of activities that can be grouped under this label, whilst also continuing to emphasize the blurred boundaries between activities under different titles such as 'outreach', 'public engagement', and 'science communication'.

6.5.1 Creating a Trading Zone

The formation of the science outreach trading zone can be a facilitated process. The university science outreach team act as facilitators between the university researchers and publics (e.g., school children, teachers, adults, etc.). This role of the science outreach team is explained in the following quote,

> *...we are facilitators. I hate that expression, but we are, on some level. We offer opportunities to the guys around this university to engage with the public in science 'outreachy' activities; be it in schools or ... science festivals, or whatever.* (Senior Outreach Officer, 2013).

Science outreach performs the role of a 'facbilitator' by bringing scientists and publics (e.g., general public, school children) together. In particular, the science outreach body offers researchers opportunities for engagement with non-academic groups. These opportunities are coordinated and provided either through the central outreach office or via the 'outreach ambassadors' in the departments (as mentioned above). For example, a large event such as a science fair is coordinated through the central outreach office whereas a particular researcher's visit to a school can be facilitated through an appropriate representative within their department. However, it is notable that outreach activities such as giving talks in schools and carrying out smaller scale engagement events (e.g., demonstrations) are also carried out by the science outreach staff in parallel to the activities facilitated for researchers within the university. Therefore, professionals working in the science outreach boundary zone occupy a dual role – a role as a facilitator of engagement between researchers and publics (especially school children) and a role as a science communicators. The duality of roles occupied by the professionals of the science outreach boundary space is indicative of the hybrid identity adopted by this space which requires both an external and an internal orientation. The activities that they have carried out and the recruitment of staff to take part in these activities have mobilized the emergence of a group of researchers who actively engage in science outreach (to school children). In the words of the interviewee below, these researchers are referred to as the 'coalition of the willing'.

> *....we always find that there are…a coalition of people who will come forward. And I'm sure you know the names and they'll say, 'Yep. I'd love to do that.' And they'll come and do it. And we're happy with that up until now because most of those people who come along are very good. They do it for the right reasons. They want to talk to kids about science because they're interested in explaining their science to children.* (Senior Outreach Officer, 2013)

The above quote suggests that the emergence of the coalition of the willing is contingent on two factors: communicative expertise (interactional expertise) and motivations. Interactional expertise is required in order to communicate with children. In terms of communicative expertise, reference is made to interactional expertise. In particular, the expertise required is for interaction with children (school children). Moreover, researchers must have the 'right' motivations. Their motivation for enrolment in the 'trading zone' is to communicate 'knowledge' about 'their science' to the children. Thus for the researcher the benefits are largely 'intrinsic', in terms of satisfaction gained from contributing to wider society, rather than 'instrumental' in generating a more 'material' or 'strategic' reward for the researcher. However, the interaction does contribute to the researcher's acquisition

of tacit knowledge which further boosts their levels of interactional expertise. Previous research has demonstrated that, for researchers, a number of motivations encourage them to engage, such as the improvement of public understanding, awareness, enthusiasm and interest (Martin Sempere et al 2008; Poliakoff & Webb 2007; Royal Society 2006; Tsfati *et al* 2011; Watermeyer 2012a). The quote referred to the 'coalition of the willing' constructs a particular imaginary of a rather specific type of researcher who engages beyond academia (someone in possession of a degree of interactional expertise and the 'right' motivations) promoted through the science outreach-facilitated trading zone. In contrast, others who might be willing may not be seen to have the necessary expertise to engage with children, as suggested in the next quote.

> *[Male Name] for example. I know [Male Name] reasonably well enough. Yeah, he can wing that [presenting in front of school children without preparation]. He can get away with that. There are other people around the place, who if they said to me, 'I'm going to a primary school,' I would have done my damnedest to say, 'Do you know what? Perhaps that's not such a great idea.' But ultimately, you know, what can I do? There are some people who'd be great talking in front of six form groups, but put them in front ten year olds and it would just be horrendous for both parties. (*Senior Outreach Office, 2013)

This quote underlines the importance of acquired interactional expertise through experience in presenting to children or 'natural talent' (Feist 2013) for this form of engagement. Other researchers are not equipped to function in this trading zone as they do not fit this imaginary. The broader point that is made in this quote relates to the notion that the 'effectiveness' of an engagement event is contingent on the construction of the social space and the way the researcher is able to interact with others in that specific space. Some researchers lacking the necessary interactional capacity may be unsuitable to engage with a particular audience in a given social space, just as some research is unsuitable to be communicated to certain audiences. The science outreach staff are seen as qualified to assess the relevant capacities of the researchers. This highlights a process of standardization of science outreach activities, their scientific content and their connection to the ongoing academic research. Consequently, this trading zone for research communication by means of outreach, is seen as a homogenised field of practice aimed at a particular audience and either run by science communication practitioners themselves or an exclusive group of researchers comprising the 'coalition of the willing' representing a standardized imaginary of a scientist. This, in principle, excludes from this research communication space researchers who are unwilling or unable to participate in science outreach activities, although it is evident from the quote above that some of the researchers who do engage are not, in fact, adequately trained to do so.

6.5.2 Science Outreach as an Interactional Expertise Trading Zone

In light of Collins' (2007) typology, science outreach, as constituted within the case study university, can be described as 'fractionated trading zone', particularly an interactional expertise trading zone where mediation is largely based on language and styles of self-expression, in the absence of a boundary object to facilitate the engagement process.

Science outreach officers are not only involved in the coordination of activities in which researchers from the university participate, they also conduct science outreach activities themselves. These officers have mastered the tacit knowledge and the language associated with science outreach in order to become skilled practitioners of science communication. The science officers were academics themselves, trained to Ph.D. level, with the senior science outreach officer having worked in a post-doctoral academic capacity. This experience gives them 'interactional expertise' required to deal with academics from the university as well as the audiences of science outreach.

The participants in this trading zone include various publics (usually school children, adults and occasionally teachers), researchers, university and science. Effective communication is seen to lead to positive outcomes (gains) for participants in this trading zone, including benefits for particular public(s), outcome for science and outcome for researcher, summarised in Table 6.2.

For the young people and the school teachers, new knowledge and continuing professional development were identified as likely gains.

> *I think ... in terms of the schools, it's a really good thing because if we can bring cutting edge science into them, because then we can make it relevant and exciting for the young people in ways that teachers themselves do not have experience of.* (Science Outreach Coordinator, 2013)

For the university participants, most of the gains described seemed to be 'intrinsic', 'emotional' benefits bringing satisfaction and a sense of making a positive contribution in society, rather than instrumental benefits that reap obvious rewards for the researcher, although recruitment of students to the university at a later stage seemed to be among the institutional benefits.

Actant	**Gain**	**Example Quote**
Publics (general public; students)	Excitement Interest Inspiration Scientific Literacy (Basic science; role of science in society) Knowledge (leading edge	About School's Science Festival "…stimulate interest…"

	developments, research, thinking in field) Encouragement – science as career	
Researchers	Interactional expertise Transferrable skills – presentation and communication skills in science Knowledge – developments in school science Doing something out side of 'normal work' Enactment of role – ambassador for science,	
University	Publicity (Promotion of science [teaching & research]; university in community) Recruitment Widening participation Financial	About annual Science Festival - "...to promote its science, both teaching and research, to a general audience through engaging outreach activities. The aim is to stimulate interest in science and to inspire young people to study science in the future, while putting the University at the heart of a fun community event." (Science Outreach Website 2014)
Students (3rd year undergrads)	Interactional expertise – working with schools Communication / Presentation – explaining concepts at an appropriate level Knowledge – relevant elements of National Curriculum and its associated terminology	About 'Science into Schools – "A primary aim of the module is to develop a range of key skills in the student and to offer an early taste of teaching science to those interested in pursuing it as a career or for other career pathways where public understanding of science is required."
Students (PhD Students)	Interactional expertise – working with schools (working with teachers, students) Knowledge – role of science and society; Knowledge – developments in school science	About Science Teaching Consultants – "…develop their key transferable skills and a greater appreciation for their own research in a wider context…"
Teachers	New methods to use in teaching students New resources New after school clubs New Field trips Greater confidence in science teaching	About Science Teaching Consultants – "…The research students spend one year half-time supporting the teaching of science in the school, while spending the remainder of their time continuing with their research…"
Science	Increased participation in science Increase profile in schools Increased acknowledgement of importance of science in world Reframed as fun	About School's Science Festival "…encourage wider participation in science…"

Table 6.2 - Summary of some of the ways that benefits from outreach activities were expressed by participants in this study.

Whilst the focus of science outreach is on the audience, the actors who usually carry out the activities, researchers, do also gain from participating in the activity. On the most basic level, science outreach represents an opportunity to have a 'change from their normal work'. The implication here is that doing outreach is not part of the role of being a scientist. Therefore, to do outreach is to enact a hybrid role, as a 'positive role model for future scientists' and an 'ambassador for their science', as well as a university academic. Grounded in this idea is another benefit of science outreach for the researcher, which is suggested to be the development of transferrable skills such as communication and presentation skills. Whilst the science outreach website particularly emphasizes the importance of this for postgraduate researchers, it is equally relevant to members of the academic staff. In addition to the acquisition of interactional expertise, researchers may acquire domain-specific interactional expertise and new knowledge including information about developments in school science (suggesting ways to address a knowledge deficit) and new roles (through the 'science teaching consultants' scheme, for example).

Engagement with society through science outreach may also lead to gains for the university that include: profile raising, student enrolment, widening participation and financial income. In the first instance, science outreach enables the promotion of university science, both in terms of teaching and research. Moreover, science outreach events also enable the university to demonstrate its connection to the local community. Encouraging and nurturing the enthusiasm for science may lead students to pursue a scientific career via a science degree at the university. These students may be drawn from the groups who expect to attend the university, or they may be drawn from groups that are traditionally underrepresented at the university. Thus, science outreach contributes to student recruitment and the widening of participation. Since students pay tuition fees, greater student enrolment means generation of additional income for the university. Moreover, the university receives a (socially limited) level of publicity for the university through their science outreach.

In this context, intrinsic benefits of science communication (science outreach as a greater good) may seem to be at issue, as well as other more instrumental institutional objectives such as recruitment and the widening participation agenda. These objectives appear to have generated a sense of tension in the science outreach space, as reflected in the following exchange:

> **[Senior Engagement Officer]** *And we're not about recruitment. That's another key message. It's about people. And we're not about recruitment. Those are the two mantras. Because we have our whole office that's about widening participation, student access and recruitment office. That's what they do. And we're not about recruitment. We are about getting the audience, whoever that audience be, enthused about science; inspired, excited, informed, whatever, all these 'i' words.*

[Engagement Officer] *Engaged.*

[Senior Engagement Officer] *Engaged. All the good words. It sounds cynical but I think, we both feel it's about what it is. We're about engaging. We're about inspiring.*

[Engagement Officer] *It's a very different message as well.*

[Senior Engagement Officer] *It is. Definitely. We don't sell [Case Study University] per se. We just sell the science. Our science and other people's science too actually, you know. It's about the science. It's taken me a long time to get that message clear, I think, with my committee and what not, my management people. And it's still not liked. And I still get told...*

[Boris Popov] *Do they want more recruitment?*

[Senior Engagement Officer] *Well, you see, as an adjunct to that, it's not about recruitment but it does have an impact. There are students in this department, and I'm sure across other departments, who are here because of a talk they've had from somebody, or something they've seen on the web, or a project or a summer school they've come to that's an outreach organised one, not a widening participation one, who are here. I can reel off names actually. So it does have an effect. But that's not our prime motivation. But it's not to say it doesn't have an effect. Of course, it does. It does, and we can back that up with numbers. That's not why we do it. It's really not why we do it.*

The foregoing exchange demonstrates a degree of incommensurability between the motivations of the science outreach staff and the science outreach management committee (i.e., the university), which is grounded in the differing perspectives of the two sides in regards to the gains to be made from science outreach. This atmosphere of tension created between science outreach officers and the management suggests that the formation of a 'trading zone within a trading zone', with participants working with different paradigms regarding the intended aims of science outreach. The 'problem of communication' is addressed through acknowledgement by science outreach officers that science outreach events do, in fact, contribute to recruitment without this overtly being the main aim of the activities.

'Science' is also seen to benefit from science outreach. In broad terms, science outreach activities can contribute to raising the profile of science in schools. This is especially the case for disciplines that are practiced by researchers who choose to engage in science festivals or participate in the teaching consultant scheme. This may involve science being re-framed 'socially' rather than 'academically' as a 'fun' activity rather than something that is practiced by 'reclusive people in white lab coats'. Also this process highlights the real importance of science in the modern world (in other words, it addresses the 'science-in-society' deficit). The ultimate goal of such initiatives is to increase participation of school children in science, which, in turn, may lead to students pursuing a scientific career, ensuring the future viability of the scientific work force to maintain the research effort, advancing the scientific body of knowledge and contributing to progress of knowledge. It also sees science being reconstructed socially rather than institutionally by the university.

6.5.3 Conclusion

Science outreach functions as a trading zone based largely on interactional expertise. This is in contrast to the communications trading zone and the BEKT trading zone which both function as fractionated trading zones, grounded in interactional expertise and boundary objects. However, as demonstrated above, the science outreach officers are facing internal pressure from the university to modify the basis of this trading zone and to incorporate an orientation towards transactions-focused practices rather than maintaining a relations-focused practice. This speaks to the role of institutional factors in mediating the research communication process via the boundary spaces, and suggests that the university is attempting to reformulate the identity of the science outreach trading zone to be more in parallel with the other two trading zones that I have discussed earlier in this chapter.

6.6 Conclusion

The trading zone between researchers and can operate through institutional (university) mediation through three types of boundary spaces: communications office, business engagement/knowledge transfer (BEKT) and science outreach. In the preceding discussion, I have demonstrated how the communications office and BEKT trading zones both operate through relations-focused and transactions-focused practices for research communication. In contrast, science outreach operates primarily through a relations-focused approach, whilst being subjected to organisational pressures to develop a more dual approach that is consistent with the other two trading zones. The practices that are facilitated and enabled by these boundary spaces contribute to an atmosphere of engagement within the university that exists in a liminal state. The emergence and maintenance of an atmosphere in a liminal state is reflective of the boundary spaces attempting to negotiate a hybrid identity. Overall, this raises the questions about the purpose of these spaces and their role in research communication. More broadly, this chapter has raised some fundamental questions concerning the purposes of science communication in wider society. Is the purpose of science communication to be relations-focused or transactions-focused activity? In the next chapter (Chapter 6), I explore how the trading zones will potentially be affected by the introduction in the latest instalment of academic research assessment in the UK, Research Excellence Framework (REF), the 'impact' component which assesses the 'societal impact' of academic research.

7 Chapter 7: Conceptualizing Research Evaluation Framework (REF) Impact as a Trading Zone

7.1 Introduction

In the U.K., the 1980s saw a decline in availability of public funds. For science, this meant the necessity for the introduction of mechanisms to carry out audits of its accomplishment through internal assessment (commonly referred to as peer review). The focus of this assessment was maintained within academia – evaluation was conducted in regards to an 'impact' on scientific knowledge and academia more broadly. The assumption within this assessment of science was that the benefits derived from research went back into science conducted at the highest level (Bornmann 2013). However, since the 1990s, there has been a transition away from blindly trusting this assumption towards the necessity for provision of evidence in order to demonstrate the value of science in society (Bornmann 2013, Martin 2011). These trends have manifested themselves in the development of national research evaluation systems. The most widely known national research evaluation system has been implemented in the United Kingdom, the Research Assessment Exercise (RAE), since the 1980s.The evaluation determines the best quality research and the corresponding allocation of funding. In the 1990s, "the scope of research evaluations becomes broader as the societal products (outputs), societal use (societal references) and societal benefits (changes in society) of research come into scope" (Bornmann 2013, p. 217). In 2014, the economic and societal impact of research featured for the very first time as a substantial component (20% of all assessable units) of the U.K. academic researchers' assessment under the bracketing of 'impact' within the newly minted successor to the RAE, the Research Excellence Framework (REF). 'Impact' is the focus of this chapter.

Building on the themes developed in the previous empirical chapters, 'impact' is considered through the lens of a 'trading zone'. The fundamental idea of the 'impact trading zone' is that in return for the public money and recognition that is given to universities, through research grants and through non-specific research funds allocated to academic institutions, various groups of actors in wider society will benefit from 'impacts' of the research. This trading zone has therefore come to represent one of the main justifications for public support for university research and the role of communication of research to realise these impacts is crucial to the operation of the trading zone. In order to understand how this trading zone is to operate, we first consider how 'research impact' was constructed by the interviewed researchers. This allows for developing a construction of what is traded in these zones and the gains from the trade for the various actors involved. Consequently,

the chapter investigates the issues concerning impact identification confirmation (challenges in impact evaluation). My research suggests a much narrower interpretation of engagement beyond academia than demonstrated by the engagement practices outlined in the previous chapters, thereby implying a much narrower trading zone.

Grounded in the foregoing information, and with reference to the previous chapters in terms of multiplicity of engagement practices and the lack of overall public engagement culture in the academic circles, I argue that the introduction of the 'impact agenda' may result in what I term as a 'funnel effect' whereby framing impact in terms of particular forms of engagement may result in unequal value being allotted to various forms of engagement beyond academia. In particular, researchers' interpretations of what impact is, suggests that engagement with government, policy and policymakers as well as industry will receive prioritization thereby narrowing the trading zone in terms of stakeholders, practices and gains. Furthermore, occurrence of this process would contribute to the homogenization of the science-society space. However, the findings from my research also reflected the recognition by my interviewees that there are a number of challenges and uncertainties involved in this form of 'trade' of research knowledge. It is difficult to predict what the impacts of research will be and particularly whether the returns in terms of demonstrable impact will take the form that universities are seeking. This alludes to forces that aim to keep the more informal trading zones described earlier.

I therefore suggest that actors in universities may need to work on reframing of engagement. I argue that in order to facilitate the permanent integration of engagement beyond academia there will need to be a change of 'affect' within scientific academic circles (creating an atmosphere of engagement and increasing the engagement identity salience within the academic self). This new frame should highlight public engagement as a way of mobilizing and articulating impact (Watermeyer 2012b). This approach shifts the focus away from the currently rather polarised atmosphere generated by a narrow range of forms of exchange that have been viewed as relevant for generating 'impact'. It emphasizes the importance of a range of diverse forms of engagement between researchers and various publics which lead to generation of societal impact

7.2 Trading Zone - What is 'Impact'?

Within the trading zone created under the 'impact agenda', the gains from exchanges for society (various publics) as a result of engagement with academic researchers can be grouped under the broad umbrella of 'societal impact of research'. There is no single definition of what exactly 'societal impact of research' is (Grant *et al*. 2009, Penfield *et* al. 2014, Russell Group 2009). Numerous concepts have been introduced to provide an encompassing terminology. These include

'third stream activities' (Molas-Gallart *et al*. 2002), 'societal quality' (van der Meulen & Rip 2000), 'social relevance' (Evaluating Research in Context [ERiC] 2010; Holbrook & Frodeman 2011), usefulness (Department of Education and Science Training 2005), public values (Bozeman & Sarewitz 2011), knowledge transfer (van Vught & Ziegele 2011). All of these conceptualizations are underpinned by the idea of assessment of economic, social, cultural and environmental returns, whether they are in the form of products or ideas (Bornmann 2012; Bornmann 2013). 'Societal', 'cultural', 'environmental' or 'economic' benefits' contribute respectively and in combination to the social, cultural, natural or economic 'capital' of a nation. For example, societal impact of research may permeate various spheres such as policy, professional practice, business or have wider impacts (e.g., on culture, media, community) and consequently may materialize in a number of forms such as jobs, education, networking building, trust, community formation. Across a number of countries (e.g., Australia, USA, New Zealand, etc.), attempts have been made to introduce appropriate mechanisms in order to 'evaluate' the impact of academic research on society. In the U.K., 'impact' emerged initially at the level of Research Councils and REF in its most prominent form within the newest incarnation of a process for evaluation of academic research, Research Excellence Framework (REF).

Research Councils U.K. definition of 'impact' breaks down impact into two explicit components: academic impact and economic and societal impact. Academic impact is defined as "demonstrable contribution that excellent research makes to academic advances, across and within disciplines, including significant advances in understanding, methods, theory and application" (RCUK 2013, n.p.). Additionally, economic and societal impact is defined as the:

> "demonstrable contribution that excellent research makes to society and the economy. Impact embraces all the extremely diverse ways in which research-related knowledge and skills benefit individuals, organizations and nations by: fostering global economic performance and specifically the economic competitiveness of the United Kingdom; increasing the effectiveness of public services and policy; enhancing quality of life, health and creative output" (RCUK 2013, n.p.).

This definition of 'impact' provides one characterisation of research communication. Research is communicated in a variety of forms, such as 'research-related knowledge' and expertise in the form of 'skills'. The process of communication can occur at a spectrum of levels from the micro to the macro: individual, organisations and nations. This indicates that research communication is a process that occurs across numerous socio-spatial contexts, which leads to a number of envisioned outcomes. These outcomes are also variable and will occur across a number of contexts in isolated or integrated forms. However, these outcomes must occur in such as a manner as to be 'demonstrable' through an appropriate method (the definition leaves this to interpretation and

therefore allows for envisioning of a spectrum of methods for demonstration of impact. In academia, case study is considered 'state of the art' (Donovan 2011) method for demonstrating societal impact of research). Therefore, here the process of research communication is implicitly coupled with research adoption/utilisation leading to impact.

The U.K. Higher Education Funding Council (HEFCE) has also developed its own definition of 'impact' for the purposes of the REF. Within the **c**ontext of the REF**,** impact is defined as "an effect on, change or benefit to the economy, society, culture, public policy or services, health, the environment or quality of life, beyond academia,"[83] (Higher Education Funding Council for England, 2011). In contrast to the RCUK definition, the HEFCE definition primarily focuses on the outcomes of the research communication process thereby also adopting the implicit coupling of research communication and research adoption/utilisation. However, the definition implicitly conveys similar ideas about the process of research communication. Research is communicated in a number of forms across a number of multi-scalar socio-spatial contexts leading to a variety of outcomes ('impacts') which ideally are demonstrable.

Due to the ubiquitous nature of the impact agenda within the academic sector in the U.K., it emerged as a prominent topic during the interviews. Every single interview eventually veered towards a discussion of 'impact' and the REF more generally in some capacity further acknowledging the presence of an 'atmosphere of engagement' which was described in Chapter 4. The broad nature of impact was also acknowledged by most of the interviewed researchers. The following quote reflects the potential broad nature of impact.

> *…impact itself is defined very broadly. It's basically the impact beyond academia. So that's a very broad definition. It's an effect or a common good beyond universities…* (Physical Geographer 4, 2012)

The above quote reflects the amorphous associated with the nature of impact as found amongst the interviewed researchers. However, the interviews did reveal three prominent understandings of what 'impact' is amongst the interviewed researchers. Impact was understood to be 'gains for society' in terms of**: products; knowledge use; and social benefit**.

Some of the scientists I interviewed discussed how 'societal impact' was embodied in a 'product' that may be used by publics to whom research communication is directed. This category can incorporate the different ways that knowledge is converted by society into 'products' - tools,

[83] For the purposes of impact in the context of REF: "a) Impacts on research or the advancement of academic knowledge within the higher education sector (whether in the U.K. or internationally) are *excluded*; b) impacts on students, teaching or other activities within the submitting HEI are *excluded*; c) Other impacts within the higher education sector, including on teaching or students, are *included* where they extend significantly beyond the submitting HEI" (p.40).]

processes, technologies, techniques and applications. The following quote is a representative example of researchers that did mention this category of societal impact.

> *…this impact is tricky as well unless you're doing stuff that's getting wound into products or processes.* (Computer Scientist 1, 2012)

For example, talking about 'impact' in terms of technology can be developed commercially from patented ideas originating in research conducted at the university.

> *I have a colleague, who, you know, we're looking for impact statements now for the REF, and he's done stuff that has resulted in patents that have been turned into technology that's gone everywhere.* (Computer Scientist 1, 2012)

The above quote alludes to the notion of scientific knowledge as a 'raw commodity', which can then be converted into new products. Moreover, the above quote, also points to the conditionality that in order for impact to begin to emerge knowledge must be appropriated from a form that makes it useable / tradable. One condition for establishing 'usability' is that it must be grounded in sound science. Scientific basis forms the backbone for the materialisation of knowledge in its various product formats. This is indicated in the next quote.

> *…you've got to be developing things which are useful to people, which open the doors which lead to impact. But behind those tools has got to be the solid science.* (Physical Geographer 5, 2012)

The conversion of scientific knowledge into technological products (materialization) is one example of a process of research communication (knowledge transfer) as a result of which various public stakeholders may ultimately take up research knowledge for use outside academia. More generally, impact can manifest itself through occurrence of some sort of 'change'.

> *Impact is actually [research] which affects some kind of change. So you know, it's something that one can actually say, 'I've changed X and Y'.* (Archaeologist 3, 2013)

These potential changes can occur in a variety of publics (both publics-in-general and publics-in-particular). Groups of publics that were identified by the interviewed researchers included: government (e.g., policymakers), industry (e.g., hydrocarbons industry, mineral industry), third sector (e.g., community groups) and the broader ('general') public. The interviewees broadly indicated that there can be numerous outcomes as a result of knowledge use: **acquisition of new knowledge or changes in previous knowledge in individuals** (and groups of individuals), **changes in practices** (both at the management and individual [employee] levels within organizations), **policy changes** (at governmental levels, industry levels).

Across the interviews, industry engagement was cited as one of the most prominent routes to attainment of impact (the other being policy change). Its desirability is grounded in the perceived

linear nature of the path from research to impact. The linearity refers to the pattern that there is traceable route from research, through publication of results, to the manufacturing and the subsequent sale of the item and the benefit that it provides. Each step in the sequence can be isolated as well as characterized (e.g., quantified) as part of an economic process.

> *… impact for REF at the moment is based on… an industrial spin out model; the idea that there is a discovery that leads to an economic impact. Yep. Now that's one case where you can probably say, 'Well actually it was that paper that lead to this company being created or this patent being filed, or whatever. Yeah, that's impact'* (Physical Geographer 4, 2013)

This model disregards the more contextually nuanced nature of knowledge transfer as a part of this process and its subsequent adoption and utilization. Implicit in this suggestion is the notion that research can also reach impact through a linear process where impact is not necessarily easily quantifiable.

In addition to the industry/business sector, two other groups of non-industrial stakeholders are viewed as desirable publics for targeted communication with the view to generating impact: governments and/or Non-Governmental Organizations (NGOs). In relation to these target audiences, impact as change can be envisioned as a change in policy or managerial or professional practices. The following examples are reflective of these types of impact described during the interviews.

> *… 'impact' is…. changing government policy. You know, changing the way things are done.* (Physical Geographer 2, 2012)

> *My understanding is, what they're after* [for the REF] *is contributions outside of pure academic pursuits that can be demonstrated in terms of a policy change, a government policy change or industry policy change or change in management and practice.* (Physical Geographer 6, 2013)

> *We can actually point* [to evidence of impact]*; we developed this technique here, published in this paper here. It is now used by these following companies. And I think the game plan is, we're actually asking the companies to partly write the impact response because they can actually say, 'This paper has had the following impact in...Or this research has had the following impact in the way we do our business.'* (Earth Scientist 1, 2013)

Whilst the foregoing quotes referred to 'impact' at the broader organisational level, social impact in organizations can also be viewed as occurring at the level of individual practice. For example, through consultancy, new knowledge can be acquired that may allow advancement of current work that have been stalled. An example of this is when industry drafts in academic scientists as consultants in order to provide alternative perspectives, based on their expertise, in fields of research that those companies are undertaking. While in the broader sense, the academic consultants are dealing with the company, in a more practical sense, they usually deal with the individual research analysts who are tasked with working out the issue/problem and resolving it (and

sometimes with their managers). In their interaction with the research analysts, academics provide knowledge (in the form of expertise) thereby allowing research analysts to better address the research in question, advancing the work of the company and their commercial projects. This example is a demonstration of knowledge transfer in the more amorphous form of *expertise (*in this case it is specialist expertise*)*, which is traded for a consultancy fee. This knowledge is then potentially adopted at the level of individual practice and can potentially be translated into action more widely within the organisation and beyond.

Societal impact of research can also occur beyond the boundaries of specific organizations. Within the context of a broader society, which is greater and more amorphous, impact in the form of change occurs which is beyond characterisation through economic quantification. As a result, for research areas such as in archaeology, demonstration of societal impact in terms of economic returns is difficult, if not impossible. This is elaborated upon in the following quote.

> *… the sort of things that we do, in terms of informing the public … how the past was lived by different societies; that can have an important esoteric heritage impact to a local group, whatever the size of the group is. It can be on a national level. It can be on a very small local level. But how that translates into … what impact is really about … economics, is very hard to demonstrate. And how can you demonstrate policy change with something like identity; national identity? These are very interesting theoretical concepts. But they're also very tricky to translate into the economics that the government wants*. (Archaeologist 1, 2012)

The above quote provides an example which juxtaposes the more ephemeral nature of impact that is hard to quantify versus the paradigm where impact is understood in terms of economic returns (and maybe policy change). Moving away from the economic model, the quote emphasizes the amorphous nature of impact and its potential to occur at multiple scales across various socio-spatial configurations (in small, local spaces or in large national spaces amidst a vast number of publics). However, in this example, we see that there is an issue of translatability of the perceived social impacts into the 'valid currency' for the impact case studies required for REF by HEFCE. The U.K. government seeks evidence that the money invested in research is of value for society and contributes to the U.K., and commercial or social benefits that can be quantified (especially in economic terms). For some research areas, including work in fields such as archaeology (or geography for example), translating societal research impact in terms of identifiable (and ideally measurable) 'commodities', such as commercial products or changes in practice clearly attributable to specific research, represents an obstacle. For example, in the next quote, knowledge use may lead to changing people's thinking.

> *You have got to demonstrate that you've had impact and changed people's thinking. So it's not just showing stuff, it's actually measuring in some way that you've changed the way they think.* (Computer Scientist 2, 2013)

The foregoing quote hints at another format of research communication that is not identical with knowledge transfer for the purposes of research commercialization. Research can also be communicated in yet another form for the purposes where impact is not necessarily an economic outcome nor a change, but something that is somewhat broader, '**societal benefit'**. Societal impact as social benefits refers to the effects of the use of research results. This notion can incorporate a number of avenues of impacts and can focus on policy, professional practice, business or impacts on culture, media and the community. These gains can be characterized as both intrinsic or/instrumental in terms of their value to society. The appropriate characterization will strongly depend on the particular context. In the most ideal case, 'societal benefits' are achieved through balanced involvement of parties in the research process; ideally, through co-production. The quote below highlights a situation where two way exchange over a prolonged (which evolved into a co-production) period of time leads to benefits to society and to the engaging academics.

> *… you try and do things which will benefit the community and benefit your understanding of what the community needs. If you understand their problems better, when you come to write the next grant application, you target more on what's actually needed. Your letters of support [when bidding for grants] are far more genuine because you've engaged with them over a long time and they know what they need, which then helps to get the research grant.* (Physical Geographer 5, 2013)

The foregoing quote is an example of knowledge exchange between the community and academics. For academic scientists, engagement with the community taps into local knowledge (or 'contextual' knowledge) that then informs the development of a grant in such a manner that it addresses the broader institutional requirements of socially relevant research. In other words, research becomes more 'socially robust' (Nowotny *et al.* 2001), through the integration of engagement with non-academic communities. In turn, for the community, engagement with academic scientists allows the community to address its need (for example, this may be a deficit of knowledge) and affect the research process. Therefore, through closer engagement between the academic and the non-academic stakeholders, the supposed 'gap' between the two social worlds (is if only for the duration of the project) closed, and both communities benefit from the interaction.

In summary, this section explored the broad notion of societal impact of academic research. Achievement of impact is strongly contingent on the interactions between the parties thereby highlighting the importance of the interaction between them and therefore the communication process within the context of engagement. In order for impact to occur, research must be

communicated in a variety of formats that can then be adopted and used by appropriate publics. Lack of an appropriate format undermines the effectiveness of the communication process. This is further amplified by the fact that research travels in its various formats across a complex range of socio-spatial contexts, which may render the initial format different or facilitate its conversion into new forms. Not all these formats can be subject to further materialization through identifiable or quantifiable 'instrumental' outcomes in terms of changes in practice.

However, as the previously presented quotes from the interviewees began to indicate, the REF impact process generates a particular trading zone involving three groups of partners; academic researchers, the publics they engage with and the government. Here the 'valid currencies' are forms of research knowledge and communication which can be converted into activities by research users who gain in terms of advantageous practical (e.g., policy change) or commercial outcomes (e.g., commercializable technologies), and which academics 'trade' in exchange for evidence of these impacts which are valued for REF impact case studies. Here knowledge exchange is expressed in very instrumental terms. This raises further questions about the actual characterisation of the trading zone: What forms of communication are allowed and what format is the research communicated in? These questions are explored further in the next section in order to advance the argument that despite the broad definition of impact adopted in the REF, the interviewees' understandings of what impact is and what is required for the REF, ultimately, narrows the trading zone in terms of actors, engagement formats and impact outcomes, whilst also reconstituting the role of academics.

7.3 What cannot be traded in the impact Trading Zone?

The new dynamics within the REF trading zone discussed above focuses activity on some types of research at the expense of others thereby reconstituting the boundaries of the 'engagement trading zone' (ETZ). In particular, these boundaries are seen to be reconstituted in relation to research types and some types of research communication were seen to be 'devalued' in the trading zone (pure, and blue skies research as compared with applied research, and broader engagement and outreach activity beyond academia.

7.3.1 Different 'valuation' of communication of 'Applied' versus 'Pure' research

The impact agenda in broader terms is about connecting academia and society. The aim is to stimulate increased production of 'socially robust research' (Nowotny *et al.* 2001). Among the interviewees, one of the outcomes of the impact agenda was suggested to be a change in the

relationship between applied[84] and pure (basic) research[85]; and in particular, the relative value given to each amongst the researchers within the context of an atmosphere of engagement that was not dominated by impact. The resulting dilemma facing researchers concerning which side to veer towards is encapsulated in the following quote.

> *You get some academics that are only interested in publishing in journals, doing work which may or may not have any kind of practical relevance. And if for some reason, it doesn't have any practical relevance then sometimes it's more difficult to sell that to the public. And then again, you get to where I've been to on many occasion, where it has a lot of practical relevance, but then it's difficult to sell to the research community. But then, if they want impact, somewhere there's got to be a middle ground because if it has to be rigorously theoretical and completely inaccessible but scientifically great, but no one can actually use it, how you going to show impact?* (Computer Scientist 1, 2012)

Computer Scientist 1 eloquently summarises the dilemma that many researchers have faced in the past. Implicit in this dilemma is the search for balance – how to do research that is academically rigorous and valued scientifically but also societally accessible and relevant. How does research become a tradable commodity in multiple trading zones (scientific and public)? This question speaks directly to the appropriateness of the format in which research is communicated within each trading zone. Ultimately, several interviewees stressed that there is a need to maintain a balance between applied and pure research. The following set of quotes is indicative of this position amongst the researchers.

> *I think we need to acknowledge that there is some pure research that is not going to be applied. I wouldn't want to see that not happen. I don't want to make the distinction that one is better or the other.* (Physical Geographer 1, 2012)
>
> *I don't think it should ever have happened actually to get people who've become so pure [in their research work]...* (Physicist 1, 2013)
>
> *You can't get too far divorced from the real world. And I think there was a tendency where that sort of thing started to happen. And you need a balance between the two things.* (Physicist 1, 2013)

Whilst a balance of the two types of research is ideally desirable, this distribution varies considerably depending on the discipline. More broadly, the call for balance between the two types of research implicitly suggests that there is a case to be made to be for maintaining a degree of separation between science and society. In other words, some research is meant to remain in the scientific trading zone and is therefore not suitable for broader communication.

[84] Organisation for Economic Co-Operation and Development (OECD) defines 'applied research' as an "original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective."(OECD 2013a).

[85] Organisation for Economic Co-Operation and Development (OECD) defines 'basic research' as an "experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view" (OECD 2013b)

Ultimately, the question of having a balance between the two types of research invariably connects to the issue of what 'we' (as a society) want the researchers to do. What is the role of an academic researcher? As previously indicated in the above quotes, some researchers positioned their roles substantially towards the 'pure' side of the research spectrum.

> *But again, it depends on what you want academics to do, what you want them to be there for. Are they there for a range of things or are they there to solve a range of practical issues but at the same time they're there to advance knowledge of society. What are we saying here? We're going to remove the latter so we all become just teachers of techniques and practices? That to me seems to be anti-intellectual.* (Physical Geographer 6, 2013)

The above quote suggests that the impact agenda can be understood as the redefinition of the expectations that are associated with being an academic scientist In other words, this is construed as a redefinition of an academic role. For the interviewed researcher, this attempt may be viewed as 'anti-intellectual'. More broadly, this is indicative of the 'atmosphere of engagement' resulting in potential change to the academic culture. For example, this can be indicated through the changing perceptions within the academic trading zone, as exemplified in the next set of quotes.

> *…for a very long time within universities, definitely [in the] U.K., it might be broader than that; …the pure science held very much higher sway because they went into the pure, high impact science journals.* (Physicist 1, 2013)

> *Very often, the sort of physics that I do is looked at as being 'dirty'. It's very applied. Whereas the particle physicists and the theoretical cosmologists, they do 'nice' physics. It's clean. It's on a different level. And, there was undoubtedly in many physics departments (I think the same is also true within chemistry and engineering) …"this theoretical bit and there is this dirty bit".* (Physicist 1, 2013)

> *But there also needs to be mutual respect and perhaps that is the crucial bit that is beginning to change. I said slightly flippantly that what I did was 'dirty physics'. That would have been generally looked down upon in many institutions. It's now looked at going 'Actually, that's an important a role,' so therefore I think that the people doing the applied research are now getting the respect that they probably should have had. And I think that's the crucial bit. I think it went back the other way. You can always respect someone that's doing the pure theory type thing. And I think now it's sort of balanced back and gone back in the other direction.* (Physicist 1, 2013)

The above set of quotes describes the changing dynamics in academic culture resulting in the change of perceptions. The outcome of the introduction of the impact agenda is framed as a change in scientific culture in terms of perceptions of what type of research is deemed 'worthy'. Previously, worth was judged purely on academic merit and therefore publications in prestigious academic journals were the most valued outputs. However, now, although publications are still important, the criterion of 'social relevance' is also becoming important as exemplified by the impact agenda in the U.K. higher education sector. Thus, there is a redressing of the 'balance' in the relative evaluation of

applied and pure research within the scientific trading zone which contributes to the reformulation of the expectations that are associated with the traditional role of an academic scientist.

Thus a view was expressed that the impact agenda may have a negative impact on blue skies research (pure basic research[86]), which may potentially be deemed as a non-tradable commodity in the impact trading zone.

> *And I suppose you might judge the research as more important if it has had an impact which is not necessarily a good thing because we need blue skies*. (Engineer 1, 2013)

Within the context of assessment of societal impact, blue skies research may be judged to be of a 'lesser value' in comparison to other more societally relevant research, such as applied research, for example. One reason why a lesser value is attributed to blue skies research is the length of time required for it to make a contribution to society.

> *And of course a lot of blue skies research doesn't have impact for a long time but is fundamental. So it's getting that balance correct.* (Engineer 1, 2013)

Justification for keeping the balance between societally relevant and blue skies (which may prove to be societally relevant in the future) is grounded in the potential capacity of blue skies research. Just as nothing can come of it, there have been and will be instances where blue skies research has led to monumental breakthroughs. Thus, in trades-based on blue skies research, gains can be quick or may reach maturity over indeterminate timelines.

> *You need to have the blue skies research because you never know what's going to come out from that sort of thing.* (Physicist 1, 2013).

> **[Archaeologist 2, 2012]** *Research moves in a very evolutionary way. I do things because of accidents and happenstance and then connections that I didn't see before. So I put in a research grant to do something, but if halfway through I realize that, well actually, we found this, we didn't expect to see this. That means that this is true. Holy cow! We should really start exploring this. Now we get a real insight. It was never part of the initial research agenda. If you are only doing things where you know what the outcome is going to be before you start that is not science. Science is exploratory and interest and discovery and you try mapping that, saying that impact has to be directly tied back to research. I mean, come on! It's insane.* ()

> **[Boris Popov]** *So do you think it's ...a sort of a hit against blue skies research?*

> **[Archaeologist 2, 2012]** *That's my fear.* ()

It is interesting to note in the quote above a suggestion that the influence of the impact trading zone goes beyond realignment of priorities away from more exploratory research towards a more

[86] Organisation for Economic Co-Operation and Development (OECD) defines 'pure basic research' as "research carried out for the advancement of knowledge, without working for long-term economic or social benefits and with no positive efforts being made to apply the results to practical problems or to transfer the results to sectors responsible for its application"(OECD 2013c).

directed type of research focused on problems that are known to be important in society. Here the suggestion is made that the potential outcome of the impact agenda is to eliminate the process of discovery that is inherently embedded in research, thereby removing a degree of uncertainty around research outcomes. However, as is shown in the following quote, this unforeseen 'potential' and unpredictability are essential attributes of 'strong' research.

> *And I suppose you might judge the research as more important if it has had an impact which is not necessarily a good thing because we need blue skies.* (Engineer 1, 2013)

> *You need to have the blue skies research because you never know what's going to come out from that sort of thing.* (Physicist 1, 2013)

Thus, overall, one of the 'fears' that stood out in the conducted interviews, was the potential marginalization of blue skies research outside the impact trading zone. Whilst this may speak to marginalization of a type of research across a number of disciplines, I suggest that this is indicative of reconstitution of an academic role as one that is not simply focused on research that may not have any applicability in the present or the future, but rather as a role that also incorporates a strong component of working within the 'engagement trading zone' and thus engaging in communication beyond academia.

7.3.2 Potential devaluation of 'Public Engagement'

Another area of research communication that emerged as potentially subject to influence from the 'impact agenda' is the broader engagement beyond academia. In particular, two contrasting perspectives emerged amongst the researchers in the interviews. Those adopting the first perspective imagined that the introduction of the 'impact agenda' would adversely affect the broader engagement beyond academia such as outreach. The other perspective reflected the view that the introduction of the 'impact agenda' would complement the broader engagement agenda that is also prevalent in the higher education sector in the U.K.

Adverse effects of the impact agenda on engagement practices were seen to be concerned with the reconstitution of the previously diverse trading zones, involving a multiplicity of engagement practices and publics, into a more constrained trading zone which only valued certain types of engagement practices (those leading to preferred demonstrable forms of impact) and a limited number of publics. This view is reflected in the following quote:

> *But you know, I just worry that in the rush perhaps to focus on particular constituencies we might lose that broader outreach.* (Archaeologist 3, 2013)

The articulation of such a concern suggests that researchers may potentially begin to differentiate between participation in engagement activities versus participation in 'impact'-related activities. In

light of the broader definitions of impact purveyed by HEFCE and mostly echoed by researchers, the distinction between the two types of activities may be somewhat trivial. However, when coupled with researchers' perceptions of aspects of engagement viewed to be of value for the purposes of demonstrating impact, then the distinction becomes an important issue. The emergence of this concern can be in part attributed to a lack of institutionalization of diverse engagement practices in the case study university (meaning that engagement is treated as a discretionary activity by individual researchers). The scenario may unfold further in response to the ways that various engagement forms have been evaluated against the criteria set out in the 2014 REF. (These outcomes from the 2014 evaluation are likely be 'felt' more strongly in the preparatory stages for the next REF in 2020.) This overall point is made in the following quote,

> *There is actually a danger there because it might end up being seen as some activities are not worthy because they don't meet that very specific REF impact, even though they're actually good for the local community. These are the things we should be doing. The danger is actually we might end up withdrawing resources and so on. I don't know but I could see a situation where I might be told, 'Don't go and talk to a local group. Use your time more strategically.'* (Archaeologist 3, 2013)

The above quote highlights the potential for creation of a dichotomy between 'devalued' forms of public engagement and more 'highly-valued' impact-related engagement. The result may be the creation of separate trading zones for 'engagement and 'impact engagement', with the latter encouraged more actively by academic institutions and former remaining to be more ad-hoc. The process of differentiation can occur at the organizational level through the allocation of funding. To a certain extent, this has already been observed at the case study university through the establishment of seed funding for impact generating activities at the university-wide level and at the departmental levels as well. In contrast, most departments do not have a fund allocated to engagement activities; nor do they necessarily carry out engagement activities (This is reflective of time when interviews were conducted.). These developments contribute to the polarization of the atmosphere of engagement towards engagement that is deemed to be leading to 'impact'. Whilst the polarization of the atmosphere does not necessarily lead to adoption of different research communication activities by all researchers, in a practical sense, researchers do report the potential for changes in the ways they interact with their audiences, as suggested in the quote below.

> *And also, because of the way REF define impact, a lot of things, just like talking to local groups, most of the basic dissemination, doesn't count. You know, it may count for RCU.K.. It may count for general wellbeing but it doesn't 'count', you know. You've got to be more strategic. And also you've got to be much more strategic about monitoring it and recording it. Now whenever I go and do a course we have a questionnaire for people to fill in. Previously, I'd just go and do the course. I might try to review it just to make it work better but I wouldn't be kind of, starting to get all strategic about it.* (Archaeologist 3, 2013)

Here we see knowledge (as conveyed through a training course) is exchanged ('traded') for questionnaire forms providing indicators of some form of 'impact' achieved. This represents perhaps one of the greatest fundamental changes in the dynamics within the trading zone. In contrast to previous engagement practices, researchers now implement methods of evidencing in order to attempt to capture and demonstrate 'impact'. This also transforms the audience from being passive recipients to instead being engaged as active 'traders' in the process. In this case, at the evaluation stage (as suggested in the above quote) they are providing feedback of instrumental value to the researcher and the academic institution hosting the research.

Further indication of the emergence of changes in the academic culture involving a transition toward creation of a more and 'collective' atmosphere of engagement with a more formal purpose is demonstrated in the next quote.

> *However, impact is only one component of REF. Impact goes well beyond the way REF chooses to measure it. And so, if impact is actually about changing our research culture so that from the point where we start to formulate a research project to the point where we, you know, we write the final report, we're engaging with external partners in order to kind of maximize the impact of our research...* (Physical Geographer 3, 2012)

Researchers adopting this perspective suggested that the impact agenda will further legitimize and indoctrinate engagement beyond academia within the academic culture thereby creating a more 'permanent' and 'collective' atmosphere of engagement.

> *I think engagement with more diverse communities beyond science may begin to be valued as well as just being science with an end result, if you see what I mean, as being a measure of impact. After all, public perception or public awareness, or public understanding of environmental issues is a very important part of decision making nowadays. And you've got to ask yourself, …what is the best way to share that public opinion?.* (Physical Geographer 2, 2012)

The quote is interesting because it envisions a shift in the perspectives on impact from an outcome (or results)-based approach to a process (interactions) based approach. It suggests that there will be recognition that "engagement is the method of its [impact] articulation and the means by which impacts are mobilized" (Watermeyer 2012b, p. 115). This means that there may be a shift in evaluation away from focusing on the research findings and towards the process of interaction (e.g., de Jong *et al*. 2014, 2011; Molas-Gallart & Tang 2011; Spaapen & Drooge 2011) thereby recasting the trading zone as a continuously evolving relational space where the act of research communication and knowledge exchange is valued as well as the actual content of the scientific

findings. Moreover, this increases the number of stakeholders involved, and consequently, presents a greater challenge for the researchers and evaluators. [87]

This section demonstrated growing differentiation between communications that can and cannot be occurring in the impact trading zone. It has advanced the argument that the introduction of the impact agenda leads to the narrowing of the engagement trading zone by polarisation towards certain types of research as well as polarisation towards certain types of engagement practices that may become seen as more suitable towards demonstration of impact. This reconstitution of the engagement trading zone also feeds through into changes within academic culture in terms of the expectations regarding institutionally legitimized roles associated with being an academic researcher. The next section explores the extent of this transformation connected with the emerging impact trading zone.

7.4 Confirming the Trade

A confirmation with appropriate evidence is required in order to document that the trade has been 'conducted' between researchers and society resulting in 'impact. Since impact is a nebulous concept and will vary according to research area and discipline, there are numerous challenges associated with understanding and evaluating it. Penfield *et al.* (2014) list five challenges: time lag; developmental nature; attribution; knowledge creep; gathering evidence. According to a similar argument put forward by Martin (2007), there are four problems which present issues for societal impact assessment: causality, attribution, internationality and timescale. The causality problem refers to the issue of attributing impact to a particular cause. Due to the often complex, contingent and diffuse nature of impact, the attribution problem refers to the issue of attributing a portion of impact to certain research or to other inputs. The internationality problem is connected to the attribution problem – a vast proportion of commercial application of research is international, which renders attribution of impact almost impossible. The evaluation timescale problem highlights the importance of when impact measurement occurs as impact can occur at various points. Further questions arise around the timing of impact relative to the research communication as well as the length of time between communication of research and the impact it produces. To these problems, Bormann (2013) adds four more. Societal impact evaluation may take scientists beyond the parameters of their disciplinary expertise and may require working with others if the assessment goes beyond evaluation against indicators. Another problem is that a single assessment mechanism across disciplines is difficult to devise. Moreover, the assessment models should account for the fact

[87] This approach is reflective of the approach that has been focusing on 'productive interactions' (de Jong et al., 2014, 2011; Molas-Gallart and & Tang, 2011; Spaapen and & Drooge, 2011).

that assessment should be tailored for each individual institution in regards to its teaching and research, cultural context and national standards (Goransson *et al*. 2009; Molas-Gallart *et al*. 2002; Rymer 2011; van der Meulen & Rip 2000). Lastly, research will not always have a desirable or positive impact (Martin 2011). In the rest of the section, I discuss the following factors that were brought up in the interviews and have an influence on the confirmation of the trade: timescales, developmental nature of impact; attribution; knowledge creep; evidencing of impact; cultures (scientists and various stakeholders).

One of the pressing issues in the assessment of societal impact of research relates to ***timescales***. The time between research and impact can vary considerably amongst different research fields.

> *….it's how you measure it that's always the problem and how long it takes to have an impact.* (Engineer 1, 2013)

Research communication as a process does not necessarily lead to impact. In theory, societal impact of research can occur in the short, medium or long term. In idealized conditions, the potential for impact to occur at different timescales is equally probable. However, although impact can be beneficial in a variety of areas such as society, culture, environment, economic, it frequently occurs in the future rather than in the immediate present. For example, according to Buxton (2011) there is "an average time-lag between research funding and impacts on health provision of around 17 years" (p. 260). The interviewed scientists frequently referred to the timescale associated with research impact as an obstacle to 'impact trading zone' formation. The following quotes reflect this perspective.

> *Research moves in a very evolutionary way… more often than not, the things that have the biggest impact happen decades after the initial finding and there is no way, if you were given a hundred things, you'd never know which one of those things in ten years' time is going to be the most important thing.* (Archaeologist 2, 2012)

> *…certain areas of research, you have no idea what the potential impact of them could be in the longer term; and everyone quotes things like the transistor or the laser.* (Physicist 1, 2013)

As indicated in the first quote above, research moves in 'evolutionary way' and as such it is contigent on a plethora of socio-spatial and socio-temporal factors. Different areas of research will be impacted in different ways by a combination of these factors. Consequently, for some areas of research impact will be predictable while for others it will not be. For some areas of research, impact will occur in the short-term whilst others will require centuries to come to fruition. This makes the process of impact evaluation in relation to the process of knowledge production and its subsequent communication a difficult undertaking. However, regardless of the timescales, it is important to

maintain a record suitable for demonstration of impact in relation to the communication of research.

Connected to this question of timescale, is the issue that impact is also ***developmental in nature***. "Impact is not static, it will develop and change over time and this development may be an increase or decrease in the current degree of impact. Impact can be temporary or long-lasting. The point at which assessment takes place will therefore influence the degree and significance of that impact" (Penfield *et al*. 2014, p. 26). The following quote alludes to the developmental nature of impact.

> *We do not know, when we make an invention or we develop a new technique or we publish it, we don't know what's going to take off what's going to happen with it. 99.999 percent of the time, you publish a paper and it just disappears into the dirt and it's never heard of again. You know, a few people might reference it but that's about as far as it goes. But every so often, you get one of these ones that is an absolute flyer. And a new technology comes out of it that is going to transform the way we live or whatever…I just feel those things take 10, 20, 30 years or whatever for them to actually to come to fruition.* (Earth Scientist 1, 2012)

The process of research and development is framed as being uncertain, unpredictable and one that may take a variable length of time to occur in the above quote. Important to note here is that communication enables impact to evolve through its developmental nature. Communication in one format may lead to impact in a particular socio-spatial context; whilst in a different format it may not bare any results. Thus, engagement mobilizes impact (see Watermeyer 2012b for a similar argument) with communication playing an integral part.

Closely related to the issue of research development and its corresponding impact is the idea of '***knowledge creep***'. 'Knowledge creep' is an outcome of new knowledge development through research where the new data or information attains acceptance and is absorbed over time (Penfield *et al*. 2014). The following quote elaborates on the issue of knowledge creep.

> *The world of research topics that I'm doing is a lot of work with the mathematics department here. And, we're doing a lot of Bayesian statistics work. Now Bayes wrote his original statistics paper in 17- whatever it was, 300 odd years ago. And you know, if he had to write an impact plan about his, what he had done. 'You know. Fine, I've written this. It looks like a fun sort of thing to do.' But it is only now we're getting to the point where we actually have the numerical capabilities to actually implement his ideas and his theories. So potentially, I agree with people in maths. I think Bayesian systems are going to become a very dominant system to handle and manage information, uncertain, risk and all the rest of it over the next decade. So, if somebody had written this paper now, you know, bam! You've got your impact statement there and then. But, this has taken over 300 years*. (Earth Scientist 1, 2012)

Attributing impact to a particular piece of research (or to funding, strategy or organization) is complicated. Impact is not a uniform phenomenon. It is a derivative of a complex mixture of

"serendipitous findings, good fortune, and complex networks interacting and translating knowledge and research" (Penfield *et al*. 2014, p. 26). The path from research to impact occurs through a number of trading zones involving numerous processes, individuals, organizations and emphasizes the importance of interactions. The issue of attribution is explained in the next quote.

> *One of our problems was that we did an awful lot of stuff. We did lots of stuff. And actually when it came down to realizing what was relevant to a REF impact case study; a lot of it actually went out the window. And also because it has to be very clearly connected to a specific research product. A lot of the stuff we were doing, it's very hard to actually link directly to specific research.* (Archaeologist 3, 2013)

As indicated in the above quote, in order for societal impact of research to be made 'visible', ***evidence*** demonstrating this 'impact' must be gathered. Undertaking this process presents a challenge for the researcher in and of itself. "The introduction of impact assessments with the requirement to collate evidence retrospectively poses difficulties because evidence measurements and baselines have, in many cases, not been collected and may no longer be available. While looking forward, we will be able to reduce this problem in the future, identifying capturing, and storing the evidence in such a way that it can be used in the decades to come is a difficulty that we will need to tackle" (Penfield *et al*. 2014, p. 27). In terms of the trading zone concept, evidencing the impact extends the notion of the trading zone beyond one of a time limited transaction that can be confirmed in 'real time' and thus beyond the parameters of an event and its corresponding elements being emergent . Instead, the temporal scale is extended and the transaction is extended to include its outcome as well. This introduces the aforementioned issues associated with impact. In what follows, I elaborate on the challenges of impact evidencing and discuss two particular evidence commodities: citations and questionnaires (or surveys).

The traditional method for connecting a piece of published research to some other piece of documentation is through *citations*. Acknowledgement of a research publication through the citation affirms that it is of utility for the purposes of the document. Citation may be used to acknowledge previously conducted research around a subject, to justify an idea or to provide a relevant example from the literature. Essentially, a citation is an affirmation of a degree of impact of a cited piece of literature. One of the interviewees suggested that a citation is the 'strongest line' of evidence.

> *We're looking for impacts that you can evidence. So that does mean that you can pick up citations of documents or reports or papers. That's the strongest line.* (Physical Geographer 1, 2013)

It is not unreasonable to suggest that citations can be viewed as important because they have recognised validity in the academic sector, being indicative of the attribution to the work conducted by others as well as the importance of that work and showing respect of intellectual property. Several studies that have attempted to trace the flow of scientific knowledge from research to society (Grant 1999; Lewison & Sullivan 2008; Narin et al. 1997). Narin *et al*. (1997) demonstrated the flow from science to industry in the United States tripled between 1987 and 1994 through the analysis of 400 000 US patents and the scientific publications that were cited within them. Building on the work by Grant (1999), Lewison & Sullivan (2008) examined 43 U.K. clinical guidelines for references to papers. "The U.K. papers were cited nearly three times as frequently as would have been expected from their presence in world oncology research (6.5%)" (Lewison & Sullivan 2007, p. 1944). Evaluation of citations, whether it is in patents or clinical guidelines, has a number of advantages (Bornmann 2013). Societal impact is measured in the same as way as scholarly impact (through citations in preferably high-ranking academic journals) and thus a scientifically established method of evaluation is available. Evaluation of citations suggests that there is an extensive data set available. Lastly, in comparison to other formats, patents and guidelines where research may be cited are relatively freely accessible.

While a citation may represent the strongest line of evidence of impact, they do not adequately capture the emergent nature of impact. Moreover, indications of 'impact' can be embedded in various formats such as public statements, interviews, statistics, etc. For example, as highlighted in the quote from Archaeologist 3, a questionnaire may be used as a form of evidence for demonstration of societal impact. An advantage of using questionnaires (particularly in contrast to using patents), is inclusion of a larger spectrum of public groups as active participants in the trading zone (Bornmann 2013). Similarly, for example, through surveys[88], views and opinions held by different publics on the impact of research can be gathered (Bozeman & Sarewitz 2011). They have a degree of flexibility and can be utilised in a variety of contexts, for example after a workshop. There are other methods that can be used in the context of a trading zone in order to evidence impact. This can be accomplished through statements provided by stakeholders (which appears to have been a route frequently undertaken by researchers for post research evidence gathering) as well as interviews.

The foregoing sections have focused on the process of 'impact' and the obstacles to evidencing impact. However, perhaps the more fundamental challenges to evaluation of societal impact are the respective ***cultures of researchers and various stakeholders***. For the stakeholders or

[88] For the most important and much cited survey in the field of societal impact measurement refer to Mansfield (1991).

the scientists the process of evidencing the societal impact of research is not an organic process. Researchers have not traditionally undertaken the role of evaluators nor have they worked with social scientists doing evaluation research. Instead, once the academic publications are produced (or even before), researchers, usually, have already moved on to the next project. Moreover, researchers do not usually work with evaluators of research, or other researchers who work in the field of evaluation (Donovan 2011). Societal impact evaluation is not embedded within the practice of doing academic research and doing so seems to require a modification to the expectations associated with the academic role. Similarly, organisations companies and/or other stakeholders are not necessarily used to researchers attempting to trace the impact of their work. Consequently, differing work cultures, competing perceptions and lack of coherent evaluation structures present a substantial challenge to the evaluation of impact.

For some researchers, the perception may exist that companies with whom they are working would not necessarily want to provide any evidence. This may especially be the case with a large corporation where attribution of impact to a particular researcher's involvement may be commercially undesirable and difficult to show. This perspective is exemplified in the quote below.

> *…I don't think that they* [large energy company] *would necessarily want to provide any sound, clear evidence that I specifically was responsible for them undertaking a major policy change because I'm a very small cog in a large machine in that respect. So, those are difficult things to measure, difficult things to demonstrate.* (Physical Geographer 6, 2013)

The reluctance of companies to provide evidence of impact may be most prominent in cases where patent technology is involved.

> *We're looking for impact statements now for the REF. I have a colleague…And he's done stuff that has resulted in patents that have been turned into technology that's gone everywhere. But he can't talk about it because the patent is tied up into the technology, which is then proprietary. Sure he's having great impact but he can't tell anyone about it. And so, then what do you want to do?* (Computer Scientist 1, 2012)

Thus, despite being one of the desirable routes for demonstration of impact, working with industry, and especially companies on patented technology posits a risk of limited access, or no access, to evidence that may corroborate the impact. Issues usually arise around the intellectual property (IP) and the corresponding timing of academic publications versus the technological exploitation by the company. The next quote expands on this issue.

> *In some cases there is a conflict but in many cases there isn't a conflict and you can find a space where you can meet the needs of the university to publish and you can meet the needs of the company. Now the company is usually very much more interested in who owns the IP. So it's more about the timing of when you publish rather than if you can publish. Obviously*

> *you would need to make sure that any intellectual property had been secured before you published. So it's about the order in which you do things. It's about having the conversation to find a way that works.* (Business Engagement Manager 2013)

In cases where there is potential sensitivity around intellectual property issues, a trading zone coordinated through the business engagement / knowledge transfer space at the university may facilitate a negotiation process where a common ground is reached. Part of this process involves overcoming the incorrect perceptions that may exist for both parties about the research and the motivations for doing the research. In the following quote, Computer Scientist 1 speaks about the potential perceptions that may hinder the impact-related interaction between researchers and industry.

> *I think one of the sensitivities in the whole process is that [for] the companies we're trying to get evidence [from] that will link into commercial business side of what they're doing; an attempt to extract money directly from them. So if they write statements saying, 'Of course. [Computer Scientist 2]'s work did all this great stuff for us,' then the university is going to write back and say, 'Great. That is a product. Give us some money.' That is very tricky. I keep saying that we're not really bothered about your money. I get money from our government. But that, for this company on the far side of the world, that's quite a big ask. Even writing something is quite a big ask because they don't trust the confidentiality of universities anywhere, let alone here.* (Computer Scientist 2, 2013)

The foregoing quote highlights the potential that industry partners may perceive researchers' attempts to gather evidence of impact as a strategy to extract money from the companies. This is a question of who benefits commercially from scientific knowledge. The company's perceptions are framed by a business trade model whereby there is a monetary exchange for scientific knowledge. It appears to be incommensurable with the paradigm suggested by the researcher that rests on the understanding that a third party provides the funding for researchers so they are not requesting financial payment but rather acknowledgement of the impact of their work (presumably in written form). Thus, there is an underlying uncertainty about what is the 'currency' envisaged for the exchange between industrial and academic stakeholders. This can be attributed to lack of stakeholder awareness of the academic landscape in the U.K., which would have helped to justify the researcher's request for evidence. It is also grounded in issues of communications, addressing perceptions early in the collaborative process could clearly contribute to making the relationship more manageable. The other component of the relationship that is required in order to improve the communication is trust. An increase in trust should yield a better working relationship between the two parties; and may be stimulated by addressing the wrong previously formulated perceptions concerning motivations for science communication via industry engagement. The reluctance to

disclose any information on behalf of the company may also depend on the stage of the technology development cycle. This is demonstrated in the quote below.

> *Personally, it's putting a lot of pressure on me to do things faster than my commercial collaborators would want to do. So far, most of what we're doing, they've said, 'You can't talk about cause it's too soon. And maybe in two years, we'll be able to talk about it.' So I've got the university jumping up and down…There is a lot of pressure because it's worth a lot of money for the university and yet on the company side, they're trying to commercialize it and they don't want to talk about it. So the things they're doing in the film industry with the technologies and systems that I've produced are too confidential for them to even want to mention what they might be. And I was in the US over the summer and sat down with two lawyers and a chief scientist and was told, 'This is commercial. Don't talk about it or else!' So, we are negotiating quite carefully, at least I am, cause I'm the only one who knows what we're doing, what we can/can't say and we'll get a statement from them in the near future, I hope. But if we were two or more years down the line, I don't think it would be such a problem because it would be commercialized and it would have been what the REF reviews had been and what was working and what was not. I'm told there is a few cases like this. It's just at a very sensitive point in the cycle where it would be really bad news if their competitors found out what they're trying to do.* (Computer Scientist 2, 2013)

Consideration of the stage of the commercialisation cycle and the careful negotiation required to overcome the discrepancies between the different parties are exacerbated by the difference in temporal working patterns between academic scientists and companies. When the evidence for impact may be needed by the researchers, this may not coincide with the stage in the commercialisation process at which the company would be willing to divulge this information. Therefore, the alignment of the commercialisation and impact timelines is essential in order to partially mitigate the difference between the two cultures (academic and industrial). However, this may not be acceptable. Therefore, another way to reach a degree of consensus is for the researcher to reach an understanding and adapt communication practices to the conditions in these non-academic contexts, in ways that are sensitive to their dependence on the business cycles, and how these cycles influence the type of communication that is acceptable.

In addition, temporal context gains further importance in light of the fact that in some cases relationships with key informants in companies, or indeed the company itself, may no longer exist at the necessary time for gathering of evidence for impact demonstration.

> *I think it will need to be much more proactive from our viewpoint because we really need to gather evidence when we can because if the company closes or if the people move on, and they move on a lot faster in industry than they do in academia, it will be very hard to trace back where it came from…once you lose the personal relationships it gets much, much harder.* (Computer Scientist 2, 2013)

The above quote provides a strong indication of the difference in the working timescales between industry and academia, contributing to the difficulty of tracking the industrial impact of research over time. The quote also reflects the ephemeral relationships involved in science communication between university researchers and industrial partners. The impact trading zone dictates that the communicative relationships may be extended over prolonged periods of time (to the extent of sometimes being indefinite, depending on the type of research that is being communicated). Thus tracing impact is seen to be contingent on the long term personal relationships that scientists develop with individuals working in a particular company. Development of these relationships is contingent on a degree of harmonisation of organisational cultures. The difficulty of achieving this means that scientists generally do not trace the societal impact of their research over time, and there is no audit element in conventional research practices to account for what happens to academic research in society. Similarly, business and/or industrial cultures are not motivated to provide evidence of 'impact' of the research that was done in collaboration with academics or on a contractual basis. This is why 'societal impact of research' represents a specialised trading zone specifically designed to facilitate and formalise and 'commodify' the relations between science and society in the context of research communication and research impact.

Overall, we see that evidencing of societal impact of research is a complex process which necessitates the development of a new type of trading zone where the particular issues of communication can be addressed and at least partially resolved. In these specialised engagement trading zones, evidence of impact has become a new currency by means of which research findings are to be traded. Nevertheless, the overall process is immensely convoluted by issues of timescales, developmental nature of impact, knowledge creep, as well as attribution. These factors, combined with the complexity associated with the temporal travel of research in variable formats across a number of socio-spatial contexts, undermines the complete resolution of the problem of communication through the impact trading zone.

7.5 Conclusion

This chapter focused on what has widely become known as the 'impact agenda' in the U.K. higher education sector. In particular, I have elaborated upon the researchers' interpretations of what is 'impact' and the issues associated with its evaluation. Juxtaposed against the impact conceptualisation offered by HEFCE, researchers' accounts suggest that a specific type of 'trading zone' is potentially emerging within the broader engagement trading zone in which researchers have habitually communicated their research. Grounded in the presented data, I have argued that a narrowly interpreted impact trading zone may create a 'funnel effect' whereby unequal valuation of

different forms of engagement within the 'impact agenda' may result in phasing out of some forms not deemed suitable. These appear to be steps towards the resolution of communication within the impact trading zone through the process of homogenisation / standardisation. However, the complexity associated with research communication leading to impact, compounded by the complex processes of evidencing, suggests that the problem of communication between academic researchers and society may not completely become resolved within the impact trading zone. Furthermore, the growing dominance of the impact trading zone, with its strong emphasis on the instrumental application of knowledge communicated by researchers, is raising questions surrounding the 'devaluation' of other forms of engagement and research communication, which are not 'valid currencies' in terms of REF impact. Some researchers are suggesting that these offer other, 'intrinsic' value in society which should not be lost. Moreover, it raises questions about whether 'shadow' trading zones, focused on these other forms of engagement, may continue to be important for the researchers and the publics with whom they communicate research.

8 Chapter 8: Discussion and Conclusions

8.1 Introduction

This chapter discusses some of the overarching themes in the findings from this research and the main contributions these make to knowledge in respect of the research questions addressed in this thesis. Through an intensive, qualitative investigation of the experiences of researchers and others (specifically individuals working within the boundary spaces within the university) involved in research communication in a research intensive university in the U.K., I have explored the following substantive practical questions:

1) **How do researchers view their practices in communication of their research beyond academia?**
2) **What roles do university boundary spaces play in communication of research beyond academia?**
3) **How has the recently implemented 'impact' agenda within the U.K. national Research Evaluation Framework influenced communication practices within these spaces?**

Notably, I have also attempted to address theoretical issues concerning science communication and public engagement with science. In the following discussion I summarise the general substantive findings from this study and synthesize the conclusions in relation to the research questions posed. I discuss the findings and the conclusions of this thesis in relation to the theoretical literature that I have outlined in Chapter 2. I then consider the implications of the work and appropriate recommendations. In the latter part of the chapter, I offer a discussion of the strengths and limitations of the study as well as avenues for future research stemming from the present work.

8.2 Summary of Research Contributions

In this section I aim to provide a concise summary of the original contributions to knowledge that this research has made. The conducted research has demonstrated the diversity of ways that academic scientists engage in communication of their research and the rather complex pattern of different practices they use. In contrast to, for example, their teaching practice or the actual research that they carry out, research communication beyond academia is not subject to a very rigorous assessment or generally formulated codes of practice. Researchers carry out these research communication practices according to their perception of the appropriate roles for themselves as researchers, and for the different 'infra-publics' they communicate with. Researchers are able to adapt their practices to different infra-publics and the atmospheres they encounter in diverse

settings for communication. However, it is not clear in all cases that they do so consciously and some seem to be more aware than others of the ways that communication is framed by the space in which it is carried out, viewed from a social geographical perspective. The spaces in which research communication is conducted as described by participants in this research can be understood in terms of *trading zones* comprising social and institutional spaces, framed by relationships between certain human and non-human actors. These spaces are diverse and also have an ephemeral dimension to them. Simultaneously, there are parallels with other processes in social economies and therefore the adoption of the analogy with 'trading zones' is valuable here. The concept of trading zones as originally developed in the literature on expertise (see Collins *et* al. 2007; Gorman 2010) has been developed here in light of concepts from social geography about how these zones operate as spaces constituted through social and institutional relationships and interactions between people and their material environment. The implementation of the REF impact agenda is an institutional process which has had major influences on the boundary spaces and trading zones for communication of scientific research. From the perspectives of the participants in this study, it raises important questions about how 'value' is placed on different forms of research communication and the implications for development of research communication practice. Research communication may be underpinned by a number of communication models in isolation or in variable combinations, which may evolve during the course of an engagement event. Understanding of the dynamics concerning the emergence of these models has been advanced here using perspectives from social geography. Adoption of the emergence model (see Horst & Michael 2011; refer to Chapter 2) in combination with the concept of affective atmospheres (Anderson 2009, McCormack 2008) offers a conceptual framework to understand the emergence of different roles for the researchers as public communicators and does not predicate the necessary existence of their corresponding publics. The researchers themselves were the focus of the study - the research contributed to the small body of literature that focuses on researchers, their engagement practices as well as their perspectives, attitudes and motivations (in contrast to the body of work that has focused on various publics). This research also, in part, considers how individual researchers' views evolved over a period of time. Moreover, the qualitative data that was gathered from the researchers over time is somewhat unique when juxtaposed against other research focusing on academic researchers' engagement practices during particular, time limited research communication events.

In the rest of this section, I discuss the merits of this research in terms of its general contribution to knowledge about academic researchers public engagement practices; reconstitution of public engagement events as trading zones; consideration of geographies of science communication; the

relationship between societal impact of research and public engagement; how has this thesis contributed to rethinking science communication.

8.3 Discussion

In the special issue[89] on 'Public Engagement', the Editor-in-Chief of the journal *Public Understanding of Science* (PUS)[90] wrote that public engagement of science must be understood in part as *engagement of science with the public* (Bauer 2014). Since researchers are the ones that are tasked with contributing to the scientific body of knowledge by carrying out research, then in part, investigation of 'engagement of science with the public' necessitates research on 'engagement of researchers (especially academic researchers) with the public'. The present empirical research aimed to contribute to the qualitative analysis of scientists' public engagement activities, the spaces which mediate those practices and to consider influential policy drivers that have the potential to alter researchers' engagement practices.

8.3.1 Engagement Practices of Researchers

This thesis therefore contributes to an emerging literature that highlights scientists' involvement in public engagement (Davies 2013a, Davies 2013b; Grand *et al.* 2015; Lawson 2013; Polikakoff & Webb 2007; Wilkinson *et al* 2011; Burningham *et al* 2007). The findings reported in this thesis concerning the engagement practices of interviewed researchers has further elaborate on the 'many faces of engagement' (Antonsen *et al*. 2014, p.3). This is to say that my empirical findings also reflect the ways that socio-geographical space occupied by science and society in the U.K. context is constituted through a wide variety of science communication activities. Therefore, overall, the 'science-society' space is characterized by heterogeneity and is constituted through a multiplicity of practices undertaken by researchers and is always evolving. Some of these practices are mediated by boundary spaces (such as the communications offices, technology transfer offices, science outreach, etc.), of the university and are potentially subject variation due to the emergence of the impact agenda within the higher education sector in the UK.

8.3.2 Geographies of Science Communication

This study has attempted to engage with the idea of 'geographies of science communication' ('geographies of public engagement'). Adoption of this perspective allows one to consider not only the social context within which engagement events are occurring and how it impacts the process of communication (e.g., prominence of the deficit model of communication in contrast to the dialogue

[89] The special issue of PUS on 'Public Engagement' can be found here http://pus.sagepub.com/content/23/1.toc.
[90] The journal website can be found here http://pus.sagepub.com/.

model) but also the socio-spatial context of the engagement events. A limited number of studies have attempted to engage with the socio-spatial dynamics of engagement events in depth in relation to the communication process. For example, the eleven research projects analyzed by Wilkinson *et al.* (2011) corresponded to various physical settings including community hall, university campus, learned society, public house as well as science centre/museum (with the latter being the most popular). Pearson *et al.* (1997) reported the attitudes and opinions of research scientists from a single university in the South of England who took their research into the city shopping mall. The MORI (2000) report, *The Role of Scientists in Public Debate*, highlighted that of the specific activities that were listed for researchers, scientists were most likely during the last year to have given talks to schools or colleges (21%), or participated in open days for the general public at their institutions (24%). These various spaces provide sites for specific types of co-presence. In other words, engagement events are permeated by different social relations between science and publics. These relations can be characterized by a spectrum ranging from spaces dominated by science (and therefore scientists) to spaces that are entirely dominated by publics. The physical settings can contribute to the definition of the social space within the context of engagement events.

There have been studies that have alluded to the importance of the setting (including its material elements) for public engagement with science (Overskaug *et al.* 2014; Riise 2008). In the UK, science festivals have become a prominent context which facilitates the connection between researchers and various publics, who attend science festivals for a variety of reasons (Jensen & Buckley 2014). Events such as science festivals and sciences cafes can be good meeting places for publics and scientists because they can represent a type of "'neutral ground,' where people do not have to go out of their way to approach science" (Riise 2008, p. 301). Science festivals can actually represent a 'neutral ground' for science and society to meet in a literal sense since science festivals are often held within cities on grounds that do not necessarily belong to the university. For example, when the CSU has conducted its science festival it was usually situated within the city center area which enabled a number of publics to be able to access the engagement event. Venues can play a role in attracting publics (Riise 2008) and can potentially encourage discussions and posing of questions (Overskaug *et al.* 2014). Other spaces that appeal to variety of publics are zoos which serve as sites for research and education (Ross & Gillespie 2009). Recent research has suggested that zoos have a great potential for public engagement with science (e.g., biological sciences) as they offer a more encompassing venue (Bowler *et al*. 2012; Waller *et al*. 2012). Moreover, zoos provide sites which can be to a certain extent staged through manipulation of animate and inanimate elements. Ross *et al*. (2012) investigated how might the physical context of a species enclosure affect the visitor exploration of the exhibit space and found that in comparison to a more traditional

design structure, visitors spent 59% more time with a naturalistic setting and moved more slowly through the space. Lukas and Ross (2014) have suggested that more naturalistic exhibits may be more effective than traditional exhibits at improving the attitudes of zoo visitors towards African apes. Overall, we can begin to see the importance of the physical context for the emergence and the subsequent experience of various publics within the parameters of engagement events. In the present work, I have highlighted three types of spaces of engagement: spaces of science, public spaces of science, and spaces of publics. These spaces are essentially characterized by dominance of publics or by dominance of scientists and scientific knowledge. In other words, the physical context contributes to the formation and evolution of the social spaces that are formed through engagement in those contexts. Emergence of various social spaces as part of engagement events highlights further the importance of the physical context within which the engagement event is situated. However, from the perspective of researchers, the physical context selection of their engagement events is frequently not determined by them. Therefore, consideration should also be allotted to the material elements found within the physical context of engagement events.

In addition to the actual physical context of the exhibit, exhibitions are able to integrate additional material elements to facilitate visitor experience. For example, research conducted by Waller *et al*. (2012) at a 'primate research centre'[91] situated within a zoo demonstrates the importance of information signage as well as the presence of scientists themselves. More visitors actually approached the primate research centre more often when the scientist was present and working with the primates; whilst those individuals that did engage with the signage[92] demonstrated increased levels of knowledge. Whitehouse *et al*. (2014) designed and installed interactive games on touchscreens at two primate research centres based in zoo environments and found that young individuals (under 16's) were much more likely to engage with the games and their content. Overall, studies such as this re-affirm the importance of material elements of the setting and the presence of researchers themselves. Saikkonen and Väliverronen (2014) have also suggested that public engagement can be improved through a more in depth consideration of staging, design and facilitation. They analyzed an event named *Climate change discussion panel and an online chat for young people* which was held during the Science Forum 2011 in Finland. The authors identified an occurrence of 'interactive dissonance' where "the informality of the cafeteria as a physical environment and the promoted interactivity and possibility for audience participation were in dissonance with the theatrical staging of the event" (Saikkonen & Väliverronen 2014, p. 14). Therefore, researchers should begin to consider the physical environment of the engagement events

[91] The Macaque Study Centre (http://www.port.ac.uk/department-of-psychology/facilities/macaque-study-centre/) at Marwell Wildlife (https://www.marwell.org.uk/zoo/), Hampshire, UK.

[92] Ross and Gillespie (2009) found a significant difference in the way visitors engaged with signage.

vis-à-vis their interactive approach in order to ensure the emergence of an appropriate affective atmosphere within the context of an engagement event.

8.3.3 Rethinking of Science Communication

This research project has made a contribution to further developing the theory of science communication. Central to my analysis has been the 'model of emergence' of science communication as suggested by Horst & Michael (2011). Within this model, the authors allow for the coming together of "numerous entities that are social and material, human and non-human, macro and micro, cognitive and affective, available and unavailable to consciousness. These entities in coming together, make the event" (Horst and Michael 2011, p. 286) and are imbued with "capacity to generate the *new*" (Horst and Michael 2011, p.286). In the case of researchers and publics, new and novel relations as well as identities can emerge. These relations can be underpinned by variable combination of communication models ranging from models identified in isolation to those that co-exist and potentially complement each other. Moreover, because the event is constituted through interactions, there is an emergence of something 'new' that is collective and is a result of those interactions. What is the collective 'new' phenomenon that 'emerges' as a result of all these entities coming together within the context of an engagement event? One of the more original contributions of the thesis lies in attempting to address this question. Specifically, I have paired the emergence model of science communication with the work on 'atmospheres' from socio-cultural geography – connecting science communication theory and the concept of 'affective atmospheres'. Anderson (2009) defines the 'affective atmosphere' as

> "generated by bodies – of multiple types – affecting one another as some form of 'envelopment' is produced. Atmospheres do not float free from the bodies that come together and apart to compose situations. Affective qualities emanate from the assembling of the human bodies, discursive bodies, non-human bodies, and all the other bodies that make up everyday situation" (p. 3)

Therefore, an engagement event (an example of a particular 'everyday situation') forms one group of materials and practices which make an atmosphere by bringing together people, objects, ideas affects and discourses. If public engagement events incorporate a range of actors and practices, an affective atmosphere (atmosphere of engagement) emerges as a result of the interactions within the context of the engagement, and influenced by pre-existing atmospheres of interrelations amongst the participants. Moreover, these atmospheres contribute to the formation of the overall 'atmosphere of engagement' that has recently enveloped the U.K. academic sector. More broadly then, one can begin to think about what the integration of the model of emergence with the concept of affective atmosphere can begin to tell us about science communication more

generally. How do engagement events contribute to the broader atmosphere of engagement? How do atmospheres evolve during the event itself? Can atmospheres be staged prior to the event in order to facilitate the emergence of particular publics? By considering the relationship between science communication and 'affective atmospheres', this research evolved towards initial engagement with 'affect', a concept that has garnered substantial focus, especially in human geography. Beginning to explore this connection indicates that there is potential for consideration of the affective and visceral registers associated with engagement subjectivities of researchers. Whilst, there is still some debate concerning how to research affect and atmospheres (Anderson 2015; Michels 2015), I believe that the field of science communication / public engagement and more broadly that of science and technology studies (STS) provides a fertile ground for elaboration on the role of affect in 'engagement beyond academia'. We can tell that there has definitely been an atmosphere of engagement that has enveloped the academic sector in the U.K. There has been a concerted attempt to stage this atmosphere through various policy initiatives. However, it has not been experienced in the same manner by the academic scientists as reflected in the variability of their engagement practices. Whilst on the one hand, an atmosphere can be 'staged', it will not be experienced in a uniform manner and therefore will be reconstituted. In the case of engagement events, the event itself (its heterogeneous composition) is affected by the overall atmosphere but generates its own to affect the former. Therefore, depending on the interactions between various bodies, the event-specific atmosphere and the broader atmosphere are subject to ongoing change.

8.3.4 Engagement and Impact – Towards an Interactions-based Perspective

The most recent research funding assessment in the U.K. was conducted within the parameters of the Research Evaluation Framework (REF). Its distinction was rooted in the inclusion of the 'impact' factor as a significant (20% of the total REF award). Since the fieldwork for this research was carried out, the evaluation has been completed and the results published on 18 December 2014. It appears that the 'impact' agenda is remaining. However, the question concerning the relationship between 'engagement' and 'impact' remains. Watermeyer (2012b) has suggested that the impact agenda situated within the REF exercise "has not eclipsed an engagement initiative for higher education (HE) in the UK but actually provided greater credence and tacit momentum" (p. 115). In a recent article, Weitkamp (2015) "'impact culture' is spreading to public engagement" (p. 1). The suggested implication is that activities that were previously deemed to be part of the altruistic activities by researchers can be potentially subjected to strategic evaluations. In my interviews, some researchers did begin to suggest that for some academics there may be this shift in mind set as a result of the engagement agenda. In Chapter 7, grounded in empirical data, I have suggested that the prevailing 'atmosphere of engagement' may potentially be polarised if not

deposed by the emerging impact agenda. This suggests that scientists' perceptions of the policies may differ from the perceptions intended at the policy level. de Jong *et al*. (2015), in the context of the Netherlands, highlight a gap between the policy and how scientists perceive that policy in addition to the uncertainty in scientists' knowledge about how societal impact is evaluated and organized. My research can be said to be in unison with that of de Jong *et al*. (2015). There was clear discrepancy between what scientists understood impact definitions to be (as defined by the government body), and scientists' interpretation of impact in relation to what they believed the assessment panels wanted to see from their submissions. Subsequently, it is important to emphasize that engagement in its various forms (particularly engagement types that are not viewed as the most direct routes to impact, such as through commercialization or policy engagement) are methods of impact articulation and mobilization of impacts (Watermeyer 2012b). Therefore, emphasis is placed on the interactions between different actors rather than just on outcomes. This expands the focus from just being on outcomes as a result of interaction to including the actual interactions (i.e., engagement events) as 'potential' precursors to impact. The framework of 'productive interactions' (Molas-Gallart & Tang, 2011; Spaapen *et al*. 2011; Spaapen & van Drooge 2011), as developed by the SIAMPI project (Spaapen *et al.* 2011), sees engagement beyond academia as 'productive interactions' between the researchers and various publics as "as a 'proxy' for (future) impact" (de Jong *et al*. 2011, p. 62) by highlighting interactions that are precursory to and are in and of themselves 'productive' outcomes and lead to 'impact'.

8.4 Implications

The findings reported in this thesis can be of interest to a number of communities of practice including academic researchers, academic management of universities, professionals working in boundary spaces of universities (e.g., business engagement, knowledge transfer, science outreach) and other academic institutions and more broadly professionals working in the public engagement sector. In this section, I would like to draw out a number of implications that may be of relevance to the various communities of practice.

In Chapter 5, I have reported the diversity of engagement practices of the interviewed researchers. The engagement practices varied considerably for the different researchers within and across disciplines. Within the sample of interviewees, there was a more or less even distribution of researchers who actively sought out opportunities for engagement versus those researchers who participated once the opportunities presented themselves. However, it was apparent from the interviewees that engagement beyond academia for academic scientists whose research was not dependent on publics, was not considered to be a part of the academic role identity. Thus,

researchers' contribution to the constitution of the 'science-society' space is through multiple practices that may vary across the temporal scale. Therefore, researchers engagement trajectories are variable and do not adhere to just one path. Implicit in this is the diversity of understanding of what 'public engagement' amongst various researchers in and across various disciplines as well as particular institutions. In contrast, at the government and organizational levels, discourses around public engagement, knowledge transfer, consultancy, business engagement and others appear to occupy separate arenas. Consequently, there appears to be a need to apply a holistic, integrative approach to connecting science and society, scientist and publics in order to avoid dominance of particular forms of engagement. In particular, developing a discourse of 'trading zones' in relation to 'public engagement' events (also known as science outreach, popularization events, vulgarization events, etc. and which are often considered altruistically-driven) will contribute to its cultural integration amongst academic scientists within the case study university. In a broader sense, it will have an impact on the evolution of the 'atmosphere of engagement' within U.K. universities.

This thesis also highlighted the role of university boundary spaces (Chapter 6) which mediate scientists' engagement practices through processes of gatekeeping, mediation and management. I have identified two modes of interaction that are advocated across these boundary spaces - relations-focused or transactions-focused interactions. According to the gathered data, the boundary spaces within the case study university have attempted to facilitate both approaches thereby highlighting the intention of these spaces to maintain dual identities (one relation to management and one in relation to researchers) befitting of their position at the interface between university and society. Attempting to negotiate the two identities rather than developing a single identity (or 'hybrid' identity) that incorporates the other two actually may not contribute to greater legitimation of the boundary space within the university (O'Kane *et al*. 2015), particularly from the perspective of the researchers. Consequently, it is appropriate to begin to re-evaluate the mission of these spaces which are situated within the university (science) – public(s) trading zone and where the interactions between the two both emerge and are re-shaped. This focus is also inclusive of the relationship between these particular spaces and university researchers. Whilst the efficacy of the approaches which are enabled by the boundary spaces is debatable (e.g., Chapple *et al*., 2005; Friedman & Silberman 2003; Siegel *et al*., 2003), my research suggests that there needs to be a realignment of perspectives within the boundary spaces (and more broadly within the university) from purely focusing on standardized approaches for facilitation of relationships between researchers and publics towards developing 'bespoke' approaches which would reflect the diversity of the university academic research workforce, publics and the constantly evolving, contingent nature of the relationship between them.

Whilst I have emphasized the importance of researchers and publics as actors in in the functioning of the trading zone between science and society, this research alluded to the importance of both animate and inanimate actors that are involved. Therefore, it is also important to consider the materiality of engagement - settings, technologies and materials that are associated with engagement events. This knowledge is of value to science communication practitioners who can apply this understanding when designing communicative activities using appropriate spaces, technologies and props in order to 'appropriately' stage the event. However, it can also aid academics who are planning and/or designing their own engagement activities in focusing their thinking not just on the broader issues but also on the more minute details that can be connected with the materiality of engagement. The overall point is that it is important to create a synergy between the engagement events and the settings within which these engagement events are situated.

Engagement events are not socially isolated activities and in fact are outcomes and determinants of 'atmospheres of engagement'. This finding has direct implications for the science communication / public engagement literature and practice. Specifically, the implication here is that to provide a fuller understanding of public engagement with science and technology in the broader sense and also specifically engagement events, one must not only consider the observable and/or recordable practicalities associated with it, but one must also consider the more ephemeral aspects that need be inferred from a number of levels (national agency, university, department) before, during and after the event. For natural science researchers who are not necessarily working with social scientists who may be able to addresses these foci, this presents an unprecedented level of commitment to engaging in reflexivity regarding their scientific practice and their public engagement practice. At the theoretical level, the challenge is represented in connecting and integrating theories around affect, affective atmospheres and atmospheres with models of science communication and public engagement. This thesis has contributed initial steps towards accomplishing this integration.

Finally, the 'atmosphere of engagement' within the U.K. context, has now been to an extent polarized by a powerful driver in the form of the 'impact' agenda as a part of the REF. Whilst the interviews were conducted prior to the completion of the REF cycle (see Chapter 3) and the subsequent announcement of the results, the views expressed provided a strong indication that researchers and their institutions may interpret impact in a narrow way. Coupled with a poorly integrated engagement culture, the impact agenda may lead to prominence of certain engagement types whilst excluding the formats which would be deemed not suitable for the REF. Institutional insistence on instrumental 'impact', reported in chapter 7, is inconsistent with what some

researchers individually perceive as a broader role in research communication which is appropriate for them to carry out, and which is valued differently in terms of the intrinsic value of knowledge for society. It is interesting that this view (often attributed to researchers in Arts and Humanities) is also apparent here among physical and social scientists. In this case the research findings are suggestive of the need to re-orientate institutional priorities to be more inclusive of the diverse engagement formats and to value the commodities produced in 'shadow trading zones' outside the impact trading zones.

At the time of the interviews, part way through the REF cycle, researchers across several departments expressed a view that there had been poor communication coming from the university management about the impact component of the REF. It is interesting that at about this time a new central managerial role was set up in the case study university, specifically to help steer the process of organising REF submission of impact case studies. This speaks to the necessity of maintaining clear lines of communication in order to ensure that the expectations associated with subsequent incarnations of impact in next assessment exercises are understood by researchers. These initiatives need to reach a balance such that the multiplicity of engagement across the university is maintained whilst facilitating the emergence of impact policies that are compatible with the diversity thereby contributing to further integration of a culture of engagement. For at least 30 years, there has been extensive discussion about how to improve the relationship between science and society, particularly through communicative engagement. Yet there is still work to be done towards developing a *culture of engagement* (Neresini & Bucchi 2011) within academic institutions with the view of making 'engagement beyond academia' a part of the research profession (Casini & Neresini 2012).

8.5 Limitations

I have highlighted a number of implications stemming from my work and drew out a number of recommendations. In addition, I recognize that there are a number of limitations associated with the thesis. In particular, I consider the limitations imposed by the sampling population, conducting the research as an organizational case study and the temporal window of the research.

One of the limitations of this study concerns which scientists are included or excluded in the sampling population In the first instance, there may have been an implicit selection bias through utilization of the 'risk research register' which suggested that the researchers on that list would potentially be more likely to engage beyond academia in a number of ways since their research had elements of societal 'risk' associated with it. However, it is important to note that non-response to the participation request does not necessarily imply a lack of engagement practices beyond

academia. The initial set of interviewees had a range of previous experiences in engagement beyond academia in various formats. Furthermore, having been open to the idea of discussing engagement practices of researchers, the initial set of researchers, aided in identification of other researchers who would be open to the idea of participating in the research project (snowball sampling). The implemented approach can be contrasted with other studies that have been conducted in single institutions (Grand et al., 2015; Lawson, 2013; Pearson *et al*. 1997; Poliakoff & Webb 2007; Watermeyer 2012a). One common strategy used to ensure a greater body of information, particularly in studies with larger sample size, was to utilize a survey supplemented by interviews rather than purely relying on the latter for the bulk of data.

Stemming from the above point, another limitation (although it may also be considered as strength) is the fact that interviews were conducted within a single university. Due to the small sample size, the presented data from the conducted interviews is not generalizable to the case study university nor to the disciplines that were represented by the interviewees. Disciplinary differentiation may have been a route that was worth a stronger consideration for the purposes of sample attainment. Whilst focusing on a particular discipline, it would still be possible to demonstrate engagement diversity within one institutional setting. It is important to recognize that conducting research within a single university allows for demonstration of the diversity of engagement practices within one institutional setting, this picture is constrained by the numbers of researchers from various disciplines, as was the case with the conducted research. Nevertheless, the interviewed researchers did express a range of experiences, views and issues which may serve as foundation for further research, especially if situated still within the same university. Moreover, these findings can contribute to the wider literature on science communication / public engagement and can be used to further understand and improve the relationship between academic researchers and external stakeholders. Moreover, it is important to remember that this study was conducted during a particular time period in a particular context in the United Kingdom. Since then, the academic spectrum in the U.K. has changed substantially. For example, the performances of the various academic institutions in the REF, which include the landscape-shifting assessment criteria of 'impact', have been announced[93]. The interviews on which this research is based were conducted during the time when the function and assessment of 'impact' was still a debated topic. Therefore, the findings reported here have to be considered in light of that, since the engagement practices of the interviewed researchers may have shifted since then in order to accommodate the evaluation of 'impact' in future assessment exercises (e.g., REF2020).

[93] Results of REF2014 can be found at http://results.ref.ac.uk/.

This brief discussion has focused on the limitations associated with the present research. An exhaustive list of limitations has not been provided. However, the author selected those limitations that he judged to be of greater relevance for further elaboration. The limitations that have been considered above included the sample size, the nature of the research, and the temporality of the research.

8.6 Future Directions

The research presented in this thesis can be expanded into future work. In this section I list several potential directions that tie in the most with the research that has been presented here. As I have previously discussed in the literature review (Chapter 2), research in science communication / public engagement has overwhelmingly focused on publics – their composition, views, attitudes, beliefs. In comparison, there have been by far fewer studies that have specifically focused on the researchers. Studies that focus on the scientists still have room to make a contribution to this evolving body of knowledge. However, it is imperative to avoid treating scientists as a homogeneous group. Researchers can be found across a number of disciplines, research areas and organizational settings. In this study, the largest proportion of researchers was from physical geography (the second largest group was archaeology). At the time of writing, there has not been any extensive research concerning physical geographers, their views and practices of engagement[94]. Similarly, whilst archaeology is a discipline that is more socially embedded (Rockman & Flatman 2011) resulting in discussions around public archaeology (Hauptman 2015; Matthews *et al.* 2011; Schadla-Hall 1999), civic archaeology (Little 2007; Little & Shackel 2007; Shackel 2005) and community archaeology (Derry & Malloy 2003; Nevell 2013; Perkin 2010; Simpson & Williams 2008), public engagement is still an issue that is up for debate (Flatman *et al*. 2012; Little 2012; Pyburn 2011) and therefore, a focus on archaeologists would also be fruitful within the context of this discipline as well. Even more so, research disciplines such as computer science and chemistry have also been underrepresented in the studies that focus on scientists. Furthermore, there is scope to conduct research on engagement practices with researchers in specific organizational settings, such as individual universities, as was the case with this research. Moreover, there is potential for this type of research to be integrated with institutional research agendas and thus gain more legitimacy and potentially have avenues towards 'making an impact' (for a recent example from Open University see Grand *et al*. [2015]). Lastly, emergent contexts such as scientific controversies provide

[94] In May 2015 a Masters by Research student at the University of Glasgow was recruiting academics through the *Critical Geography Forum to participate in a study which investigates* the ways academic geographical staff in the UK have reacted to the introduction of 'Impact' as a criterion in the REF assessment. https://www.jiscmail.ac.uk/cgi-bin/webadmin?A2=ind1505&L=CRIT-GEOG-FORUM&F=&S=&P=135373

opportunities for research to explore communicative practices and engagement activities of particular researchers (potentially from different disciplines under very specific conditions. Currently, I would suggest that one such area is extraction of shale gas[95].

Finally, in the U.K., the introduction of the 'impact' agenda as a part of the REF, will invariably shift (as suggested in this work[96]) the factors that motivate researchers to engage beyond academia to be more externally motivated, with factors such as public or private funding opportunities, incentives and/or rewards, colleague participation, effect on academic prestige. These factors, in light of the new agenda, also present foci for further studies. Moreover, it is important to consider in future research how researchers' understandings of engagement and their actual engagement practices have changed in the post-REF2014 context.

Some of the aforementioned work would involve ethnographic methods. Thus far, these methods have dominated the work that has been focused on affective atmospheres. Therefore, case study research based on ethnographic methods within the context of an engagement agenda or a particular engagement event offers further opportunities for investigating the relationship between science communication / public engagement and affective atmospheres. This in turn can allow for the development of additional theory. In particular, I am suggesting for potential exploration of how theories around affect (and affective atmospheres) can be integrated with models of science communication and public engagement.

[95] Molinatti and Simonneau (2015) analysed discourse, practices and representations of a group of scientists who issued public statements about the French shale gas controversy. Williams *et al*. (2015) explore the public perceptions of hydraulic fracturing in the UK.
[96] Similar point is made in de Jong *et al*. (2015).

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Appendix I-A: Introductory Email to Researchers

Dear Prof. / Dr. _____,

My name is Boris Popov. I am a PhD student in the Department of Geography at [Russel Group] University. I am supervised by Prof. S.E. Curtis, Dr. A. Densmore and Mr. S. Sutherland.

I am carrying out field work as a part of my PhD work. It is focused on Communication of Scientific Research.

I am contacting you in order to invite you to take part in this stage of the research.

Prior to making a decision, I would like to provide you with an overview about why the research is being done, why I am contacting you and what it would involve for you. This can be found in the notes at the end of this email.

Please indicate by replying to this email whether you would be happy for me to send you further details about the study, including a survey questionnaire. (The questionnaire can be completed electronically, however I would appreciate the opportunity to meet with you in person for an interview.)

Thank you for your time and consideration.

Best regards,

Boris O. Popov

Appendix I-B: Participant Information Sheet

PARTICIPANT INFORMATION SHEET

I, Boris Popov, am a PhD student in the Department of Geography at Russel Group University. I am supervised by Prof. S.E. Curtis, Dr. A. Densmore and Mr. S. Sutherland.

My research project is focused on the '***communication of scientific research to non-academic audiences***'.

I am carrying out fieldwork as part of my PhD research.

I invite you to take part in this part of the research. Prior to making a decision, I would like to provide you with more information about why the research is being done and what it would involve for you.

I can personally go through this information sheet with you and answer any questions that you may have. Please do ask me if anything is not clear.

You can take your time to decide and to speak to others about this study if you wish.

3.7 Why is this study being done?

Scientists are facing increasing pressure to communicate their research findings to a variety of audiences in an effective manner. However, the ways in which scientific knowledge is transported and translated across the boundaries of different worlds has not been explored much. The main aim of this research is to assess and enhance strategies for translating and communicating to diverse non-academic audiences, the findings from research (with implications of risks to human populations).

3.8 Why have I been asked to take part?

I am contacting you to take part in this research because your profile on the university website indicates your previous / current involvement in research that has a 'risk' dimension / implication.

I would like to have the chance to ask you about your experiences in communicating research to non-academic audiences (e.g., 'lay' publics, policy makers, industry and other stakeholders). Amongst other things, I am interested in learning about your overall views on communication of research to non-academic audiences (issues, obstacles, influences, approaches). Furthermore, I am interested in how you develop communication strategies and materials for various audiences. From

your experience of such communication, I would be interested to know what has and hasn't worked, what has and hasn't been effective, about the actual process and the various factors and influences (both internal and external) at the institutional and societal levels.

Do I have to take part?

You have a free choice to take part or not. You do not have to take part if you do not want to. If you decide not to take part you do not need to give a reason why.

All information will be kept on secure, password-protected computers in locked offices at Durham University.

Any identifiable information about you will only be seen by the researcher (Boris Popov).

The only exception to this is that if you give information, which affects the health and safety of you, or someone else, or is a disclosure of a criminal act.

What will happen to the results of the study?

An anonymised report of the research will be shared with researchers from the BIOPICCC project that is being a used pilot study. The anonymised information may be used for publications and educational purposes.

Who has reviewed the study?

The study has been reviewed by the Department of Geography and SASS Ethics Advisory Committees at Durham University.

What are the possible problems or risks of taking part?

There are no special risks to you when taking part in this study. I am interested in finding out about how research is adapted and translated to fit the needs of various audiences; so no sensitive information is sought after. Any identifiable information will be anonymised. If at any point you feel uncomfortable about taking part, you can ask to stop the interview and it will finish.

What are the possible benefits of taking part in this research?

The relationship between science (scientists) and society is one that is very complex. Science researchers are expected to communicate complex research findings in an effective manner to a variety of non-academic audiences. By participating in the research you will contribute to gaining a better understanding of how researchers can improve the translation of their research for various non-academic audiences so that the researchers can begin and/or continue to improve their communication initiatives to better suite non-academic audiences.

What if there is a problem?

If you have a problem to do with this research, you can either speak to the researcher (Boris O. Popov), who will do his best to help. Alternatively, you can get in touch with the researcher's supervisor, contacting Professor Sarah Curtis at S.E.Curtis@durham.ac.uk and on 0191 3341830.

Will my taking part in this study be kept confidential?

Yes, this study is confidential, so your name will not be given to anyone. When I write up the study and tell other people about it, I will make sure that no one else knows that it is you that has answered the questions.

The only time I would have to give the name of a study participant to anyone outside myself would be if they tell us something that might be dangerous for themselves or someone else, of if they tell us that they have carried out a crime. I will not ask about those things, as they are not part of this study.

Therefore, I will follow ethical and legal practice and all information about you will be handled in confidence. I will treat all that you say in confidence. Should you choose to participate, the information that you provide in the interview will not in any way affect your status or employment.

If you decide to take part, you will be asked to sign a consent form to show that you agree to join the study. If you do agree to join the study and then change your mind at any time later, you can stop taking part. All you need to do is tell the researcher that you no longer want to be part of the study. I will then keep and use what you have already told me, but I will not ask you anything else.

What will happen to me if I take part?

If you want to take part in this study and you sign a consent form I will arrange for you to meet myself to provide your views in a one-to-one interview.

The meeting will usually last about between one and two hours (Usually, approximately 1 hour). You can ask to take a break or leave the meeting at any point, if you wish.

I may ask you to take part in another meeting for interview after the first one (and/or potential discussion group in the future). Before each new (additional) meeting, you will be asked to confirm that you will to participate in the research and, if necessary, to sign a consent form.

Permission will be requested to record the conversation with the researcher so that the researcher can listen to it again and write out what was said. The recording of the conversation will be destroyed at the end of the project.

If you take part in this study you will not receive any payment for your time.

What will I have to do?

If you decide to take part, I will ask you to sign a consent form and then to be interviewed for between one and two hours. I will ensure that the discussion takes place at a time convenient for you and that you have a safe and comfortable way to attend the meetings. I will not ask you to take part in an interview without someone to accompany you unless the meeting is being held in a safe, publicly accessible location such as local government offices or voluntary/statutory service premises.

Further information

If you would like any further information about the study you can ask the researcher (Boris O. Popov) who has given this sheet and the consent form to you. Alternatively, you can contact Boris' supervisor, Professor Sarah Curtis on 0191 3341830 at Durham University.

Appendix I-C: Consent Form for Interviews

Project – Communicating Scientific Research (PhD Research)

Researcher: Boris O. Popov (Doctoral Researcher, Durham University)

CONSENT FORM FOR INTERVIEWS (with Case Study University Researchers)

	Please tick yes or no next to each statement below		Please initial in each box below.
	YES	**NO**	
1. I have read and understand the information sheet for this study. I have had time to think about the information, ask questions and have answers to my questions that I am happy with.			
2. I understand that I have free choice whether to take part or not. I understand I can stop taking part at any time without giving any reason, and that this will not affect my legal rights.			
3. I understand that if I want to stop taking part in this study I can tell the researcher and leave straight away and that what has been recorded up to that point will not be used for this research study, unless I agree for this to be used.			
4. I understand that information collected during the study, may be looked at by research supervisor (in anonymised form: no identifiable information) from Durham University, where it is relevant to my taking part in this research. I give permission for these individuals at Durham University to have access to the information you give me: Boris Popov, researcher [if required, Prof.S.E. Curtis (primary supervisor)].			
5. I agree to the audio-recording of this interview and I understand that the researcher will write up what has been said as part of this research (but will not include my name in the write-up). I also understand that the recording will be destroyed at the end of the project.			
6. I understand that the anonymised information may be used for publications and educational purposes. I give permission for the information to be used in this way.			
7. I agree to take part in the above study.			

Name of Participant (in block capital, please):	
Signature:	
Date of Signature:	
Name of Person taking consent:	
Signature:	
Date Signature:	

**** When completed: 1 for participant and 1 for researcher file. ****

Appendix I-D: Interview Prompts (21 November 2012 Draft)

MAIN BODY OF QUESTIONS – for all Scientists

INTRODUCTION TO THE RESEARCH

Overall, my research looks at the ways in which scientific (research) knowledge is translated and moved across boundaries for different worlds. The research is grounded in the complex relationship between scientific and social worlds which has created added pressure on scientists in Britain to engage with various non-academic worlds and communicate their research. This pressure has been compounded through the incorporation of 'impact' within the new research assessment framework (REF). Within this context, a new category of individuals / organizations is emerging who may be classified as intermediaries / knowledge brokers.

Through this interview my aim is explore a set of issues related to the science-society relationship including: background, motivations, outlooks, role of intermediaries and/or knowledge brokers and the role and importance/influence of REF.

INTRODUCTION / BACKGROUND QUESTIONS

The questions in this section explore the autobiographical history of the interviewee; skills and expertise of the interviewee; personal and professional satisfactions and dissatisfactions with work.

Could you tell me about your own area of scientific work?

- What do you do now?
- How you came to be doing what you are doing now?

– a short history of your career to date.

Can you tell me something about the kind of work that you do – e.g., modelling, statistical, empirical, involving fieldwork, analytical etc.

- What kind of skills do you need?
- How varied is your job?
- What are the different elements of work that make up your job?

What is the real motivation for you doing your job and your research? Are your motivations connected to commitments inside/outside the purely scientific realm?

Does being a scientist in your sphere of research have any particular significance for you? Does it have any particular significance for the wider society?

What would you say is the most important thing in your work that you do, for you personally?

What is the most important thing that you do professionally? Is there any tension with the personal sense of achievement we talked about in the last question?

SCIENCE, SOCIETY & SCIENTIFIC RESEARCH COMMUNICATION

I am interested in the areas where science and non-academic publics (e.g., 'lay' people, policy/decision makers, industry, NGOs, etc.) come together.

As an academic scientist, how do you view society generally?

From your perspective, what is the relationship between science and society and in particular, your discipline and society?

How do you think scientists are viewed in society more generally?

Scientists are expected to engage with a variety of non-academic 'publics'. Can you tell me about the ways in which you find that you have to relate your research to these 'publics'? Can you give examples from your work?

How do different types of science-publics relationships work? What is your relationship to such people or bodies? How do you see your own role in relation to these different types of publics?

In which ways are you communicating outside the strictly scientific world with/to decision / policy makers, advisory committees, NGOs, 'lay' people, etc.? If at all, in which ways are you communicating scientific research (results)? How do you translate your scientific knowledge from one social world to another? Can you give some examples relating to your work?

Are these interactions satisfying in professional terms (e.g., does the communication work well, the flow of knowledge smooth) Where are the difficulties?

Have you ever had to communicate scientific research that you have felt to be difficult to translate for non-academics because of the associated complexities, uncertainties and/or risk? Can you give

examples from your own work? How do you communicate things like complexity, uncertainty and/or risk to various non-academic publics?

KNOWLEDGE BROKERS / INTERMEDIARIES

The relationship between scientists and various social worlds is often mediated by individuals (e.g., university communications officers, dissemination writers) / organizations (e.g., Science Media Centre) which can be described as intermediaries and/or knowledge brokers, who are found at the 'boundaries' of various social worlds.

Taking this into consideration, have you ever worked with an individual and/or organization that can be classified as a knowledge broker and/or intermediary? Can you give an example?

- If YES,

o Who was it?

o Can you tell me something about the kind of work that they did?

 What kind of skills do they need?

 How varied is their job?

 What are the different elements of work that make up their job?

o What was the nature of your work with them? Can you give an example?

 What motivated you to work with them?

 How did you work together?

 What worked?

 What didn't work?

 Would you work with that type of individual/organization again? Why or why not?

INSTITUTIONAL CONTEXT - REF

The higher education sector in the UK is undergoing great changes under the new REF, in particular due to its 'impact' component.

What is your opinion of the new REF, and in particular its 'impact' component?

From your perspective, within the context of REF, how would you define 'impact'?

From your perspective, why has 'impact' been included within the REF?

Can 'impact' be demonstrated?

How can impact be demonstrated?

From you perspective, how will the new REF (and in particular the 'impact' component), if at all, affect the way scientists work?

How will the new REF (and in particular the 'impact' component), if at all, affect your personal work?

Will the new REF (and in particular the 'impact' component) affect communication of scientific research? To non-academics? (by the wider scientific community? by you personally?)?

- If YES, how?
- If NO, why not?

What will the post-REF academic landscape look like?

- What are your expectations?
- How will it affect the scientific culture?
- What will be the impact on the communication of scientific research to non-academics?
- How will the REF affect the relationship between science and society in general and more specifically the relationship between scientists and society?
- How will the REF affect the public perception of scientists and vice versa?
- What will be REF's legacy?

REFLECTIONS ON THE INTERVIEW

Do you think about the kinds of issues that we have covered in this interview much?

Is it useful to think about these kinds of issues?

Is it usual / unusual for you to discuss these types of issues?

AT THE END

Is there anything that you would like to add that we haven't covered?

Is there anyone at Durham University or at another higher education institution in the UK who it may be worthwhile to speak to about the topics raised in this interview?

SUPPLEMENTS

For those that worked with the communications office

The following questions are aimed at scientists who have worked with the communications office with the view towards engaging with traditional media (newspapers, radio, television).

Can you tell me something about what you think the job of the communications office (people working in the communications office) involves?

- What kind of skills do they need?
- How varied is their job?
- What are the different elements of work that make up their job?

To sum up, from your perspective, what is the purpose of the university communications office?

Can you provide an example of working with the communications office in relation to your work?

- Did you pitch the story to them or did they come to you?
- What did the working process involve?
- How did the relationship develop?
- What were the advantages of working with the media office?
- What were the drawbacks of working with the media office?
- What was the overall experience like?
- Would you do it again? Why or why not?

What do you see as some of the alternative options available to scientists to communicate their research to non-academic publics? What are some of the alternative ways that you have

communicated your research to non-academic publics (apart from academic publications)? Can you give examples?

For those scientists that have attended the Media Training

The following questions are aimed at scientists who have attended media training.

Why did you decide to attend media training?

What did you expect from the training?

How would you assess your communication skills before attending the training?

How would you assess your communication skills after attending the training?

What did you find useful about the training?

What did you find not so useful about the training?

Did the training meet your expectations?

Would you consider attending more advanced training? Why or why not?

For those scientists that have communicated through traditional forms of media (newspapers, radio, television)

The following questions are aimed at scientists who have engaged in communication through the traditional forms of media.

Traditional forms of media (newspapers, radio, and television) represent powerful mediums which allow scientists to reach large audiences. However, the relationship between science and journalists has often been described as 'contentious'.

Can you describe your experience?

- How did the opportunity come about?
- Did you have any reservations about the process?
  - Was proven to be the case or not?
- Type of media (TV, journals, newspapers, radio, etc.)
- What difficulties did you encounter?

- What didn't work?
- Was there anything positive gained from the experience? If so, what was it?
- Was the reporting truthful?
- What were the consequences?
- Would you proceed down the same route again?
- What was your opinion of journalists prior to working with them?
- Did it change after working with them? Why or why not?

For those scientists that use social media

The following questions are aimed at scientists who have (had) engaged in communication through various social media tools.

How would you define social media?

Do you use social media?

If NO, why not?

If YES, what types of social media to you use?

Can you expand on why you use those particular social media types?

BLOGS

Why do you blog?

Can you tell me about your blog?

- Is it an academic blog or a personal blog?
- How long have you been blogging?
- What do you blog about?
- How often do you blog?

Do you blog about your scientific research?

Do you blog about research done by others?

How would you characterise your readership?

Do you engage in dialogue with the readers on your blog?

What are the positive aspects of blogging?

What are the drawbacks?

Do you know of other academics in your field (in Durham or at other higher education institutions) that blog?

- Who are they?
- What is the name of their blog?

Despite the widespread popularity of blogging and offering a direct way to engage with a variety of non-academic publics blogging hasn't been taken up extensively by academic scientists.

How is blogging perceived by academic scientific community? In your field of research?

Why aren't scientists blogging in general? In your field of research?

From your perspective, what are the individual, organizational (university, department), institutional (higher education sector) factors that affect whether scientists engage in blogging? Can you give examples?

How can more scientists be encouraged to engage in blogging?

For those that worked with industry

The following questions are aimed at scientists who have (had) engaged with industry.

Engaging with industry is another route available to scientists (in particular fields such as Earth Sciences, for example) to communicate their research, albeit in a very translated form, to non-academic publics.

How is engaging with industry perceived in your discipline?

- Why is it or isn't important? Is there pressure to do it?

How do you think the public perceives when academic scientists engage with industry?

Can you tell me about the ways in which you find that you have to relate your research to industry partners? Can you give examples from your work?

What is your relationship to industry?

How do different types of science-industry relationships work? How do you see your own role in relation to industry? How do you translate your knowledge from one sphere to another?

From your perspective, as a university-based academic scientist, what is the utility of working with the industry?

- What are the positives?
- What are the drawbacks?

Can you give an example of when you worked with industry? Can you talk about the process that you underwent in working with the industry?

- What are the advantages of working with the industry?
- What are the drawbacks of working with the industry?
- What mechanism did you use (e.g., KTP, own time, sponsoring a research student, etc.)?
- Apart from you and industry reps, who was also involved? What did they do?
- How would you characterize your experience of working with the industry?
- Would you do it again? Why or why not?

Are these interactions satisfying in professional terms (e.g., does the communication work well, the flow of knowledge smooth) Where are the difficulties?

As part of the REF, 'working with industry' is one of the most talked about ways to demonstrate impact. What is required for smooth scientist-industry relationship? What are the current obstacles?

Appendix I-E: Event Descriptions

3.9 How to Write a Press Release

Course code	GD127
Course title	How to Write a Press Release
Description	The media, print and broadcast, is a powerful, readily available vehicle for researchers to reach a wide audience. This half-day session for early stage researchers will provide an introduction to working with the media. Participants will find out what makes news and write and review their own press release. The course will build both knowledge of the media and confidence in interacting with it, as well as giving you the opportunity to write a press release describing your area of research.
Tutor(s)	---
Places	20
Free places	20
Booking policy	Postgraduate withdraw up to 1 day ahead of course

Course sessions

Room	Date	Start time	End time
Removed to maintain anonymity	31 January 2012	13:00	16:00

3.10 REF Working Lunch

Course code	GD479
Course title	REF Working Lunch
Description	**Research Excellence Framework** The policy is set out below but what does it mean for the individual researcher? You will be hearing much about REF in the coming months. Do you know what it is all about? Case Study University's REF Manager, will be providing an overview and answering questions. The Research Excellence Framework (REF) is the new system for assessing the quality of research in UK higher education institutions (HEIs). It will replace the Research Assessment Exercise (RAE) and will be completed in 2014. The Higher Education Funding Council for England (HEFCE) working with their equivalents in Scotland, Wales and Northern Ireland are managing the REF on behalf of Government. The primary purpose of the REF is to produce assessment outcomes for each submission made by institutions: · The funding bodies intend to use the assessment outcomes to inform the selective allocation of their research funding to HEIs, with effect from 2015-16. · The assessment provides accountability for public investment in research and produces evidence of the benefits of this investment. · The assessment outcomes provide benchmarking information and establish reputational yardsticks.
Tutor(s)	---
Places	20
Free places	20
Booking policy	Postgraduate withdraw up to 1 day ahead of course

Course sessions

Room	Date	Start time	End time
Removed to maintain anonymity	18 May 2012	12:15	13:30

3.11 Research Excellence Framework (REF) briefing for researchers

Course code	GD482
Course title	Research Excellence Framework (REF) briefing for researchers
Description	Wat are the implications of the Research Excellence Framework for the individual researcher? You will be hearing much about REF in the coming months. Do you know what it is all about? Case Study University's REF Manager, will be providing an overview and answering questions. **The Research Excellence Framework (REF)** The new system for assessing the quality of research in UK higher education institutions (HEIs). It will replace the Research Assessment Exercise (RAE) and will be completed in 2014. The Higher Education Funding Council for England (HEFCE) working with their equivalents in Scotland, Wales and Northern Ireland are managing the REF on behalf of Government. The primary purpose of the REF is to produce assessment outcomes for each submission made by institutions: • The funding bodies intend to use the assessment outcomes to inform the selective allocation of their research funding to HEIs, with effect from 2015-16. • The assessment provides accountability for public investment in research and produces evidence of the benefits of this investment. • The assessment outcomes provide benchmarking information and establish reputational yardsticks.
Tutor(s)	---
Scheduling Notes	Refreshments will be provided.
Places	40
Free places	40
Booking policy	Postgraduate withdraw up to 1 day ahead of course

Course sessions

Room	Date	Start time	End time
Removed to maintain anonymity	25 May 2012	11:00	12:15

3.12 An Introduction to Media Relations: How to Make the Headlines (Level 1)

Course code	GD498
Course title	Level 1: An Introduction to Media Relations: How to Make the Headlines
Description	Level 1 is for anyone at Case Study University who is not familiar with the Media Relations Office and wants to know more about how we engage as a leading University with the world's media and how we can publicise your work.
Tutor(s)	---
Places	10
Free places	10
Booking policy	Postgraduate withdraw up to 1 day ahead of course

Course sessions

Room	Date	Start time	End time
Removed to maintain anonymity	14 February 2013	10:00	12:00

3.13 Newton's Apple - an introduction to science policy

Course code	GD506
Course title	Newton's Apple - an introduction to science policy
Description	• Have you ever wondered how scientists and their research can influence government science policy? • How can scientists help prevent budget cuts, increase funding and improve the public standing of science? • Would you like to contribute to the decisions that shape science and society in the future? These 'Introduction to Science Policy' Workshops will give you the chance to find out more about the policy processes and the methods by which you can contribute to it. The Workshop will also give you the chance to put your questions to the people who have worked regularly on science policy issues. The Workshop is suitable for postgraduate research students. **Seminar structure:** **An introduction to science policy** – Presentation by **Dr Monica Darnbrough** , (Formerly Director of Biotechnology, Department of Trade and Industry, and a former civil servant in the Cabinet Office) The guest panelists will provide information from their own unique perspective on ways in which scientists can communicate more effectively with policy makers. **Science in Parliament - Mr Andrew Miller MP**, (Chair of the House of Commons Science and Technology Select Committee). **Science in Government - Dr Elizabeth Sturkivic**, (Deputy Director, Science in Government, Government Office for Science) **Role of the Scientific Societies in Policy formation - Dr Stephen Benn**, (Director of Parliamentary Affairs, Society of Biology) **Can scientists influence policy? - Two Case Studies** - "The 2008 Fertilisation and Embryology Act" **Dr Ian Gibson**, (Formerly MP for Norwich and Chair of the House of Commons Science and Technology Select Committee.) - "The EU Physical Agents Directive and its potential impact on use of MRI" - **Dr Michael Elves,** (Chairman, Newton's Apple, formerly Director of Scientific and Educational Affairs, Glaxo Wellcome and Special Adviser to the House of Commons Science and Technology Select Committee) **Discussion –** Participants will have the opportunity to pose their questions to the panelists on science policy issues and how the science-into-policy process can be improved. Participants will be provided with Newton's Apple booklets – "Science Policy Explained and Explored", "How Policy is Made – A Short Guide" and " An Introduction to Policy Making the the European Union" – and

	also “A Directory of Useful Science Policy Websites”.
Tutor(s)	Removed to maintain anonymity
Places	40
Free places	40
Booking policy	Postgraduate withdraw up to 1 day ahead of course

Course sessions

Room	Date	Start time	End time
Removed to maintain anonymity	15 July 2013	09:00	13:00

Appendix I-F: List of Analysed Documents

Royal Society (1985) Public understanding of science, Royal Society: London. [Bodmer report]

Committee to Review the Contribution of Scientists and Engineers to the Public Understanding of Science, Engineering and Technology, (1995) Report, http://collections.europarchive.org/tna/20060215164354/http://www.dti.gov.uk/ost/ostbusiness/puset/report.htm [Wolfendale report].

House of Lords (February 2000) Science and Society, HMSO: London (http://www.parliament.the-stationery-office.co.uk/pa/ld199900/ldselect/ldsctech/38/3801.htm).

Hargreaves, I. and Ferguson, G. (September 2000) Who's misunderstanding whom? Bridging the gulf of understanding between the public, the media, and science, ESRC: London.

POST (March 2001) Open Channels: Public dialogue in science and technology, [Report], POST: London.

Research Council UK (August 2002) Dialogue with the public: practical guidelines. RCUK:

London. [commissioned by RCUK and OST from People Science & Policy Ltd & Taylor Nelson Sofres]

Roberts, G. (April 2002) SET for success: the supply of people with science, technology engineering and mathematical skills. [Report] HM Treasury; London http://www.hm-treasury.gov.uk/ent_res_roberts.htm

Council for Science and Technology (March 2005) Policy through dialogue: informing policies based on science and technology. CST: London http://www.cst.gov.uk/reports/#Dialogue

Wildon, J., Wynne, B. and Stilgoe, J. (2005) The public value of science, Demos: London.

Lord Sainsbury (October 2007) The race to the top: A review of Government's Science and Innovation policies, HMSO: London.

Department of Innovation, Universities & Skills (July 2008) A vision for Science and Society [Consultation] http://interactive.dius.gov.uk/scienceandsociety/files/A_Vision_for_Science_and_Society.pdf.

Science and Trust Expert Group (March 2010) Staring a national conversation about good science. [Report] http://interactive.bis.gov.uk/scienceandsociety/site/trust/2010/03/08/new-science-and-trust-expert-group-report-starting-a-national-conversation-about-good-science/

Appendix I-G: Research Ethics and Data Protection Monitoring Form

Research Ethics and Data Protection Monitoring Form

Research involving humans and environmental impacts by all academic and related staff and students in the department is subject to University requirements for ethics and data protection review. The Department's Research Ethics and Data Protection Peer Review Group will assess research against the guidelines given by the British Sociological Society Association and the Natural Environment Research Council.

It is a requirement that prior to the commencement of all research that this form be completed and submitted to the Department's Research Ethics and Data Protection Peer Review Group. The Peer Review Group will be responsible for issuing certification that the research meets acceptable ethical standards and will, if necessary, require changes to the research methodology or reporting strategy.

A copy of the research proposal detailing methods and reporting strategies is attached ☒**Yes**

Name of principal investigator or main applicant: **Boris Olegovitch Popov**

Title of research project: **Scientific Research Communication: Translating the 'science' and the 'social'**

Main subject area: **Human** Physical Interdisciplinary

Questionnarie

		YES	NO	
1.	Does your research involve living human subjects?	Yes		IF NOT, GO TO DECLARATION AT END
2.	Does your research involve only the analysis of large, secondary and anonymised datasheets?		No	IF YES, GO TO DECLARATION AT END
3a.	Will you give your informants a written summary of your research and its uses?	Yes		If NO, please provide further details and go to 3b
3b.	Will you give your informants a verbal summary of your research and its uses?	Yes		If NO, please provide further details
4.	Does your research involve contemporary covert surveillance (for example, participant observation)?		No	If YES, please provide further details
5a.	Will your information *automatically* be anonymised in your research?		No	If NO, please provide further details and go to 5b

5b.	IF NO Will you explicitly give *all* your informants the right to remain anonymous?	Yes		If NO, why not?
6.	Will monitoring devices be used openly and only with the permission of informants?	Yes		If NO, why not?
7.	Will your informants be provided with a summary of your research findings?	Yes		If NO, why not?
8.	Will your research be available to informants and the general public without authorities restrictions placed by sponsoring authorities?	Yes		If NO, please provide further details
9.	Have you considered the implications of your research intervention on your informants?	Yes		Please provide full details
10.	Are there any other ethical issues arising from your research?	Yes		If YES, please provide further details

Further details

3a – Those individuals that will participate in the project (researchers at Durham University) will make that decision based on a provided outline of the purpose, aims and objectives of the project. This document will provide enough information for them to make an informed decision about whether to complete the survey or not.

3b – Individuals selected for the interviews will be the researchers that expressed interest in working with me upon initial contact. Therefore, they will initially already have knowledge about the project. Prior, to the interview the purpose of my research will be restated in order to maintain a consistent procedure. However, there will be interviews with individuals that were not part of the targeted survey audience. When conducting interviews with them, the purpose, aim and objectives of the survey will be outlined in order to maintain a consistent procedure.

5a – No names will be used in writing up of the research and I will be careful not to publicly mention other information that will identify individuals.

6 – Prior to arranged interviews the participants will be made fully aware that the interviews will be recorded. They will have the option of opting out based on this consideration.

7 – A full draft of my thoughts for each case study will be provided to the researchers involved in order to solicit written comments. According to Yin (1984), such comments are an important part of the validation procedures for case study research and are not merely a professional courtesy. Such comments may provide corrections as well as additional information that the informant may now understand to be relevant, after seeing the draft of the case study. Following such feedback, it may be possible to write up the entire findings as a synthesized thesis.

An offer will be extended to the departments to conduct a seminar on 'research communication' / public engagement where issues raised within the case studies will discusses within the general context of research communication/science communication/public engagement in the UK.

9 & 10 – I have considered the implications of my research for the participants. As a researcher I have the responsibility to the pursuit of objective knowledge and the truth, but also to the participant(s) of my research. (Munhall, 1988; Robinson & Thorne, 1988). Diener and Crandal (1978) emphasize four dimensions of ethical considerations: whether there is harm to the participants, whether there is lack of informed consent, whether there is an invasion of privacy, whether deception is involved.

Consequently, several considerations must be accounted for:

- Questions about researchers' own ways of working might seem intrusive

- There may be issues of team dynamics and issue management that needs to be resurrected - Research may touch on sensitive issues associated with the REF assessment

- My research in part deals with institutional dynamics and determinants that affect the development of research communication strategies. For some interviews (researchers, administrative staff, etc.) this may prove to be a sensitive topic as they may feel it may not be inappropriate to effectively provide 'critical' information of the institution that is employing them. However, this issue should be mitigated by the anonymity guaranteed by the researcher.

References –

Diener, E., Crandall, R. (1978) Ethics in Social and Behavioural Research. Chicago, Illinois, USA: University of Chicago Press.

Munhall, P.L. (1988) 'Ethical considerations in qualitative research.' Western Journal of Nursing Research 10, 150-162.

Robinson, C.A., Thorne, S.E. (1988) 'Dilemmas of ethics and validity in qualitative nursing research.' The Canadian Journal of Nursing Research 20, 65-76.

Yin, R.K. (1984). Case Study Research: Design and Methods. Beverly Hills, CA, USA: Sage

Continuation sheet YES (delete as applicable)

Declaration

I have read the Departmental Guidance on Research Ethics and Data Protection and believe that, where appropriate, the research proposal complies fully with the requirements of the documents listed (Appendices B-F). I will not deviate from the methodology or reporting strategy without further permission from the Department's Research Ethics and Data Protection Peer Review Group. CRHS

Signed **Boris Olegovitch Popov** Date **September 2011**

Submissions without a copy of the research proposal will not be considered.