INNOVATION AND POLICY NETWORKS: THE SOCIAL SHAPING OF BSE-RELATED TECHNOLOGIES AND THE INADEQUATE ASSESSMENT OF RELATED RISKS

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Preface

This research has emerged from a two year project entitled *'Consumer, environmental and sectoral networks in the societal management of food technology'*, a study sponsored by the European Commission's *'Environment and Climate'* programme. Within this project four case studies were selected as a means of illustrating the close relationship between food technology and social risk. The cases included a) the vessel monitoring system technology, introduced to regulate overfishing; b) growth enhancing animal feed and its link with BSE; c) genetically modified crops and the possible repercussions upon human health and the natural environment; d) PVC food packaging as a possible cause of endocrine disruption. The innovation processes and associated risk debates were analysed across four countries: the UK, France, Denmark and Spain.

This case study explores growth enhancing animal feed technology in the UK and in particular one feed ingredient, meat and bone meal (MBM), which has spread BSE across the UK, as well as abroad. The use of MBM in animal feed, MBM manufacture, and any associated risks, form the core of this analysis. This thesis seeks to present a useful model for incorporating the innovation and risk arenas so that social disasters like BSE are not repeated. The research has revealed the reluctance of UK policy-makers to open up the innovation process to wider society, failing to embrace the precautionary voices of actors external to the core policy arena in which mainly regulatory and industry actors reside. However, negative impacts of technology are increasingly being experienced by society, demanding a new approach to technological innovation.

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Innovation and policy networks: the social shaping of BSE-related technologies and the inadequate assessment of related risks

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Abstract

BSE (Bovine Spongiform Encephalopathy) is one of the most prominent public controversies of the twentieth century. Involving the slaughter of thousands of cattle and the death of over 100 people, the disease has had devastating effect upon the personal lives of many people in the UK. Furthermore, it has had a damaging effect upon the country's economy and due to its sudden emergence and uncertainty over its cause, BSE has greatly challenged political actors during management of the crisis.

This analysis explores how this agricultural disaster is closely related to technological innovations adopted by the related agricultural industries. Through a framework which defines technological innovations as being socially shaped, this study examines how the MBM technological trajectory involved the participation and influence of a number of actors who for various reasons sought to develop two innovations associated with a) the use of MBM in animal feed and b) the manufacture of MBM. However, during the innovation process there were also actors expressing a desire for precautionary action in relation to the innovations. The concerns of these actors were sidelined and the arguments of these two groups of actors have been studied to understand how the BSE technologies failed to incorporate adequate risk assessment.

The influence of social actors, involved in either the advancement of the innovation or in desiring greater control over the technologies, has been determined through a process of discourse analysis of an array of primary documentation. This has been supported by more recent evidence from the public BSE Inquiry, as well as by interviews with key actors involved in post-BSE discussions and management.

The objective of this study is to develop the *social shaping of technology* approach through extending its social network model of innovation to incorporate the innovation-related policy network. This permits an analysis of the (in)effectiveness of the regulatory control of technology. This BSE case study has exposed the limitations and repercussions of closed policy networks in terms of risk management. In the current social and political climate of organisational interdependency, policy formulation in relation to technological change also needs to embrace the views of actors who are not traditionally a part of the core policy sphere. State encouragement and institutionalisation of such social groups is a much needed step forward in ensuring that technological innovations are socially less problematic. The BSE controversy serves as a powerful example of the sometimes grave consequences of marginalising such voices.

Key words: actors, discourse, network graphics, precautionary principle, policy community

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Abbreviations

- AMA: Association of Metropolitan Authorities
- ARC: Agricultural Research Council
- BPF: British Poultry Foundation
- BSE: Bovine Spongiform Encephalopathy
- CTA: Constructive Technology Assessment
- DEFRA: Department for Environment, Food and Rural Affairs
- DoE: Department of Environment
- DPM: Dried poultry manure
- FDA: US Food and Drugs Administration
- FMD: Foot and Mouth Disease
- FPRF: Fats and Proteins Research Foundation
- GM: Genetically modified
- GMOs: Genetically modified organisms
- IEHO: Institution of Environmental Health Officers
- MAFF: Ministry of Agriculture, Fisheries and Food
- MBM: Meat and bone meal
- MLC: The Meat and Livestock Commission
- MMC: Monopolies and Mergers Commission
- NFU: National Farmers Union
- NRA: US National Renderers Association
- nvCJD: new variant Creutzfeldt-Jakob Disease
- PDM: Prosper De Mulder
- PPO: Protein Processing Order
- RRI: Rowett Research Institute
- SBO: Specified Bovine Offals
- SCOT: Social Construction of Technology
- SOA: Scottish Office of Agriculture
- SST: Social shaping of technology
- SVS: State Veterinary Service
- TEN: Techno-economic network
- UKASTA: United Kingdom Agricultural Supply Trade Association
- UKRA: United Kingdom Renderers Association
- USDA: United States Department of Agriculture
- WSL: Warren Springs Laboratory

1 Introduction

1.1 Rationale for the study

The ubiquitous existence of food makes food-related matters an important focal point for sociological research. Technologies through which food is produced equally deserve examination, especially as risks in the production of food often impact upon human health, as continuous examples illustrate (salmonella, listeria and E-Coli 0157). The BSE (Bovine Spongiform Encephalopathy) controversy further amplified social concerns over food-related risks and most explicitly highlighted that technologies that produce food need to be controlled.

The social impact of BSE has been phenomenon, making it a popular topic of study. There has been massive economic damage experienced by a once thriving UK beef industry due to the slaughter of almost 200,000 confirmed cases (DEFRA, 2001a). A decline in beef sales because of the crisis means that the related industries are suffering long-term financial losses (Fiddes, 1991). There have also been human deaths. The human form of BSE, new variant Creutzfeldt-Jakob Disease (nvCJD), has claimed the lives of over 100 people in the UK in the most frightful way. BSE and nvCJD illustrate the very serious consequences of allowing technological developments to continue without adequate risk assessment. Discussing the common criticism of the UK government's management of BSE, it is therefore of little surprise that Shaw (1999) concludes:

'BSE, is the last time that the consumer will allow a delegated body, be it government or industry, to tell them reliably that things are safe' (page 8).

BSE has also re-underlined the nature of our global society where agricultural production reaches not only national but international markets (Yearley, 1996). Through exports of UK MBM, other countries have also experienced BSE cases (e.g.

France, Spain, Portugal and Germany), identifying BSE as an international problem (Hadjikhani and Seyed-Mohammad, 1997; Gonçalves, 1998; Brookes, 1999). The numerous BSE regulations at EU level further indicates this (Tacke, 2001). Such impacts of technology strengthen the argument for greater social responsibility in ensuring that our food products are safe.

Though some would argue that BSE was an unforeseen disease for which no prior risk assessment could be conducted, this analysis presents contradictory findings. During the adoption of the BSE technologies there were various actors highlighting possible risks with the technologies. 'Actors' in this analysis refers to organisations or individuals. The core of this research is to study why such social concerns failed to gain the necessary recognition.

1.2 Aims and objectives of the study

The central argument of this project is that technological innovation and risk assessment must be conducted simultaneously, within an open structured policy network. The conventional source of risk assessment, pure science, has failed to provide societal protection and therefore society needs to supplement such scientific sources and adopt a more active role during periods of technological change. Social actors need to be encouraged to participate in the innovation process and where need be, challenge the dominant actors in directing technology-related policy. Through such pluralistic policy-making risk management promises to be far more effective.

This study of technological innovation contributes to the *social shaping of technology* (SST) school of thought where technologies are stated as being a production of various social influences. Taking social actors as the forces of social influence, this analysis explores the wider societal role in the formulation and development of technologies. Contradicting the traditional explanation of technological evolution as resulting from R&D activities, this theoretical framework provides a more holistic context in which to examine innovation.

Arguing that actors have the potential to control a technological path, SST theorists emphasise that rather than a single technological choice, there are instead a variety of technological options from which a technological selection can be made. There is therefore the possibility of selecting a technology which will be less hazardous.

This research centres upon meat and bone meal (MBM), the ingredient in animal feed which spread the BSE pathogen throughout the UK. Not only is the use of this technology in animal feed identified as a contributing factor in the emergence of BSE, but so too is the manufacture of MBM. Both the use and manufacture of this technology are therefore discussed, using Tidd et al's (1997) definition of innovation as being a change in technological product or process. How the use and manufacture of MBM for inclusion in animal feed represent important factors in the advent of BSE are themes which have barely been focused upon by other social scientists.

Consisting of composites of slaughtered animal waste, MBM is manufactured by the rendering industry. Prior to 1996 it was supplied to the animal feed industry which included portions of it into compound feed and fed it to animals; MBM making up approximately 5% of a compound feed ration. Such use of MBM in the UK was banned in 1996, having been forbidden for inclusion in ruminant feed since 1988, following the early cases of BSE (see Appendix 1 for a chronological list of BSE legislation). The increase in the use of MBM signifies a change in the *process* of how MBM was used in feed and changes in MBM manufacture represents a change both in *product* and *process* terms (Abernathy and Utterback, 1978). An investigation of the policy networks formed during the technological changes will reveal how arguments promoting the innovation rather than arguments discussing possible risks, dominated the policy arena. The case studies on the two technologies highlight how pre-BSE policies were directed more by short-term objectives rather then long-term precautionary objectives.

The period covered by this research project spans the 1960s to the 1990s: the introduction of the innovations to the ban of MBM in the UK. To link the innovation and earlier controversies to the more recent public controversy, BSE, it has been necessary to also discuss the post-BSE period. This illustrates the likely consequence of earlier risk neglect including the total elimination of the MBM technology.

Whereas once this agricultural technology was embedded in a common discourse of scientific progress in agriculture, its technological trajectory has now degenerated into something which no longer serves a purpose in UK agriculture.

1.3 Chapter summaries

The theoretical context for this study is presented in Chapter 2 where the social shaping of technology and policy network literature is examined. Other sociological studies on BSE will also be briefly discussed in this literature review in order to locate this analysis amongst the existing sociological works on BSE. Literature on the methodologies used will also be identified. Chapter 3 explores the research process and discusses the two methodological approaches employed, namely discourse analysis and network mapping. The two technologies will be explored in separate chapters, Chapters 4 and 5. Here a discussion of the emergence of the technologies will be paralleled with related risks identifying actors as the dominating elements of activity. Innovation and risk networks will be used to illustrate the social process of both technology adoption and the formulation of related regulatory policy.

Chapters 6-8 present the analytical response to Chapters 4 and 5. Through amalgamating the innovation and risk networks from the previous chapters, Chapter 6 examines the meaning behind the innovation and risk interactions, determined through analysis of actor arguments, discussing how this influenced policy. Exposure of closed processes of innovation and the marginalisation of risk actors explicates how this case study strengthens SST arguments for an open model of policy-making. Chapter 7 discusses how the occurrence of BSE was a further example of the public loss of confidence in technological change, examining how BSE reconfirmed civil adherence to the precautionary paradigm. However, an open policy arena where risk issues are commonly known, will not alone enhance actor capabilities to influence policy. The establishment of constructive actor coalitions by risk actors is also a necessary prerequisite in reducing the dominance of the traditional, closed system of policy-making.

Chapter 8 is the concluding chapter, drawing together how this case study contributes to previous analyses of technological innovations by social constructivists. It emphasises how the wide social context in which innovations occur need to encompass wider social concerns connected to particular technologies, requiring changes to the closed model of policy-making. The recommendation to use the experience of BSE as an important source of knowledge in deciding *what* future technological innovations are adopted, is made in this concluding chapter.

Chapter 2

2 Theoretical examination of innovation and policy networks and the powerful influence of social discourse - presenting a model of innovation which provides a renewed approach to managing technology-related risks

2.1 Introduction

This chapter discusses the three main sets of literature reviewed for this analysis.

The core literature centres upon examining innovation within the *social shaping of technology* (SST) context. How this analysis conforms to earlier studies of innovation based on this approach, and yet also develops existing work, will be revealed. Through adoption of the SST model of innovation, a means of linking technology and society is emphasised and will be illustrated through examining how technology-related risks can be socially managed through incorporating the concerns of social actors.

How technology policies can be enhanced to incorporate these wider social concerns will be proposed through examination of a second set of literature concerning policy formulation, expressed through the *policy network* model. How a network approach to innovation and policy-making provides for improved technology risk assessment is reviewed by proposing a closer relationship of innovation and risk policy. Whether better management of pre-BSE risks in relation to the MBM technologies could have dampened the effect of BSE underlies the objectives of this analysis.

The third set of literature discusses the methodological approaches used in this study. This is network and discourse analysis. The exploration of the social influences upon innovation and the involvement of actors raising concerns over risk makes good use of the network and discourse analysis methodologies. How these methodological tools have been used and developed in this research will be investigated.

It is has also been necessary to summarise previous sociological studies on BSE in order to highlight the different dimension from which this study has approached the BSE controversy. Within this recognition of other BSE works, this literature review provides a critique of the public Inquiry on BSE (commonly referred to as the Phillips Inquiry), which after a two year period published its conclusions in 2000.

2.2 The social shaping of technologies

Since its identification in the 1980s to the present day, BSE has provided a rich basis for sociological research. This analysis will approach the sociological analysis of BSE differently from previous studies. Within the SST framework it seeks to attribute greater focus to the technologies involved in the BSE controversy and how these were introduced and developed in the UK. This will include an examination of associated risks. Studies of innovation examining related negative externalities number far fewer than those discussing positive outcomes. With regard to BSE, a very small minority has explored the 'dark side' of the BSE technologies. One of these is Jean Shaoul.

In relation to the manufacture of MBM, Shaoul (1997a; 1997b) has employed an economic analysis through which she argues the UK renderers adopted new technology which would manufacture MBM more efficiently, suggesting that this may have resulted in poorer processing standards. Due to the absolute necessity of disposing of slaughtered animal waste, Shaoul presents the rendering industry as a very powerful actor in the agro-circle arguing that this position has been exploited in the UK by business actors seeking high profitability. Winter (1996) also makes a link between technology and BSE suggesting that changes in rendering processes, namely a decline in temperature, increased the likelihood of the BSE pathogen surviving.

Some studies have referred to the inadequate regulation of the rendering industry prior to BSE, arguing that this allowed for insufficient risk assessment of how MBM for inclusion in feed, was manufactured. Here the emphasis is upon the role of political forces and how they shaped the development of the technology. The Tory government of 1979 is often cited as being responsible for allowing a weaker

regulatory regime for the manufacture of MBM which failed to reduce the level of infectivity of the BSE pathogen (Jasanoff, 1997; Shaoul, 1997b; Bartlett, 1999; Miller, 1999).

However, this analysis will reveal that such studies are misinformed and though this study agrees that the rendering technology does have an important role in the story (as does the use of MBM in feed), it also argues that the regulation of the rendering industry was not weak simply because of the incoming Tory government but because of policy actions which resulted from the particular policy networks managing the technologies.

Other BSE studies have therefore discussed the role of either economic or political influences in the shaping of the technologies. This analysis uses the SST approach to examine far wider social influences and locates actors (organisations or individuals) as key determinants in shaping the technology. These actors represent different organisational roles (e.g. governmental or research actors) and are located in the innovation network as deriving from different social arenas (e.g. regulatory or knowledge). Within this more holistic study of innovation an examination of innovation related risk assessment can simultaneously be studied.

By presenting a detailed case of the pre-BSE policy arena, significant vigour is added to the SST arguments emphasising that the innovation process must adequately embrace risk assessments and that precautionary voices must be attributed with significant attention.

2.2.1 Innovation and risk policy

Due to the 1776 publication of Adam Smith's *Wealth of Nations,* studies of innovation have largely emphasised the need to exploit profit-making opportunities through technological innovations. Technological change has undoubtedly become a symbol of industrialised nations: railways, iron and steel structures, electricity and biotechnology, to name a few. However, the activity of innovation has been significantly challenged in the latter half of the twentieth century where social welfare

has been threatened by harmful innovations. This has redirected the traditional perception of innovation as being 'good for society' and instead social actors seek to influence the form of technological innovations, increasingly becoming aware that allowing innovations to travel an uninterrupted journey to their desired destinations can have great social costs.

However, a key problem in determining more socially desirable technology is the common separation of spheres in which innovation and risk policies are formulated (Irwin and Vergragt, 1989). Despite increasing technology-related risks, highlighted by disasters like the 1962 Thalidomide controversy, Exxon Valdez and threats from nuclear power, this polarisation continues to a large extent (Russell and Williams, 2000). This analysis seeks to present a network model in which these two spheres can be brought closer together so that the social understanding of technology is increased:

'We all need a good sense of how technology and society work together so that each of us can make better decisions about how we integrate technology into our lives' (Westrum, 1991; preface).

Such an approach seeks to achieve a better balance between technology promotion and technology control. The policy network analysis as presented by Smith (1993) and discussed later, provides a means of achieving this integration in practical policy terms.

2.2.2 The role of regulatory actors

The regulatory arena has key responsibility for assessing societal risks emerging from technological innovations and there is a strong case for regulatory actors to be more participative within this context. Regulatory intervention can and does prevent potentially harmful technological paths from being adopted (Smith, 1993; Hansen, 2000; Lemarie, 2000).

The core problem facing governmental actors is their dual role in stimulating innovation and regulating innovation. Correlated with high profits and a positive impact upon the general economy, innovative activity is greatly encouraged by the

state (Rothwell and Zegveld, 1981). The UK government's 2000 Science and Innovation White Paper demonstrates this (Department of Trade and Industry, 2000). The desire for a rapid introduction of new technological products and processes can, however, mean regulatory actors fail to conduct adequate risk assessment (Beck, 1997). Furthermore, Groenewegen and Vergragt (1991) discuss how regulation is commonly perceived by business actors to be a hindrance to technological progress, dissuading regulatory actors to intervene during the innovation process.

However, Hansen (1998a) has examined how Danish regulatory authorities adopted an active role in the development of modern biotechnology in Denmark and rather than being a disadvantage, this brought the biotech debate into the public arena and resulted in better social acceptance of the biotech technologies. Therefore, business actors gained from regulatory intervention. Also, regulations for the pulp and paper industry led to the elimination of old processing plants, and stimulated the introduction of more efficient and environmentally-friendly equipment (Rothwell and Zegveld, 1981). Nevertheless, despite such benefits of regulatory intervention, the common assumption that regulatory intervention needs to be a marginal rather than a central role in the innovation process, largely remains.

The other problem in achieving effective regulatory risk assessment is the government's approach to risk management. There is often a failure to consult with risk actors whom they regard as *outsider/secondary groups* (Smith, 1993). Instead, risk assessment largely results from interaction with groups which they regard as legitimate *insider/primary groups.* These are often business actors who have vested interests in minimising regulatory intervention. This specific route to policy-making greatly constrains adequate risk assessment and will be discussed in relation to a preferred more open policy model. It is the structure of regulatory policy-making which is the focus of this analysis because regulatory actors form the most crucial component of the risk assessment process. They therefore need to approach innovation with the aim of introducing less harmful technologies (Caldwell, 1990).

2.3 How a closed policy network inhibits optimum risk management

2.3.1 The policy community network

The policy network model identifies a new model of governance for modern societies (Marsh, 1998) where the emphasis is upon the interdependency of actors, from the public, private and voluntary sectors. Though Marsh questions whether policy networks represent little more than a heuristic device through which a social situation is explored, this analysis will discuss how the structure of policy networks *can* effect policy outcomes.

The recognition that government cannot be the lone most influential actor in public policy-making (Kickert et al, 1997) signifies the opportunity for better special-interest group representation in the policy domain. However, there are two very different basic models of policy-making; one which allows this representation and one that does not.

Marsh and Rhodes have identified the *policy community* model as limiting wider actor involvement and the *issue network* model as encouraging it (Smith, 1993; Marsh, 1998). Furthermore, they emphasise that the influence of actors in the policy arena is heavily determined by actor resources which can include physical (e.g. machinery), human (e.g. knowledge) or financial assets. Scientific knowledge is a particularly powerful resource (Renn, 1992) and is the main reason why risks unsubstantiated by scientific evidence lack influence in the policy arena. *Resource dependency* is therefore a significant feature in why certain actors form more collaborative relations with core policy actors and why others do not (Smith, 1993; Bomberg, 1998). Because non-government and non-industry actors often lack crucial resources (Smith, 1993), they are often excluded from the core policy arena.

The type of policy network existing in the pre-BSE years was a *policy community* network. This network represents a small number of actors and shared interests amongst this actor membership. Seeking consensus and avoiding conflict are key

objectives of such policy-making process, resulting in a stable network. The main features of the policy community model are shown below:

Table 1: Features of the policy community model

Dimension	Policy Community
Membership	
Number of participants	Very limited, some conscious exclusion
Type of interest	Economics/professional
Integration	
Frequency of interaction	Frequent, high quality
Continuity	Membership, values, outcomes persistent
Consensus	All participants share basic values
Resources	
Distribution of resources within network	All participants have resources. Relationship is one of exchange
Distribution of resources within participating organisations	Hierarchical leaders can deliver members
Power	There is a balance among members. One group may be dominant but power is positive-sum

Source: Smith (1993).

Within this policy community model, business actors, government and its scientific committees are often the dominating actors, all sharing a common ideology and therefore determining a shared policy outcome. Though the policy community model is the traditional approach to Western policy-making (Jordan, 1990), the model is especially suited to British policy-making where consensus, rather than conflict, is particularly emphasised. In contrast, the policy model in North America has increasingly represented the *issue network* model where an incorporation of multiple viewpoints is considered as an essential element to most policy discussions (Marchi and Ravetz, 1999). This policy approach includes a large number of actors from varying interest groups, welcoming rather than avoiding conflicting views and representing a more fluctuating network, as will be discussed later.

2.3.2 Application of the policy community model to post-BSE policy-making

Two core features of the policy community network model are:

a) the reliance upon government selected scientific advice
b) the exclusion of, or inattention to, actors whom government actors do not regard as legitimate

Both these characteristics exhibit poor opportunities for other actors to become a part of the policy-making process and both features are often applicable to the way in which UK agricultural policy is determined (Smith, 1993). In examining studies on BSE by other social theorists, this policy community model is again subjected to similar criticism.

2.3.2.1 Government scientific committees

Jasanoff (1997) examines how regulatory actors often seek scientific advice from government selected committees. Such policy input is therefore a controlled and often a potentially manipulative process, limiting broader consideration of social risks. This collaboration means that the information upon which policy decisions are made are largely only accessible to these actors, along with the businesses who will be affected by technology-related risk policy. Bartlett (1999) and Miller (1999) discuss how the availability of scientific data was restricted during the preparation of BSE policies.

BSE is a good example of the reliance upon scientific evidence in determining policy action. The lack of scientific evidence signifying a direct risk to humans was used as a means of assuring consumers that eating (possibly contaminated) beef was safe (Marchi and Ravetz, 1999). BSE was undoubtedly managed as a scientific issue and regulatory actors did not act in any way according to the wishes of precautionary actors who argued for policy action which was not directly supported by scientific data (Lacey, 1998; Dealler, 1998a, 1998b, 3/12/99; Berry and Smith, 1998; Simpson, 1998; McKechnie, 1998). However, these actors appear as *isolates* in the policy network (Scott, 2000).

Furthermore, scientific contributions from those outside of the government selected committees were inadequately considered (Lacey, 1994; Lacey, 1998; Dealler, 1998a, 1998b, 3/12/99; Winter, 1996). Though external scientists are increasingly influenced by corporate agendas (Monbiot, 2000; Evans, 2001), in relation to an issue like BSE, they will not be tied into government confidentiality and so can be expected to have greater freedom in how they perform in the policy arena.

Instead, regulatory actors relied solely upon its selected science, and controlled how it would use this scientific advice. Making public statements not necessarily warranted by its scientific sources is a frequent criticism (Weir and Beetham, 1999; Panorama: The Great British Beef Fiasco, 1996; Beef Encounter, 2000).

However, BSE has highlighted that social risks cannot always be quantified in a scientific way due to the absence of complete knowledge about such risks (Engelhardt and Caplan, 1987). Incidents of such uncertainty demand a more permeable policy framework as discussed by Marchi and Ravetz (1999) and their model of a *post-normal science (PNS)* approach. This exposes the inadequacy of science (alone) in providing social protection and is a positive diversion away from the *British Science-based Policy Approach* (Hajer, 1995). Such studies strengthen the case for allowing increased groups of actors who may or may not be from the scientific field into the core policy arena. In short, scientific arguments identifying the absence of a risk should not indicate the end of a discussion on risk.

2.3.2.2 Wider representation of non-government groups

In relation to post-BSE events the primary policy community consisted of the Ministry of Agriculture, Fisheries and Food[1] (MAFF), government scientific committees and the National Farmers Union (NFU) (Bridges, 1998), the latter with whom MAFF has always had a close and consensual relationship (Smith, 1993). The secondary community included non-government scientists and the many consumer

[1] MAFF has now been replaced by DEFRA (Department for Environment, Food and Rural Affairs), but because this thesis studies events occurring before this change, the MAFF acronym has been used. Where the government department is discussed in the recent climate, DEFRA has been used as the appropriate term.

and environmental groups, discussed in Chapter 7. The policy community model of policy-making is particularly common when the subject of policy is of a scientific and technical nature, as BSE certainly was. However, the model proved disastrous in the management of BSE, resulting in a loss of public confidence in both the state and science; a social change referred to by Jasanoff (1997) as 'civic dislocation'. The exclusion of actors (both those with a greater knowledge of BSE-type diseases and those presenting dissenting voices), from the core policy arena has frequently been identified as the explanation for BSE policy failure (Winter, 1996; Bartlett, 1999; Miller, 1999).

In their analysis of the BSE policy community Weir and Beetham (1999) and Lacey (1994), continue Marsh and Rhodes' argument concerning the preference of government to collaborate with certain groups rather than others (Smith, 1993). Due to the lack of rules governing such collaborations, government departments are greatly inclined to seek advice/expertise from those groups who present the least conflicting arguments and who are likely to agree with government action. The damaged government-public relations resulting from this approach during BSE strengthens recommendations for a more *open* rather than *rational* system of policy-making (Scott, 1992). The SST theory supports such recommendations for an open policy model in which pluralist policy-making reduces the potential for single or small groups of actors to control policy-making.

2.3.3 The Phillips Inquiry: recognising the limitations of the policy community model

The Phillips Report produced a voluminous account of BSE at the end of the year 2000. The focus of the BSE inquiry was to better understand how the crisis was managed by government officials and the strengths, but more so the weaknesses, of the official response. In this regard, the Inquiry Report concluded that the BSE crisis could have benefited from a more open system of policy-making (BSE Inquiry Report Volume 3, 2000) where precautionary voices from outsider groups should not have been sidelined simply due to lacking scientific credibility (BSE Inquiry Report Volume 4, 2000). The Report is also sympathetic to the plight of scientists who

struggled to present views which were contrary to those of government scientists (BSE Inquiry Report Volume 11, 2000). The Report has recognised the need for better incorporation of social actors in regulating risks, stating that government actors must not regard their sources of knowledge as being the only sources of information and advice.

Many studies on BSE have therefore centred upon the limitations of the policy community model, focusing upon the need for wider social participation in the management of social risks *after* the technology has been introduced into the market. This analysis of innovation, however, centres upon improved approaches to risk assessment during the design and development of the technology; *before* its launch. Not only is this likely to prevent a harmful technology from ever being introduced, but it also avoids the complexity and costs of modifying a technology once it has become entrenched in society (Collingridge, 1980; Rip et al, 1995b). Such complexity and costs have been demonstrated by the ban on MBM in animal feed and the changes made to rendering processes throughout Europe, discussed in later chapters.

2.4 The SST framework: strengthening the case for more open policy-making

Identifying strongly with the precautionary principle, the SST approach opposes features of the policy community model. Instead, the SST theory proposes that in managing technology-related risks during the innovation process itself, there needs to be:

- a diversion from complete reliance upon scientific evidence in formulating policies
- a policy-making model based upon pluralism where risk debates can transmit to wider social sectors and acquire equally wide responses to these risks

Therefore, rather than centring upon the effects of BSE on the UK's political, social and economic systems, this research project seeks to assess the role such social systems played during the introduction of the technological innovations in the UK. Furthermore, whereas social scientists commenting upon BSE have argued for greater transparency and collaboration with multiple actors in the policy-making process when managing social risks, this research argues for this greater transparency and collaboration during the actual design and development of technological innovations. The hypothesis is that with a greater input from different actors, risk assessment will be more thorough and the innovation therefore, less socially problematic.

2.4.1 Studying innovation from the SST perspective

Research on technological innovations has been pursued by social scientists from a range of disciplines. Traditional economic studies of innovation focus upon the economic rationale for technological change, as that outlined by Rothwell and Zegveld (1981):

- reducing costs
- meeting market demand
- achieving competitive advantage

Others have focused upon either the benefits or the negative impacts of technological change upon society. Smith and Marx (1994) examine how the computer and jet aircraft technologies transformed society, providing greater personal freedom and independence. Discussions on the negative impacts include the works of Collingridge (1980) and Rothwell and Zegveld (1981).

More recent innovation studies attempt to reduce the distance between technology and society (Jasanoff et al, 1995). Such approaches seek to redress the balance of technology studies which either focus upon economic motivations for innovation, or upon the impacts of technology. This is achieved through investing greater efforts into understanding why and how a technology is introduced, and how problems related to its introduction can be minimised.

Like such social constructivist studies of innovation, this analysis seeks to:

a) present the influence of a diverse range of social actors upon innovation, thus adding to the economic rationale for innovation as summarised by Rothwell and Zegveld (1981)
b) highlight how this model of innovation provides a means for making innovation less problematic

Other than the subtle suggestion by Shaoul (1997b, 1998a, 1998b) that the pressures to use MBM in animal feed and to manufacture it through low-cost means was driven by the pressures of intensive agriculture and the production of cheap food, there has been little close examination of the broader social influences affecting technology selection. There has been even less coverage of the identification and management of technology-related risks during the pre-BSE era. This analysis therefore provides an original context in which to explore the BSE controversy.

2.4.1.1 Origins of the SST approach

Attributing significant importance to external social influences, the SST theory argues that technological selection depends upon the role of various social actors who each have the potential of influencing the technology, some more than others. Unlike traditional innovation literature where the designers of technology are recognised as the overwhelming force behind technical change, the SST approach attributes as equal importance (sometimes more) to other social forces, indicating the 'production' of technology by social actors.

For instance, Edwards (1995) discusses how the US military has been a major force in the emergence and development of computer technology. Likewise, Winner (1999) explored how US political influence led to bridges being designed with the intent of discouraging their use by buses, upon which mainly black citizens travelled. Such studies reduce the emphasis upon actors like scientists/technical engineers, influenced by economic motives, as being the focal point of technical change. Instead it is the

'complete set of [social] relationships' that determine technological change (DeBresson and Amesse, 1991; page 364).

These diverse influences suggest a diverse choice of technological paths. Competing technologies is a central concept in the SST theory where the plurality of technological choice can result in modification or even complete abandonment of a technological innovation, despite its technological supremacy. Actors can therefore achieve a *reverse salient* (Westrum, 1991), interrupting a technological path and opting for alternative technology options. These, however, need to have adequate actor support to pose as a genuine threat (Westrum, 1991).

Given the choice of alternative technologies, this analysis seeks to develop the SST arguments emphasising the need to adopt less risky technologies. The *negotiation space* within which innovation occurs (Mackenzie and Wajcman, (1999) will therefore consist of innovation and risk actors.

The SST theory originated as a means of opposing the more commonly held view of technology where technological innovation is viewed as an inevitable outcome of technological/scientific research. Such black-box studies of technology where broader social influences are not given credible status (Molina, 1999), are embraced under the *technology determinism* school of thought. The common assumption in this approach is that technically/scientifically excellent technology will become the selected technology. Dominance of this technology will define a specific technological trajectory which is powered by the *momentum* ensuing from the technology. The implication is that social influences have no real potential to modify such technology, or compete with it (Westrum, 1991; Coombs et al, 1992; Smith and Marx, 1994).

Others like Collingridge (1980), though acknowledge that technology can be modified to reduce risk, argue that this can only be achieved once the technology has been established. Such debates centre upon the difficulty in predicting risk scenarios in advance and instead propose that technology should be flexible in allowing for modifications of technology if a problem should arise. Compared to the SST approach, such studies of technology fail to recognise the opportunities to conduct

risk assessment, before technological launch into the market, regardless of the scientific/technical supremacy of the technology (Law and Callon, 1992).

Since its emergence in the 1980s, the SST theory has identified many features of analysis and encompassed many different approaches. By the late 1980s, Mackenzie and Wajcman (1985) outlined the main contentions of the SST theory highlighting that society had greater capacity to influence technological innovations than it may have realised. The SST approach was therefore identified as:

'the single most influential theory of the relationship between technology and society' (Mackenzie and Wajcman, 1985; page 4).

This analysis conforms to previous SST studies in looking at an individual artefact: *MBM*, in relation to its manufacture and use in feed, and the role of social actors in determining how a particular technology became the dominant technology. How certain actors favouring the technologies, managed to secure wide scale adoption of the technologies is discussed in later chapters.

2.4.2 SST presenting opportunities for enhanced risk assessment

2.4.2.1 The interactive model of innovation

Whereas traditional studies of innovation outlined a rather linear approach to the innovation process whereby a technology is conceived, developed and launched by a group of scientific/technical experts, more recent innovation research has established a more interactive model of how technological innovations occur. Within this interactive approach there is a recognition of the close interaction between technology and society where a balance is achieved between the emphasis upon technology-push and need-pull forces (Tidd et al, 1997). Inadequate consideration of the wider social environment was a severe limitation of the linear model (van den Ven et al, 1989; Williams and Edge, 1994). For instance, many innovation studies, in accordance with the interactive model highlight the need to consider the appropriation of technology in influencing innovation success (Mackay and Gillespie, 1992; Spilker and Sørensen, 1997). User-producer networks have therefore been used to illustrate the demand and

diffusion influences upon technology development as compared to the dominant technology-push influences e.g. from the R&D field, a characteristic of technological determinism (Hansen, 1998b; Mackenzie and Wajcman, 1999).

Within this school of innovation, the SST theorists argue that there is considerable opportunity to make technologies more acceptable to the wider social environment, rather than being resigned to experiencing technological impacts (both positive and negative). (Encountering the impacts of technology is what technological determinists would see as being the only response to technological change). A reconciliation of the conflict between the promotion of innovation and the control of innovation can therefore be attained. Through such analysis of innovation, the changing social norms and values of society in wanting to minimise technological risks, can therefore be incorporated.

2.4.2.2 Increasing wider social participation in the innovation process

In a perspective which considers the wider social implications of technology, there is a strong desire to create a policy framework which encompasses wider social concerns. Allowing a fair representation of any social risks related to the technology is a key recommendation emerging from the SST approach. The Constructive Technology Assessment (CTA) model of Rip et al (1995a) proposes such an innovation-related policy model.

Rip et al (1995a) argue that the formal participation of actors from the wider society is crucial for a holistic approach to risk assessment, and provides the most appropriate means of reducing technological risks. For example, Koch (1995) has examined how for optimum assessment of medical drugs prior to their release, the consultation of actors representing patient interests and medical ethics also need to be conducted. The argument underlying the CTA school of thought therefore is that the social implications of technology need to be considered at the very early stages of the innovation i.e. during its design rather than during only the development and implementation stages. Through various socio-technical scenarios (STS), alternative more socially acceptable technological paths can be identified (Geels, 1999).

Such actor involvement of social groups not concerned with the profitability of the innovation, is paramount as it is often the contribution of these actors that leads to any needed technological modification at all (Braun and Wield, 1994; Jelsma, 1995). Such success, however, depends highly upon the ability of interest groups to organise themselves (Steward, 1995) so that they represent a resonant voice in the policy arena, structured upon shared and consistent arguments. Real influence in the policy arena therefore, depends upon the shared arguments emerging from *actor coalitions,* where the risk actors will confront the actor coalition encouraging the innovation (which often has a very different perception of the risk being identified).

Developing from traditional *technology assessment* (TA) arguments centred upon examining the impacts of technology and how negative effects can be minimised, the reflexive approach of CTA seek to change the technology before negative effects materialise, i.e. shape technology so that socially harmful externalities do not emerge. Therefore, the CTA approach to risk assessment is intertwined with the SST framework.

2.4.3 Increasing influence of the precautionary principle

Arguments for a more open policy framework where innovation-related risks can be satisfactorily addressed, identify precautionary action as a central concept. The 'precautionary principle' *(Vorsorgeprinzip)* was developed in Germany in the 1980s, and was adopted by the European Commission in 2000. It suggests that in situations of high uncertainty, policy-makers must not refuse policy options simply because they lack scientific grounding (Winter, 1996). Waiting for science can, as has been shown by nvCJD cases, prove catastrophic.

As technological innovations in our present industrialised nations have the scope for greater social impact, there is need for a renewed approach in managing possible associated risks (Giddens, 1991; Beck, 1992). BSE meets Beck's criteria for the types of risk faced by modern society: complex, unpredictable, globalized and the result of human decision. As technologies become bigger and target a larger social audience, as MBM certainly did, their control becomes more difficult (Collingridge, 1980). Modern society's failure to solve the problems created through its own system,

therefore requires a different method of risk management. Precautionary approaches must demand equal attention and technological innovations need to become the active concern of society as a whole, rather than remain the sole preoccupation of scientists, especially as confidence in science has greatly diminished (Wynne, 1995 and 1996; Callon, 1986). This represents a truly network approach to risk management where the boundaries around the innovation process are eliminated and the input from a variety of actors is encouraged.

The BSE controversy highlighted the issue of what is fed to livestock, stirring much public feeling against the feeding of animal protein to herbivorous animals like cows and a demand to know more about such agricultural practices. The current Foot and Mouth Disease epidemic has further increased consumer anxiety regarding food production systems and strengthened the desire to be involved in the origin and development of agricultural processes and technologies, as well as a desire to have a general understanding of the implications of certain technologies (Kemp et al, 1998). In the meantime consumers are protecting themselves against possible food-related risks, indicated by the growth of the organic food sector (The Organic Consultancy, 2000). These more recent events have been added to the list of negative technology experiences.

These technology-related risks are creating *issue-attention cycles* (Ungar, 2001) where greater demands for the precautionary principle to be embedded in the process of technological change are being made. These are unlikely to be effectively achieved in a policy community model of policy-making. Instead, it is the *issue network* policy model which is more conducive to policies based on the precautionary principle and is the more likely of the two models to lead to stringent legislation (Bomberg, 1998).

Table 2: Features of the issue network model

Dimension	Policy Community
Membership	
Number of participants	Large
Type of interest	Wide range of groups
Integration	
Frequency of interaction	Contacts fluctuate
Continuity	Fluctuating access
Consensus	A degree of agreement but conflict present
Resources	
Distribution of resources within network	Some participants have resources, but limited
Distribution of resources within participating organisations	Varied and variable distribution and capacity to regulate members
Power	Unequal power. Power is zero-sum

Source: Smith (1993).

Here the extremely large membership of the policy network provides for a larger social arena in which to discuss risk, providing enhanced opportunities for incorporating the precautionary principle.

2.5 More divergent works on BSE

As discussed in the introduction to this chapter, BSE has resulted in different sociological analyses, though none seem to have adopted the social shaping of technology approach of this study. Neither have all social theorists focused upon the BSE policy community perspective as explored by Jasanoff (1997), Bartlett (1999), Miller (1999), Marchi and Ravetz (1999) and finally, Weir and Beetham (1999). Instead some have preferred to analyse the wider social implications of BSE-related polices.

How the uncertainties of the BSE controversy provided for extremely newsworthy material is discussed by Kitzinger and Reilly (1997). During official responses to BSE, some actors stated that their arguments were undeservedly being ignored by policy actors. Such actors therefore used the mass media as a medium to voice their

concerns, exploiting the capacity of mass media to publicly expose the closed policy arena. Mark Purdey, an organic farmer who argued that organophosphates rather than MBM was the vehicle through which BSE spread, was one such actor (BSE: What's the real reason?, 1996). Another was the scientist at Leeds University, Professor Richard Lacey, who in the early 1990s, used the media to argue that some humans were likely to have been infected by the BSE pathogen (Lacey, 1994). In 1996 this was confirmed by the first clinical case of nvCJD.

Hadjikhani and Seyed-Mohammad (1997), Latouche et al (1998) and Brookes (1999) have focused upon the repercussions of BSE on economic life. In April 2000 the UK government estimated that by the end of the financial year 2001/02, the total net cost of BSE to the Exchequer will be £3.7 billion (BSE Inquiry Report Volume 10, 2000). At the time BSE emerged beef and dairy farming was the largest sector of UK agriculture (BSE Inquiry Report Volume 1, 2000) and these sectors have suffered tremendous economic loss resulting from BSE. Various social theorists have therefore framed the BSE controversy within an economic argument.

2.6 Network mapping and Discourse analysis

This section concludes the literature review chapter by discussing the theoretical context from which the methodologies used in this analysis originate.

2.6.1 Use of network analysis in the social analysis of technology

Networks as a tool to analyse society are used very differently amongst social scientists, though the common recognition is that:

'[n]etworks constitute the new social morphology of our societies' (Castells, 2000).

Early use of social networks was employed mainly by social psychologists to explore the social interactions within the small group structure, relating this to human thought and behaviour. It is from this sphere that the field of sociometry emerged (Scott,

2000; Moreno, 1953). More modern times has witnessed the increasing use of the network concept to illustrate the interdependency of actors in society (Marsden and Lin, 1982), both in the pure business context, e.g. through adoption of a variety of strategic alliances (Freeman, 1991; Tidd et al, 1997), and in the public policy-making context (Kickert et al, 1997; Marsh, 1998). Network analysis as a means of governing the social risks associated with innovation is particularly purposive for public policy actors. In this research networks have been used to gain a more comprehensive understanding of the pre-BSE policy arena with regards to both technological change and risk management.

The concept of networks is crucial to understanding innovation (Aiken and Hage, 1968; Håkansson, 1987; DeBresson and Amesse, 1991), particularly as policy-makers are increasingly keen to identify sources of innovation (Conway, 1997). The study of innovation through the network lens therefore identifies the interconnecting relations between research centres, suppliers, customers and producers as representing the context for studying innovative activity. The emphasis is upon all these actors who are a part of the *actor-world* (Jørgensen and Sørensen, 1999). Studying the meaning behind these actors relations explains how innovation networks achieve stability or *irreversibility* (Coombs et al, 1992). The increasing use of network analysis in the exploration of social activity has confirmed that social networks are a value-added activity.

The SST approach has used the network model to represent this actor diversity during the innovation process, and seeks to expose how actor relations failed to conduct adequate risk assessment. To illustrate this complexity and choice in determining certain technological paths, the network mapping methodology provides a useful means of analysis. The early studies of innovation by the SST theorists employed the network model to illustrate the various actors involved in the innovation process; how actor roles and interests shaped technology.

Callon (Callon, 1986; Law and Callon, 1992) has been the key force in focusing upon individual actor roles where an actor not only represents an individual or an organisation but can also represent an inanimate object. Defined as *Actor Network Theory* (ANT), this approach centres upon core actors in the innovation process,

examining how through networking, these central actors manage to enrol other actors, or what he calls *actants,* into achieving support for an innovation. Through his use of *techno-economic networks* (TENs) Callon has illustrated the intertwined relations between heterogenous actors in the development and diffusion of goods and services (Hansen, 1998b; Jones et al, 1999). In relation to risk assessment, Callon (1995) has recommended that the CTA model adopt the network approach to depict the involvement of risk actors so that the actor-world of risk actors can also be recognised. This recommendation is taken up in this thesis.

Diverging slightly from the role of central actors is the *Social Construction of Technology* (SCOT) approach identified by Pinch and Bijker (Pinch and Bijker, 1984; Bijker et al, 1987; Bijker, 1992; Bijker and Law, 1992). Here the influence of various social groups upon the innovation is analysed, where a small group of actors are the most instrumental in bringing about innovation; termed a *clique* in the network literature (Blau, 1982). Through network analysis, SCOT theorists explore the varying conflicts resulting from technological options and discuss how technological closure is finally achieved. This provides a detailed explanation of how one technological path becomes the most dominant.

Hughes develops the broader social influences upon technological innovation even further than the SCOT school of thought (Bijker et al, 1987; Hughes, 1999). Hughes argues that the selection of an innovation is influenced by an appropriate technological system in the wider social environment. Through his infamous metaphor of a *seamless web*, Hughes therefore argues that the innovation process centres upon a network of multiple social relationships. For instance, he reveals how Edison's electric light bulb was shaped by the wider technological system of electricity generation and distribution, involving interaction between scientists, engineers, finance companies, legal institutions and political agents (Hughes, 1983). This indicates how the technology itself is only one element of socio-technical change.

Therefore, networks from the social shaping perspective either study innovation from the perspective of individual actors and their immediate social relations, or they study these same relations in the context of a wider social context where broader support for

the innovation, like finance and political approval, are also considered (DeBresson and Amesse, 1991). More recent SST studies have made the focus of study even more extensive, where economic and social factors such as the economy, the labour market and the political climate are also included (Russell and Williams, 2000).

This thesis has adopted an approach emphasising broader social influences (like the SCOT/systems approaches of Pinch/Bijker/Hughes), rather than the central actors like Callon. Though core actors have been identified and represent those who are central to introducing the technology into the UK and those who are central to regulating it, the relationships of other actors is equally important. Therefore *a socio-centric* approach to network analysis has been adopted (Conway, 1997; Conway and Steward, 1998; Scott, 2000), allowing for an analysis of both the interactions between peripheral and core actors, and between peripheral actors themselves. This highlights that actors who do not have a direct social interaction with core actors will also be examined. Direct and indirect influences upon technological innovations are equally important (Benson, 1978; Burt, 1982; Scott, 2000). Integration of the more extensive influences upon innovation as discussed by Russell and Williams (2000) has not been attempted due to the inappropriateness of such information to this research.

A recent example of network analysis which more closely resembles the objectives of this study is the concept of *arenas of development* proposed by Jørgensen and Sørensen (1999). Here the extra-organisational influences upon technology selection are emphasised highlighting that the immediate designers of the innovations have not been the only or most influential force in developing the technologies. Instead there have been external actors who have been active in contributing to the innovations. Such influences upon technology selection have been essential in understanding how the BSE technologies were socially shaped.

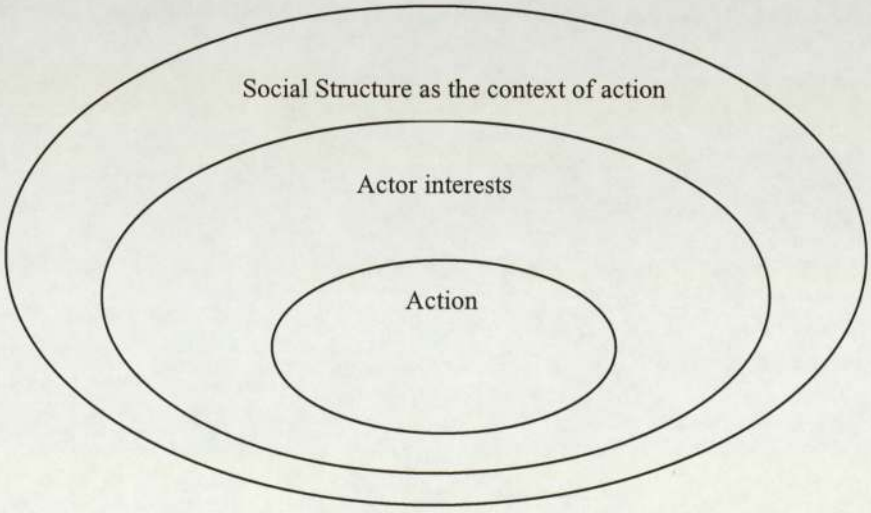
These 'external' influences upon innovation are analogous to the micro-level study of innovation whereby the ideas of innovation are shown to derive from sources external to the firm. Rothwell et al (1974) revealed the importance of such external influences upon successful innovation during the SAPPHO project, where an important factor in determining innovation success was communication with actors external to the firm.

The SAPPHO project was the start of many which confirmed that innovation success depended largely upon external collaborations (Freeman, 1991).

The network approach therefore allows for an understanding of how organisations do not operate in isolation but are enmeshed in a network of social relations, linked with other actors through resource dependencies (e.g. knowledge and finance). Actors therefore often have different motives for being a part of a particular network depending upon their relationship with the technology. (Burt, 1982; Jørgensen and Sørensen, 1999), However, the development of new social relations rather than the maintenance of existing relations, provides the opportunity of introducing new, fresh ideas about technological change (Granovetter, 1982). This illustrates that networks are not static but will change according to the social decisions made by actors (Håkansson, 1987; Coombs et al, 1992).

The following diagram illustrates the core focus of this analysis, actor interests and behaviour:

Figure 1: Structural analysis of actor interests and behaviour



Source: Burt (1982).

Actors also have varying degrees of influence in the policy arena, depending upon the strength of their direct and indirect network relationships and the significance of the technology for their organisations (Westrum, 1991). Therefore, rather than being seen

as simply a set of bilateral agreements, the configuration and content of a network represents a social process of specific meaning where, as well as allowing for a detailed analysis of individual sets of interactions between two actors, the network also allows for the exploration of multiple relations and of the diversity of communication involved in the innovation process (Jones et al, 1999).

However, the control of technologies in relation to risk assessment is a dimension which is missing from the traditional network approach and is attempted in this analysis, indicating that the opposing arguments of innovation promotion and innovation control, can and should be reconciled. Risk actors tend to appear as *isolates* (Scott, 2000) in the policy network in relation to their position to the core policy domain. Renn (1992) has made a progressive step in mapping the social analysis of risk through examining how successful resource mobilisation by various actors results in certain risks achieving greater policy influence. Renn's visual depiction of risk actors is developed in this thesis where it is argued that for policy to have any utility in shaping technology to reduce risks, a thorough understanding of the nature of the technological development is also necessary. A network approach combining the innovation and risk process to expose the isolation of risk actors, has therefore been developed.

2.6.2 Using actor discourses to understand the social shaping of technology

The selection of actors in the BSE-technology and pre-BSE risk networks has been made through studying the dominant innovation and risk discourses employed by actors. Discourse in this context is more than simply a conversation and is instead a channel through which actors can transmit their ideas and values into the policy arena, seeking to make their arguments the most prominent. In this analysis, policy outcome (like innovation) is represented as being socially determined, through the arguments of actors. The emphasis is upon the meaning implied through the actor discourse rather than upon the accuracy of the discourse (Gabriel, 1998).

Such use of discourse will reveal the social shaping of the BSE technologies and the management of related risks. Using discourse analysis to explain actor influence in

this context (i.e. innovation/risk assessment) is an approach which does not seem to have been previously attempted.

Discourse analysis in the network framework allows for the management of multiple discourses and exposes how communication between and amongst actors, heavily influences the innovation process. Analysis of actor discourses provides a useful means of assessing why certain actions are taken over others, as certain discourses become the most powerful and accepted.

2.6.2.1 Discourse: means of persuasion

Actors often use social discourse to express their individual/group interests and values, persuading others to adopt these same interests (Knoke, 1990). It is this dimension of discourse analysis which will be used in this thesis to understand why certain discourses became the more dominant in the policy domain.

The innovation and risk discourses in this analysis represent a model of *argumentative discourse* as discussed by Billig (1987) and Hajer (1995). Billig discusses how because different world views inevitably result in different attitudes towards the world, social discourse is often argumentative or conflicting: *'the social context of attitudes is the context of controversy'* (Billig, 1987; page 177). Perelmen and Olbrechts-Tytera (1969), van Dijk (1996) and Jaworski and Coupland (1999), all discuss how discourse represents the conflicting interests of actors who adopt various rhetorical arguments presenting their particular attitudes and value-systems, and who attempt to persuade others into adopting these same attitudes, creating an actor-world which suits their own purpose.

Hajer (1995) has identified the 'ecological modernisation' discourse as the new language influencing environmental policy, arguing that the strength of this discourse will encourage more sustainable technologies. However, Hajer's conclusions, though may be true for the management of 'acid rain' (his case study), do not necessarily offer the same optimism regarding technology in general. Often, risk issues are managed separately from the process of technological innovation, thus preventing an interactive argumentative discourse of innovation and risk to even emerge. The whole

purpose of this analysis is therefore to highlight the need for such polarised discussion to become unified and in this respect this analysis builds upon the models of Billig and Hajer.

The other feature of discourse used in this analysis is *management of stake* (Potter, 1996). Here the argument is that whatever an actor argues is heavily influenced by his/her organisational role. This concept of stake is a central feature in this analysis where actors are categorised according to various social sectors and their location in these sectors indicates their sector-specific interests. Appendix 5 reveals how the network graphic to be employed in this thesis accommodates for sector interests. This approach seeks to explicate how regulatory actors in the pre-BSE period were prone to side with the interests of business actors, at the expense of ignoring certain technology-related risks.

How the methodologies of network mapping and discourse analysis were used to elucidate these findings, is discussed in the following methodology chapter.

2.7 Literature summary and research problem definition

This chapter has outlined the theoretical framework for this research project, identifying how the social shaping of technology approach allows for an examination of the BSE technologies and how related risks were managed in the policy network. This dimension of the BSE controversy has previously been unexamined. The importance of effective regulatory intervention to control technology has been emphasised.

The core objectives of this study are to examine:

- how the discourse of actors performs a vital role in the selection of policy options
- how powerful pro-innovation arguments permit technological trajectories to continue unchallenged in their development
- what alternative technological choices were available and why these failed to become the dominant technologies
- how closed policy networks marginalise precautionary voices and prevent risk issues from being discussed in an open policy domain
- how the BSE incident offered an important opportunity to modify the traditional policy-making model to incorporate risk actors
- what barriers continue to exist in achieving meaningful examinations of technological innovations and related risks

Chapter 3

3 Research Methodology

This chapter redirects the focus of this thesis from *what* is being researched to *how* it is being researched. The previous chapter has identified the research objectives which seek to examine the social influences upon technology selection and the potential societal impacts of the dominating influences. This exploratory analysis has impacted upon the methodologies selected for conducting this research.

3.1 Philosophical research paradigms

3.1.1 An interpretative research paradigm

Social science research generally consists of two possible approaches to research; research under either the *Positivist* or the *Phenomenological/Interpretative* paradigms. Though the distinction between the two cannot always be so easily defined it is certain that these two paradigms consist of different modes of analysis and research methodologies. This research has adopted a more interpretative approach where rather than a linear research process where conclusive results tend to be sought, this analysis has adopted a *circular model of research* (Flick, 1998). Rather than the search for definite results, this research process has involved the continuous revisiting and reinterpreting of data where the aim has been to as much as possible, explain the research matter according to its individual social reality (Denzin, 1970).

Though it has also been necessary to research other countries in order to fully understand how the technologies evolved across Europe, the focus is on how the technologies developed in the UK, studying the meanings attributed to the technologies by various actors. This UK BSE case study therefore provides a fundamental understanding of the processes of innovation and risk assessment in relation to the technologies being explored and has also provided a general

understanding of how the innovation process, through becoming more socially enhanced, can lead to more socially-friendly technologies.

Furthermore, as the researcher I am not claiming that the research is completely immune from my personal values. Having studied the effects of BSE I was keen to highlight the sometimes grave repercussions of technological innovations, leading me to gather and interpret my data in a way which emphasised the need to incorporate sufficient and adequate risk assessment in the innovation process. Having met and spoken to the parents of a young victim of nvCJD, I was keen to use this research project as a means to counter arguments that risk assessment can be exaggerated or that precautionary action without scientific evidence is inappropriate or meaningless. This interpretative approach to my research resulted in the adoption of qualitative research tools e.g. discourse analysis of documentation, qualitative network mapping and semi-structured interviews. Before an explanation is given on how the data was analysed, a summary of the type of data collected provides a useful insight into this research project.

3.2 Data sources

3.2.1 Documentation

Because the innovations being studied occurred over thirty years ago, the types of data sources that could be used were limited and the main source has been documentation. Documents as a source of data for social science research is a neglected area of study (Denzin, 1970; Bynner and Stribley, 1978; Bulmer, 1984; Bailey, 1987; Bryman, 1988; Easterby-Smith et al, 1991; Gummesson, 1991), yet through representing an unobtrusive means of conducting a research inquiry (the evidence not being influenced by presence of the researcher) they can provide a useful means of understanding social realities (Webb et al, 1966). Forster (1994) discusses the merits of document evidence which can sometimes provide a very comprehensive account of social activity, especially as unwitting evidence (evidence which the author did not intend to communicate) can often be extracted.

The documents consulted were largely primary sources (produced during the period being studied, i.e. 1960s-early 1980s) and they were primarily used to formulate an idea about how the technologies were introduced and developed within the UK. These documents predominantly included government documents which were mainly derived from the BSE Inquiry Press Office in London where masses of documentation had been gathered in the process of writing up the Phillips Report on BSE. Public availability of such data was very advantageous because accessing such material would otherwise have been extremely difficult, as experienced by some European studies (Hansen, 2000 in Denmark; Lemarie, 2000 in France and Sacristán and Eugenia-García, 2000 in Spain). Other documentation included technology supplier brochures and agricultural journals, obtained from agricultural libraries and industry and government actors.

Since its emergence, BSE has been labelled as an unforeseeable disease against which little preventative action could have been taken. The role of MBM manufacture and use in animal feed has therefore been marginalised during the whole BSE controversy. Because of the dominance of such arguments, conducting interviews with the actors available for comment on BSE as a first step in data gathering would have yielded little valuable information, as they were unlikely to have diverted from this general discourse. It was more appropriate to invest a significant amount of time and effort into tracing all related documents and other information which would allow for a sound assessment about how and why these technologies were introduced.

Whereas this analysis has used the document data itself as a means of understanding the social processes around the technological innovations, the BSE Inquiry has in contrast taken the evidence of industry/regulatory actors to formulate this understanding. Because such actors will no doubt have been affected by hindsight, the methodology adopted in this research is claiming to be a more valid interpretation of how the MBM technological trajectories emerged in the UK and what risks were associated with them.

Nevertheless, the criticism that data sources such as documentation may not be fully representative of the reality being studied (Das, 1983) is a powerful one. For instance,

there is the possibility that not all relevant data was made available. There were many witnesses who when requested for certain documents by the Inquiry, claimed that they had gone missing! However, by using the Phillips Report, and the primary and secondary data yielded by the Phillips Inquiry, research findings from the document research were substantiated and clarified. Key actors involved with the BSE crisis were also interviewed. Such a combination of research methods strengthened the validity and reliability of the document research and provided for a sound representation of the social reality being interpreted.

3.2.2 Interviews

3.2.2.1 Purpose of interviews

After establishing sufficient knowledge about the technologies, the pre-BSE risks and the BSE crisis itself, several interviews were conducted as a means of substantiating prior findings. Selection of these actors was based upon their involvement in the post-BSE period as identified through the Inquiry. Also, interviewees themselves recommended further contacts and through such *snowballing* techniques (Miles and Huberman, 1994) the main actors and organisations involved in BSE were interviewed.

The interviewees were in the main regulatory and industry actors and access was not as problematic as one may assume considering the public emotion associated with BSE. A very plausible explanation for the willingness of actors to partake in interviews is that seven out of the nine had already been questioned by the Inquiry and so were not perturbed by questions based upon BSE.

All but one of my respondents were middle aged or older males from professional backgrounds and I was aware of how my being a young female researcher could have influenced interviewee responses, as discussed by Bailey (1987). Therefore, I decided that my supervisor accompany me to the interviews and the similarities between him

and the respondents, in relation to age, gender and professional status, had a positive impact upon the data yielded.

3.2.2.2 Type of interview structure

Because the areas upon which this research was to focus had been identified, the interviews were used more for clarification purposes and as a means of obtaining further related information. Therefore, there was already some structural format that the interviews needed to adopt and so a completely open interview format was inappropriate. However, a too rigid interview framework was also unsuitable.

Because the interviewees were from different social sectors: industry, regulatory, research, there was likely to be a variation in their capacity to discuss the core themes of this research. Where this was the case, it was useful to acquire an understanding of their general perception of risk in relation to agricultural technologies. Because of this needed flexibility *semi-structured interviews* were the most suitable (Miles and Huberman, 1994).

For example, because Dealler (3/12/99) was unable to comment on the events of thirty years ago, it was necessary to redirect the interview towards general comments about agricultural innovation and risk, and the role of MAFF in relation to this. On the other hand, because Meldrum (18/1/00) was an informant who was the most equipped to comment upon pre-BSE affairs, the interview was directed to focus upon this period.

3.2.2.3 The interview in practice

Having conducted a number of the interviews it was clear that actors were adhering to very similar arguments, in which the role of the BSE technologies in the emergence of the disease was largely under-stated. However, because of contradictory knowledge gained through the document research and due to the flexible interview framework, interviewees were often probed into justifying this point of view.

Due to the sensitive nature of BSE and the organisational interests of the interviewees, building a good rapport with respondents was particularly important. Interviewees were always informed that the research was part of a European Commission project and that there was no attempt to determine what or who was to blame with regards to BSE. The questioning style was therefore in no way interrogatory. Instead it was emphasised that the research objective was to use the BSE case as a source of guidance for future technological innovations in the food sector. This clarification at the beginning was very important as it was necessary for respondents to understand that a particular slant on the crisis was not being adopted. One of the actors, Keith Meldrum, was the Chief Veterinary Officer during the post-BSE phase and he had experienced extensive public criticism for his management of the crisis, or lack of it. However, he was also a respondent who was the most adequately equipped to comment about pre-BSE events, being a key regulatory actor within MAFF during this period. Therefore, the interview approach ensured that this interviewee was not made to feel incompetent.

Other means of creating a relaxed atmosphere was by giving interviewees the opportunity to switch off the tape recorder during periods when they felt more comfortable not being recorded. Also, they were offered the opportunity to request a copy of how I had used the interview data. None of them, however, did so. The extent to which interviewees felt unthreatened by the interviews can be demonstrated by the lengths that many of them went to in assisting this research once the interview was completed e.g. sending relevant information through the post.

These semi-structured interviews substantiated findings from the document research and also revealed fresh areas of investigation, contributing to a more rigorous research project.

3.3 The analysis

3.3.1 Identifying actors

The role of actors and their respective sectoral interests is central to this analysis and though the documentation research revealed certain actors involved in the innovation and pre-BSE risk arenas, in order to understand the depth of the involvement of these actors, it was necessary to employ an array of research techniques, again demonstrating a triangulation of research methods.

Use of the BSE Inquiry and its masses of witness statements and oral evidence proved invaluable in highlighting sources to contact, where more could be learnt about the innovation and risk actors. Subsequently, several individuals were contacted by telephone and through such initial interaction with actors, other actor contacts were often given. Through such snowballing techniques face-to-face interviews with key industry actors, such as a representative of the largest UK rendering company, were arranged, providing further data on the roles of actors in the pre-BSE period.

The numerous websites on BSE were another source of information and though they largely centred upon the post-BSE period, they sometimes provided useful contact points for the pre-BSE period. Knowledge on a key actor promoting MBM in feed, the US National Renderers Association, was obtained through the Internet.

Once this information had been obtained the actors were mapped onto a network. However, some discretion was required in deciding which actors were the most relevant to the innovation and risk processes and this was decided through the identification of the most dominant actor discourses.

3.3.2 Discourse analysis

3.3.2.1 Describing the approach

Discourse analysis encompasses numerous different approaches and its varying features have attracted the attention of disciplines including sociology, psychology and linguistics. The discourse analysis approach presents a well identified means through which document data can be analysed and though it includes different types of analysis from conversation analysis used largely by linguistics, to the broader *narrative analysis*, the objective is to understand how a research subject gives meaning to his/her reality. Certainly discourse is a significant means through which our reality is constructed. For example, the public presentation of scientific discourse concerning acid rain, test-tube babies and genetically modified food are examples of how society is currently making sense of its reality in relation to these topics (Seguin, 2001).

Narrative analysis in social science research has largely tended to focus upon the life histories of people, where research subjects recall events about a particular part of their lives that is of interest to the researcher (Richardson, 1990; Riessman, 1993). In this way certain repertoires, or what Hajer (1995) terms *'story-lines'* develop which the researcher identifies as significant themes of analysis. Narratives/story-lines are also a good way of ordering qualitative data which can often be yielded in a very non-standard format (Turner, 1983; Harris, 2001). It is this concept of narratives/storylines, which has been used to make sense of the reality around BSE technologies and the management of associated technological risks because the employment of certain narratives by actors has a direct influence upon policy action. As Hajer (1995) states:

'Once the story-line gets enough socio-political resonance it starts to generate political effects' (Hajer, 1995; page 13).

For instance, society is waiting in anticipation to witness which of the GM food narratives directs policy in relation to this technology. Will it be the *'feed the world'* narrative of the biotechnology conglomerates, or will it be the *'Frankenstein foods'* narrative of the environmental and consumer lobbies?

3.3.2.2 Using discourse analysis in my research: identification of narratives

Through use of *documentary summary forms* the contents of various documents were identified (Miles and Huberman, 1994). This involved extracting and recording various quotations discussing the innovations and the associated risks.

In order to identify some general themes from the quotations the next step was to identify what discourses were being shared amongst actors, i.e. the more dominant themes, referred to in the literature as *'interpretative repertoires'* (Potter and Wetherall, 1987 as quoted in Forrester and Percy, 1998; Marshall, 1994). For instance, there was a group of actors commenting on the technological sophistication of the new continuous systems of rendering for manufacturing MBM. There was another group of actors discussing the possible risks of MBM use in feed. Repetition of the most dominant arguments formed a group of narratives to which a specific narrative title was attributed. This set of narratives is referred to as a *discourse-coalitions* (Hajer, 1995). For example, the discourse-coalition relating to technical changes to rendering systems has been entitled the narrative of 'technological modernisation' (see Chapter 6). Analysis of actor interactions and influences upon both the innovation and risk process was possible after the identification of these various narratives.

Critics of this approach are likely to argue that selection of narratives is mostly a personal interpretation of the data, arguing that narratives other than the ones identified could also have been detected. However, such personal input is necessary during qualitative analysis of this type (Hirschman, 1986) though because the narratives are based solely on the data consulted, questions about validity and reliability are largely unfounded.

3.3.3 Network analysis

3.3.3.1 Describing the approach

The network metaphor provides a useful tool through which social complexity can be unravelled. Network methodology has therefore been frequently used within the SST approach to depict the process of technological innovation. However, the use of network mapping has not been as extensively used in discussions about risk. Neither has the parallel depiction of innovation and risk with the objective of identifying what social arguments were the most influential in the policy network, been attempted. This analysis therefore presents new areas of analysis. The network analysis in this thesis will show:

a) the innovation process
b) the risk process
c) the influence of innovation and risk arguments upon policy action

3.3.3.2 Using network mapping analysis in my research

Social network analysis can either be conducted qualitatively or quantitatively as demonstrated by John and Cole (1998) and Laumann (1973). However, this research has used the qualitative approach to network analysis where rather than seek statistical conclusions from actor relationships the objective has been to retain the diversity of social relations, where the diversity itself is the interest of research The qualitative approach of Conway (1997) and Conway and Steward (1998) has therefore been adopted. Configuration of networks, depends upon what meaning they seek to convey and so network construction requires careful consideration. In this analysis they have been used to illustrate the influence of actors and actor discourses upon technological change, for which this qualitative approach has been more appropriate. (Future development of this thesis, however, could employ quantitative methodological tools to support the existing qualitative research).

In terms of the innovation process, the network methodology allowed for the social influences upon the MBM technologies to be depicted. For example, it was ascertained that a significant influence upon the use of MBM in the UK emerged from the USA. In terms of risk, the network methodology illustrated that certain technology-related risks were only discussed amongst research institutions rather than being managed by regulatory actors charged with the responsibility of monitoring the technologies. An understanding of why risk discourses failed to receive adequate hearing in the policy arena has therefore been provided.

3.3.3.2.1 The graphic representation of networks

Analysis of the various networks has been achieved through the use of network graphics, modelled on the network template of Conway (1997) and recreated using the *Visio* software.. The growth of computer technology has increased the awareness of graphics representing (if well constructed) an analytically sound means of communicating research findings (Bertin, 1983; Conway and Overton, 1994). Social scientists of innovation networks have adopted the graphic tool to represent the social complexity involved in the innovation process, appreciating how the social network approach gives itself easily to diagrammatic representation.

In the construction of a network diagram a *focal action-set* primarily needs to be defined (Conway, 1997; Conway and Steward, 1998). This includes the set of actor relationships involved in a specific social activity. This thesis has taken the innovation and related risk assessment processes, as the focal action-set, initially mapping the interactions between innovation and risk actors separately, and then displaying the two sets of actors onto one network diagram.

In the amalgamation of innovation and risk networks, this analysis has modified the network template of Conway (1997) and Conway and Steward (1998) which was used for the innovation process only. This modification reflects a change in what the linkages (*dyads*) between actors represent in this analysis. Though these linkages continue to represent direct communication between actors, a differentiation between interactions over innovation and interactions over risk needed to be made. Furthermore, a differentiation between discourses identifying and discourses

responding to risks has been made, as a means of highlighting the marginalisation of risks. This differentiation between the risk discourses has been achieved through changes in line texture of the risk dyads. Whether or not actor interactions involved equal collaboration between actors is represented by the presence of a one-way (unequal) or two-way (equal) headed arrow link.

Like the Conway and Steward template, the focal arena is partitioned into various categories in which actors are located according to their organisational roles (see Appendix 5). These categories are knowledge, regulatory, society - present in the upper half of the network representing the more socially-oriented sphere. The other two categories are suppliers and customers - present in the lower half of the network representing the more economically-oriented sphere. The centre of the network contains core actors involved in the innovation and risk process. This extensive environment is indicative of the wider influences upon innovation.

To understand and explain the introduction of the BSE technologies into the UK and to make an assessment of how related risks were managed by regulatory actors, has required a methodological approach which appreciates the important contribution made by social actors in achieving technological change. How these methodological approaches have been applied to the social contexts relating to the two BSE technologies is examined in the following two chapters.

4 The use of MBM/bypass protein in animal feed: the innovation and its risk assessment

The two technological innovations to be explored in this analysis originated in Northern America in the 1960s. Though they each involve separate discussions of innovation and risk, it must be noted that there is a close relationship between the use of MBM in animal feed and changes in how it was manufactured, the latter which is to be discussed in Chapter 5. In this chapter, the network of innovation and risk actors in relation to MBM use in feed will be examined.

4.1 BSE: the role of MBM/by-pass protein in feed technology

Because the Phillip's Report is focusing upon post-BSE events, the BSE technologies are not viewed as a key focus of analysis and neither are the precautionary voices commenting upon MBM use in feed/manufacture prior to BSE. Furthermore, the BSE Inquiry has stated that obtaining the relevant data which would allow for such an analysis has been difficult (BSE Inquiry Report Volume 13, 2000). This thesis therefore offers a renewed insight into the BSE story.

However, the Phillips Report accepts that BSE was a consequence of intensive farming practices whereby cattle was forced to increase productivity through high protein feeding programmes which included MBM (BSE Inquiry Report Volume 12, 2000). Due to the popular use of MBM, the Report concludes that this technology was the cause of spreading BSE so widely. This analysis seeks to further investigate the development of this technology which undoubtedly played a significant role in the emergence and spread of BSE.

Furthermore, whereas the Inquiry has emphasised the benefits of MBM and its legal allowance in feed (BSE Inquiry Report Volume 1, 2000), it has failed to identify risks related to the technology which were being discussed in the pre-BSE period. Instead

the Inquiry Report concludes that MBM had always been a technology to which no significant risk was attached, and so does little to label MBM as a risk technology prior to BSE.

In contrast to the many emotional arguments condemning such use of the MBM technology following the outbreak of BSE, this analysis has explored the arguments discussing the negative implications of how MBM was being used (and manufactured) in feed, *before* the emergence of BSE. How these failed to alter the technological course of MBM, identified as a very formidable innovation in the 1970s and early 1980s, will be revealed. These findings counteract the dominant post-BSE discourse of industry and regulatory actors where it is argued that no risks from this practice in terms of animal/human health had been previously highlighted.

4.2 Network of innovation actors

MBM is produced through the processing of animal waste by the rendering industry and before its 1996 ban in the UK, MBM was commonly included in animal compound feed rations. This chapter seeks to trace the technological trajectory of MBM, identifying those actors involved in encouraging its use in feed. However, there is particular attention attributed to increases in MBM use in feed, due to it being defined as *a 'new innovation'* (National Renderers Association, 1985; page 10), through the scientific concept of *by-pass protein.* Therefore, MBM as a by-pass protein source will often be referred to in this analysis, representing a change in the *process* of how MBM in animal feed was used.

By-pass protein is a type of protein which remains undegraded in the rumen of the animal, delivering enough proteins to the small intestines to achieve maximum growth and lactation in high-yielding dairy animals. MBM was very often the preferred source of by-pass protein. At this point it is necessary to add that almost two-thirds of beef produced in the UK originates from dairy herds (BSE Inquiry Report Volume 1, 2000). Therefore, any infective material entering dairy cattle through MBM had possible implications for human health. The greater number of BSE cases in dairy herds compared to beef suckler herds (BSE Working Party, 1988; UK Government's

BSE Review Committee, 2001), confirms the important role of MBM as a by-pass protein source in the emergence of BSE.

The Phillips Inquiry concludes that MBM's value as a by-pass protein led to wider scale use of MBM (BSE Inquiry Report Volume 16, 2000). This substantiates the findings of this thesis where it is concluded that the definition of MBM as a new innovation through its delivery of by-pass protein, was a technological change which gave tremendous impetus to the technology.

Though in itself the concept of by-pass protein signifies little (if any) technological change to the MBM product itself, the implications of the technological change, i.e. how it increased MBM use was very significant. This type of innovation is what Abernathy and Clark (1985) have termed *regular innovation.*

4.2.1 Knowledge actors

The technological path of MBM/by-pass protein received its initial impetus from various scientific actors located in the knowledge segment of the network. As well as including a key US research actor, the knowledge sector included two UK research establishments.

4.2.1.1 The US Fats and Proteins Research Foundation

The Fats and Proteins Research Foundation (FPRF) was established by the US National Renderers Association (NRA) in 1962, with the purpose to stimulate research and development into new end uses for the rendering industry's products (Feed and Farm Supplies, June, 1972). Still in existence today, the FPRF has actively promoted the use of MBM world-wide. Pearl (1996) reports on how the FPRF is *'the only independent research organization dedicated exclusively to rendering'* (page 225). The concept of MBM being a valuable source of by-pass protein in animal feed, first emerged from this research actor.

4.2.1.2 The Agricultural Research Council and the Rowett Research Institute

The US NRA and its FPRF undoubtedly became a sphere of influence in the expansion of the MBM technological trajectory throughout Europe. In the UK, the involvement of research organisations like the Agricultural Research Council (ARC) and the Rowett Research Institute (RRI) continued this emphasis upon MBM, particularly through the by-pass protein concept.

The term by-pass protein was first used in the UK by the ARC (now the Biotechnology and Biological Sciences Research Council) in its 1981 publication *Nutrient Requirements of Ruminant Livestock* (Agricultural Research Council, 1981). Following the recognition of this new scientific protein system, and identification of MBM as a suitable source of such protein, the ARC was a significant actor in presenting MBM as a new innovation (Webster, 1999).

Though the Rowett Research Institute (RRI) was more concerned with the energy value of MBM (Wainman and Dewey, 1985), the discussion of MBM by scientific actors like the RRI and the ARC was used by business actors to disguise their own organisational interests in promoting MBM. Knowledge actors like the ARC and RRI, therefore, represent indirect actor interests in encouraging the technology.

4.2.2 Business actors

Though the emphasis upon economic motives for technological change is challenged by SST theorists, an economic rationale still remains an important element in understanding innovative activity. Economic arguments encouraging by-pass protein were voiced by numerous actors involved in MBM production and use in feed, keen to present MBM/by-pass protein as a symbol of industrial agriculture. This actor network included the compound feed, the rendering and the farming sectors.

4.2.2.1 The compound feed industry

4.2.2.1.1 MBM use in feed

Increases in compound animal feed are a good indicator of the economic focus upon increasing livestock yield during the 1960s and 1970s. The EU's Common Agricultural Policy (CAP) added particular impetus to growth in dairy and other cattle compounds and between 1973-1983 production of cattle feeds increased by 1.5 million tonnes, reaching a peak in 1983 (Feed Facts Quarterly, 1996); three years before the first clinical case of BSE.

Inclusion of MBM and other unlikely ingredients (e.g. sewage sludge, sawdust, and treated manure) in animal feed signifies this economic incentive where such ingredients were conducive to increasing livestock yield (Proceedings Prologue to the 1971 International Symposium on Livestock Wastes, 1971; Bird, 1974; Rampton and Stauber, 1997).

In the Phillips Inquiry the common discourse of industry actors and government officials has been that the regular inclusion rate of MBM in feed only made upto 1/2% of the total feed (Wilesmith, 1988a). However, it is possible that the maximum level of 5% inclusion (set due to palatability reasons) may sometimes have been used and/or that more feed compounders began incorporating MBM into their rations in the UK during the period when the value of MBM was being emphasised.

Evidence submitted to the Inquiry has revealed that the use of MBM did increase just before the onset of BSE (Gallagher, 1988; page 1; Garrett, 1988; page 2), and the report by the UK Government's BSE Review Committee (2001) also signifies increasing consumption trends. In this Report there has been confirmation that during the 1970-1988 period, feed manufacturers began introducing MBM into rations for calves from the first or second week of age (significant because young calves are more susceptible to the infective agent compared to adult cattle). This indicates the increasing emphasis being attributed to MBM in the period prior to BSE.

Therefore, though MBM use in animal feed had been an established practice, certainly since the early twentieth century, its technological path appears to have gained significant importance in the mid twentieth century onwards through its provision of by-pass protein which began *'receiving increased attention as a method of improving the performance of ruminants'* (The Feed Compounder, June 1981; page 26-27).

4.2.2.1.2 By-pass protein

The economic success of the animal feed industry rests upon what benefits feed products can offer farmers. In the 1960s and 1970s livestock production was becoming increasingly intensive with higher growth rate potential and the compound feed sector needed to embrace these needs. By-pass protein was a means through which the feed industry stood to gain economically as it provided farmers with a means of increasing milk yields (Cooke, 5/1/00).

The value attributed to the by-pass protein concept by feed actors is particularly noteworthy. Whereas the inclusion of MBM in feed rations by feed actors was traditionally dependent upon its price relative to the other main protein source, soya (Feed and Farm Supplies, December 1971; Feed and Farm Supplies, March 1972; The Feed Compounder, January 1981; Lamming Committee, 1992; Cooke, 5/1/00), this changed in the early 1980s, follwing the by-pass protein innovation in the UK. From this period onwards, the feed industry actively sought to promote MBM use in animal feed, whatever its price.

The feed industry was a key force in developing the by-pass protein innovation, realising the economic benefits that would ensue from acceptance of this technology. By discussing MBM under the guise of by-pass protein, the feed sector adopted a scientific discourse through which to argue the advantages of the technology. By the late 1970s and 1980s the UK feed industry was technologically and scientifically progressing and there was repeated emphasis upon making British agriculture more efficient. This economic drive was aided by a concentration of the feed sector whereby a small number of companies controlled the UK market in the 1980s (BSE Inquiry Report Volume 13, 2000).

In 1981 the UK industry began publishing a journal entitled *The Feed Compounder* which frequently discussed the value of animal protein ingredients like MBM under the label of by-pass protein (The Feed Compounder, June 1981; The Feed Compounder, December 1981; Wilson and Brigstocke, 1981). This represented arguments that the development of by-pass protein was part of the scientific developments being made in agriculture. The possibility to increase milk yields was particularly emphasised in these arguments (Agriculture Economic Development Committee's Livestock Group, 1981), making the technology attractive to the farming sector.

4.2.2.2 The rendering industry

4.2.2.2.1 US National Renderers Association and its Fats and Proteins Research Foundation

In the USA the rendering industry was led by an influential trade association, the US National Renderers Association (NRA), which made strong arguments for promoting the use of MBM in feed. Arguments emphasising the economic benefits of MBM were frequently articulated by this actor. Unquestionably, the rendering industry world-wide was out to make greater economic gain from increased use of MBM; be it for its by-pass protein potential or otherwise.

The US NRA has emerged as a powerful actor in the development of MBM use in feed (National Renderers Association, 1981; 1983; 1984), as expressed through its launch of the FPRF, where its priority was to *'promote the use of all animal by-products'* (National Renderers Association, 1981; page 4). These US actors greatly assisted in making the use of MBM increasingly pervasive, both in the US and in Europe.

The US renderers were also keen to attribute MBM with scientific values which would ensure continued and increased use (National Renderers Association, 1981; National Renderers Association, 1984). The identification of MBM as a by-pass

protein was exploited by the sector who consequently began promoting MBM as a new technological innovation (National Renderers Association, 1985), attracting renewed attention to their product.

Because the UK rendering sector has, at least since the 1950s/60s, operated as a commercial industry (unlike many European countries), exploitation of the by-pass protein concept for economic ends was even more important. Furthermore, because the UK industry since the 1960s has been largely dominated by one company, Prosper De Mulder (PDM), the US emphasis upon MBM from the 1960s onwards is likely to have been keenly adopted and exploited by this dominant UK rendering actor. PDM certainly began making certain technological changes which would ensure increased MBM production (as discussed in Chapter 5).

Intensive farming results in the increase in livestock numbers and the consequential factor of more animals being slaughtered. The rendering industry therefore had larger quantities of animal waste to process and an emphasis upon by-pass protein meant that there was an opportunity to translate this increase in raw material into considerable economic success, which is exactly what PDM did.

4.2.2.3 Farmers

The Phillips Inquiry has concluded that farmers were well aware of MBM inclusion in animal feed (BSE Inquiry Report Volume 1, 2000). Certainly the by-pass protein benefits of MBM would offer farmers direct economic benefits of increasing milk yields (The Feed Compounder, October 1981); features of the industrial model of farming.

Feed Facts Quarterly (1996) reports on increases in UK milk production, as quoted by the National Dairy Council, upto the years preceding BSE. This indicates the economic rationale of farmers in supporting the use of by-pass protein in feed:

Table 3: Increase in milk yields, 1974-1983

Date	Litres (average annual yield per dairy cow)
1974 - 1975	4,050
1975 - 1976	4,270
1976 - 1977	4,320
1977 - 1978	4,590
1978 - 1979	4,700
1979 - 1980	4,720
1980 - 1981	4,810
1981 - 1982	4,745
1982 - 1983	5,055
1983 - 1984	4,940 (decrease resulting from the EU milk quotas of 1984)

Source: Feed Facts Quarterly (1996).

4.2.2.4 Actors representing the meat industry

The Meat and Livestock Commission (MLC) is an independent organisation set up by Parliament in 1969 and it is funded by the related industrial sector. Its objective is to support the marketing of British meat and livestock, offering support to farmers and others in the industry. The MLC was keen to voice its approval of the general use of MBM, arguing that animal by-products of various sorts must be utilised more effectively to encourage prosperity amongst the meat and related industries: *'The meat wholesale industry in this country is fragmented...anything which can be done to improve the return...is of paramount importance'* (MacGregor, 1976).

4.2.3 Regulatory actors

Government support for technological innovations often depends upon the benefits that will ensue for the general economy. Recent government emphasis upon developments in the biotechnology sector is a good example of this. However, in light of such expectations there is sometimes a neglect of adequate regulatory control of the technology by government powers.

The Ministry of Agriculture, Fisheries and Food (MAFF) was keen to encourage agricultural practices which would lead to increased yield, especially as the UK's membership of the European Community in 1973 promised expanding trade opportunities. Such government rationale greatly encouraged the scientific revolution in Western agriculture, where the by-pass protein concept was just one of many government approved scientific discoveries.

In addition, governmental actors argued that the production of MBM for its subsequent inclusion in feed, provided the most efficient and effective means of processing animal waste.

4.2.3.1 MAFF and the legal allowance of MBM

In the UK, MBM has been accepted as an animal feed ingredient since at least the 1926 Fertiliser and Feedingstuffs Act. Following the second world war, agricultural practices which would lead to higher domestic yield were continuously encouraged. Use of MBM in animal feed was one such agricultural practice and so in 1946 the UK Ministry of Agriculture passed an Order whereby feed compounders were legally obliged to incorporate a minimum 5% of MBM into feed rations (MAFF, 1946; Cooke, 5/1/00). Such regulatory intervention signifies the high profile awarded to MBM as a feed ingredient.

The attractiveness of MBM was not unique to British agriculture. In North America it was also included in much of the animal feed (Fuller, 1996; Rampton and Stauber, 1997) and it was also a popular phenomenon in other European countries (Hansen, 2000; Lemarie, 2000). EU legislation of the 1970s refers to animal ingredients from animal species (European Economic Community, 1977; 1979) and this is likely to have been referring to MBM, again signifying approval of MBM in feed by government actors.

4.2.3.2 Department of Environment and arguments favouring recycling

One of the key reasons for encouraging such use of MBM is that it provided a suitable means of recycling animal waste, therefore avoiding any environmental problems (Department of the Environment and MAFF, 1976). Government bodies, especially the Department of Environment (DoE)[2], therefore argued that the manufacture of MBM represented: *'a socially and politically important industry'* (Gifford, 1978; page 1). Such arguments encouraged the more general use of MBM (without emphasis upon the by-pass protein concept).

When the government's committee of experts on BSE stated in their draft report that use of animal protein in this way was unnatural, government actors were keen to modify the report (MacGregor, 1998), emphasising that the industry performed a vital environmental role in managing animal waste. It is only in more recent times that the narrative of rendering being ecological seems to have been waived by regulatory actors (Grantley-Smith, 18/1/00).

4.2.3.3 The Institution of Environmental Health Officers

In the early 1980s the Institution of Environmental Health Officers (IEHO) was commissioned to carry out a study on the rendering industry and in its final report it concluded that the production of MBM (for inclusion in feed) was a good recycling practice (Institution of Environmental Health Officers Working Party, 1987). It also highlighted that the EU also encouraged the recycling of animal waste as an environmentally sound activity, confirming the EU's encouragement of MBM use in feed.

Arguments that the production of MBM was a sound recycling practice significantly aided in developing MBM use in feed, particularly as environmental issues gained a higher public profile in the 1960s and 1970s with the publication of Rachael Carson's *Silent Spring* and *The Limits of Growth* (Meadows et al, 1972). In such a social

[2] The DoE is now also incorporated within DEFRA, but because this thesis studies events occurring before this change, the DoE acronym is used.

context it is likely that MBM also began to be argued as an environmentally-friendly technology.

4.2.4 Comparison with other countries

Any analysis of BSE poses the question of why the disease originated in the UK. Research of French and Danish industrial sectors has yielded new findings about technology selection in the UK compared with other countries (Hansen, 2000; Lemarie, 2000). Not only do these comparisons counter criticism over the use of a single case as the focus of research, but they also identified new research questions.

It can be assumed that intensive agriculture was the norm across most Western societies in the latter part of the twentieth century. In 1954 FEFAC (Fédération Européenne des Fabricants D'Aliments) was established by the European Community, aiming to increase animal feed production. Within this industrial development of compound feed therefore, MBM use was likely to have been accepted as a good protein source. However, in light of its important role in spreading the BSE disease in the UK, whether it was used to a larger scale in the UK compared to other Western countries is a significant mode of analysis.

4.2.4.1 Alternatives to MBM as a by-pass protein source

Though the use of MBM was common practice in Denmark and France, both countries had tighter regulations governing the processing of MBM as is to be discussed in Chapter 5. Furthermore, in France, MBM was not considered to be the most beneficial protein source and tanned vegetable protein was a very popular alternative. French research establishments such as INRA (Institut National de la Recherche Agronomique) invested considerable resources in investigating such alternatives (Lemarie, 2000).

Though there were vegetable protein alternatives in the UK (The Feed Compounder, March 1981; The Feed Compounder, April 1981), agricultural scientific journals in

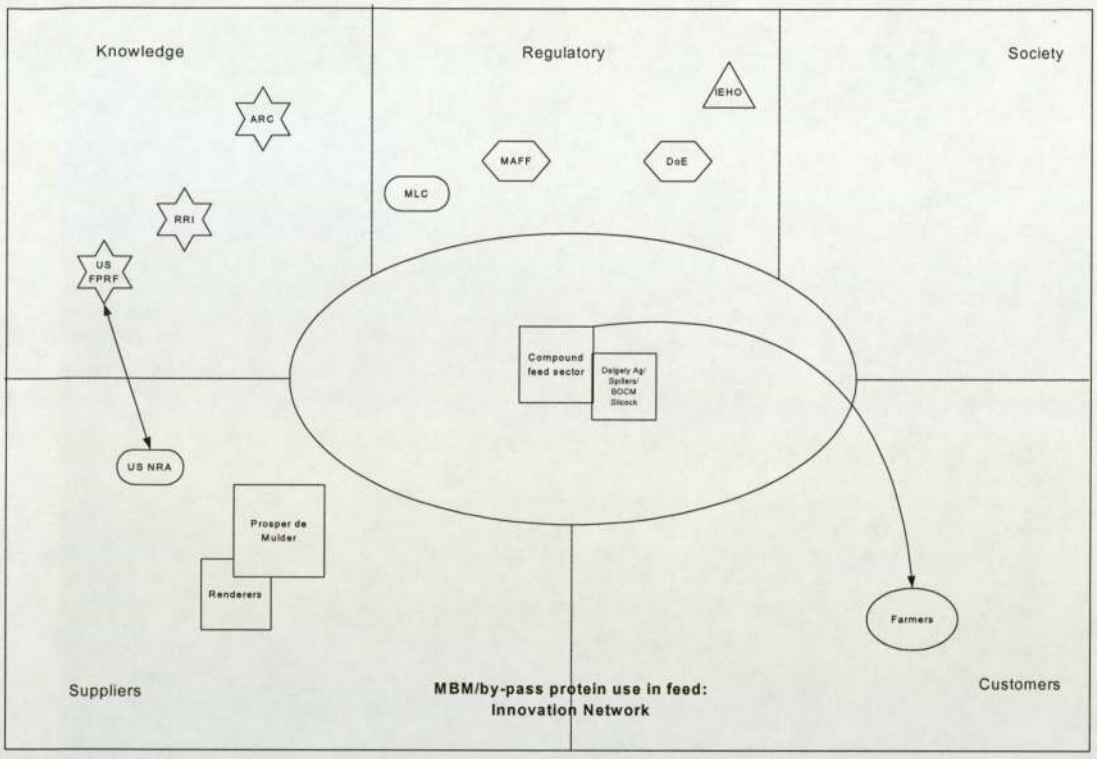
this country focused more upon animal protein sources (The Feed Compounder, January 1981; June 1981; September 1981; October 1981; December 1981). For instance, the *Feed and Farm Supplies* magazine indicates the great demand for MBM in the UK (Feed and Farm Supplies, December, 1971; February, 1972; August, 1972; November, 1972). Furthermore, the UK Government's BSE Review Committee (2001) has concluded that the feeding of MBM to calves in the period before BSE was a prevalent practice in Britain and less so in continental Europe and the USA.

The MBM/by-pass protein technology was the dominant technology in the UK and alternative technologies failed to supersede its technological trajectory.

4.2.5 Innovation summary

There were many arguments voiced in support of MBM, both as a by-pass protein source and as a general constituent of animal feed, positively influencing the development of this technology. Increases in domestic MBM production (Wainman and Dewey, 1985; The Monopolies and Mergers Commission, 1985; UKRA, 1998) signify that higher amounts of MBM had started to be used in the UK, especially as exports of MBM remained a very small market (Business and Trade Statistics Limited, 1998; Cummins, 1998). Actors forwarding these innovation arguments have been mapped onto the following network diagram.

Figure 2: The MBM/by-pass protein innovation network diagram



Network Key:

Research Organisation

Governmental Body

Representative Body for Individuals

Representative Body for organisations

Business Sector

Professional Organisation

Abbreviations used in this network: US NRA, United States National Renderers Association; US FPRF, United States Fats and Proteins Research Foundation; ARC, Agricultural Research Council; RRI, Rowett Research Institute; MLC, Meat and Livestock Commission; MAFF, Ministry of Agriculture, Fisheries and Food; DoE, Department of Environment; IEHO, Institute of Environmental Health Officers; Dalgety Ag, Dalgety Agriculture.

4.2.5.1 The innovation network

A close examination of actor influences upon the innovation and risk networks discussed in Chapters 4 and 5 will be presented during the detailed analysis of the policy networks in Chapters 6-8, where the specific meanings underlying actor

interactions will be explored. To avoid repetition therefore, only a brief summary of actors and their linkages will be provided in chapters 4 and 5.

In this network the *core* actor is the compound feed industry through which the by-pass protein concept was promoted, resulting in increased MBM use. However, the network typology illustrates the much wider influences upon the innovation, involving actors from the *knowledge*, *suppliers*, *regulatory* and *customers* segments. Significantly, there is a total absence of *society actors,* representing this innovation network as a closed process with mainly regulatory and business actors dominating.

Being external to the UK system, the US NRA and its FPRF demonstrate the extent of social influences which sometimes shape technological innovations. Seeking to directly benefit from MBM sales the US NRA was extremely active in spreading knowledge about products of the rendering industry through employing both scientific and economic arguments, through its link with the FPRF. Likewise, the UK rendering industry, represented mainly by PDM, is also an important actor in the MBM technological chain, manufacturing the MBM so that it was widely available in the UK, again also receiving direct economic benefits. The MLC has been located in the *regulatory* segment due to its supervisory role in managing the interests of the agricultural sector. This actor sought to emphasise the economic potential of MBM consumption. Farmers were the recipients of MBM and had a direct economic incentive from using feed which would increase farming productivity. The feed sector was very active in ensuring that farmers were made aware of how feed containing MBM would achieve exactly this, shown by the relevant dyad.

Non-economic influences upon the technology are represented by various governmental actors. MAFF's dual interest in MBM production and consumption centred upon increasing livestock yield and managing animal waste. The DoE, along with the professional association the IEHO, was also in favour of MBM use due to its recycling role.

Arguments related to technology-related risks will now be examined.

4.3 Network of Risk Actors

4.3.1 Pre-BSE MBM related risk arguments

The role of regulatory actors in the introduction of technological innovations remains paramount. As well as encouraging innovative activity which is conducive to economic growth, governmental actors have a twin role in protecting the general public. In relation to MBM and by-pass protein developments (though arguments in the risk network relate more generally to MBM use rather than to by-pass protein specifically), UK regulatory actors were extremely weak in responding to possible risks resulting from the innovation.

The 1926 UK Fertiliser and Feedingstuffs Act demonstrated the official acceptance of MBM as an ingredient in animal feed. In relation to protection against possible contamination the Act very briefly signified that MBM inclusion was only permitted as long as there were no health risks posed to livestock. This general safeguard against animal feed was also expressed through the establishment of the 1970 EU Standing Committee for Feedingstuffs (European Economic Community, 1970) and early EU legislation (European Economic Community, 1977; 1979). The inclusion of MBM in feed was therefore never questioned amongst regulatory actors, though the following ominous quote indicates that not everyone was so comfortable with the practice:

'If cattle were fed animal remains they would go mad' (Rudolf Steiner in the 1920s, philosopher and founder of the Biodynamic system of farming, quoted in Soil Association, 1996).

Such concerns however failed to modify the use of a technology which was legally approved. It was the risk from salmonella, particularly problematic in the 1970s, that appears to have caused the greatest concern for regulatory actors; where the quality of the product rather than the practice itself, was the focus of regulatory attention. The salmonella problem led to efforts to regulate the manufacture of MBM and will be discussed in Chapter 5. However, other risk issues related to MBM use in feed failed

to achieve any weighting in the policy arena. These included the marketing of MBM, expressed by the farming community, and the possible risk of MBM causing human disease, expressed by US regulatory actors.

4.3.1.1 The labelling of MBM

4.3.1.1.1 Farmers desiring precautionary measures

During the 1970s compound animal feed was increasing (Feed Facts Quarterly, 1996) and one group of actors which was concerned about the contents of this feed was the customer, the farmers. Farmers regularly demanded better labelling of animal feed, stating that they had the *'right to know more about the product'* (National Farmers Union, 1983; page 5). Through such demands they argued that precautionary action in relation to better marketing of compound feed was needed, especially in relation to the source of protein (Winter, 1974) i.e. MBM. The farmers feared that if there was ever to be an outbreak of a disease brought on by the use of feed, inadequate labelling of feed ingredients would not assist in finding what ingredient was responsible, therefore hindering effective management of a disease outbreak. Because MBM was an essential part of most animal feed, the farmers' arguments represent how adequate marketing of MBM in terms of product distribution, was a slow and poor development (National Farmers Union, 1988).

4.3.1.1.2 The feed industry tolerates possible risks of inadequate labelling of MBM

The passive involvement of the feed industry in ensuring better labelling indicates the sector's tolerance of the demands made by farmers, rather than adopt any measures to meet their concerns (Open Feed Executive Committee, 1978). Instead feed actors preferred to argue that what they were including in feed rations was not a secret but was common knowledge amongst farmers (UKASTA, 1981; Cooke, 5/1/00). Though farmers were unlikely to dispute the inclusion of MBM, they did fear the possible implications of poor labelling. During post-BSE investigations into MBM use in feed, farmers were unlikely to have known whether their herds had consumed MBM

or not. Only the feed compounders had this information, making the tracing of herds that had consumed MBM a lengthier and a more problematic process.

Therefore, though MBM, especially in relation to by-pass protein, was being discussed in a highly modern and sophisticated language, the marketing of MBM did not follow such a rational and technological route.

4.3.1.2 Managing scrapie infected material in MBM

Scrapie, a neuro-degenerative disease of sheep, has been a problem in the UK and many other countries for up to 200 years and prior to BSE, most countries did not perceive it as a major risk other than it affecting the individual animal. However, in the 1970s, US regulatory actors identified a possible link between scrapie-infected MBM and human diseases. In the UK, this risk discourse failed to influence MBM-related policy.

Though the current official explanation of BSE is that the 1980s disease was caused by infective *BSE material* (which had been recycled through the distribution and consumption of MBM), the role of scrapie remains a possible factor in the emergence of the disease. Transmitted to cattle via MBM, scrapie was the first official explanation for BSE and the Phillips Report, as well as the more recent UK Government's BSE Review Committee (2001), concludes that scrapie could still be a possible determinant in the cause of BSE.

Due to its possible significance, this research project has examined the UK's pre-BSE scrapie policy in relation to MBM. This has provided a good example of how an MBM-related risk was outrightly sidelined by UK authorities.

4.3.1.2.1 US regulatory bodies

By 1976 the United States Department of Agriculture (USDA) and the US Food and Drugs Administration (FDA) concluded that due to the authorities' long-held concern over possible links between scrapie and some human neuro-degenerative conditions, certain measures against scrapie had been decided upon. These including the banning

of scrapie-infected animals both from human consumption and from entering rendering plants (Chaloux, 1975; Agricultural Research Council, 1976b). This represents US regulatory actors implementing precautionary action.

The impetus for this legislation was the work of US scientists who were extensively researching human transmissible spongiform encephalopathies (TSEs) and their identification of a link between scrapie and certain human neuro-degenerative conditions (Herzberg et al, 1974; Rampton and Stauber, 1997). Though more recent scientific evidence has largely refuted links between scrapie and human ill-health, (BSE Inquiry Report Volume 2, 2000), in terms of managing a risk parallel to an innovation (i.e. scrapie and MBM use in feed), the scrapie issue provides a useful point of analysis. Whereas US regulatory authorities were responding effectively to the risk, their UK equivalents were not.

4.3.1.2.2 The UK Agricultural Research Council

Within the UK the US scrapie concerns were discussed within the government-funded research organisation, the ARC. ARC documents from the 1970s reveal that the UK authorities were aware of the US action but the research actor argued that it was not supported by scientific evidence, indicating a reluctance to adopt precautionary action. Also, the main concern was that any such similar action in the UK would seriously damage the sheep industry (the most dominant in Europe): *'A similar ban in this country would be disastrous to sheep farmers'.* (Agricultural Research Council, 1976a; page 2). Economic arguments discouraging similar action as that adopted in the US therefore prevailed (Agricultural Research Council, 1976a; Agricultural Research Council, 1977).

Though the risk was not completely dismissed in the UK, it did not result in any measure to limit scrapie material from entering UK rendering plants even though the discussions coincided with the period at which an Order regulating the rendering process was being discussed. As it was known that scrapie was a highly resistant pathogen (Agricultural Research Council, 1976b) and that the US was suggesting that there could be a link between scrapie and human TSEs, then this Order should have at least been a measure which would ensure scrapie destruction. In contrast, regulatory

actors failed to establish processing standards which would destroy resistant pathogens like scrapie (see Chapter 5). The network approach elucidates the failure of UK regulatory actors to link the technological change of increased MBM use in feed with the possible risk of scrapie contaminated MBM. There was a further failure to recognise how new technology introduced by the rendering sector could have further amplified this risk (see Chapter 5).

Instead, US scrapie concerns were paralleled with UK concerns about the economic benefits of the sheep industry. The UK authorities decided that no related precautions in MBM manufacture or use needed to be adopted. Though there were MAFF members on the ARC's Advisory Committee on Scrapie (Agricultural Research Council, 1976b), MAFF involvement in these scrapie discussions is not evident and MAFF actors have since stated that they were unaware of any risk of scrapie spreading through MBM (Meldrum, 1998b). In short, this area of risk did not get a formal response from the UK government, most probably because of the possible economic repercussions of bringing the debate into a more public domain. Instead the issue was left for the Agricultural Research Council to 'manage'.

Though ARC established a fresh scrapie research programme (Agricultural Research Council and Neuropathogenesis Unit, 1981) this was as a means of responding to the US action rather than seeking to genuinely protect against MBM risk (Agricultural Research Council, 1976b; Martin, 1998). Such action resulted from fears that no action at all was likely to lead to criticism if news of the US ban ever reached the public arena (Agricultural Research Council, 1976b; Agricultural Research Council, 1976d; Agricultural Research Council, 1977). Therefore, whereas traditional scrapie research was only conducted between the ARC and the Moredun Research Institute (MRI), the new scrapie programme increased this network to include the Medical Research Council (MRC) and the Neuropathogenesis Unit (NPU). However, set up only as a direct reaction to what was argued to be excessive US action, this risk network was a weak means of ensuring that MBM infected scrapie did not pose a risk to human health.

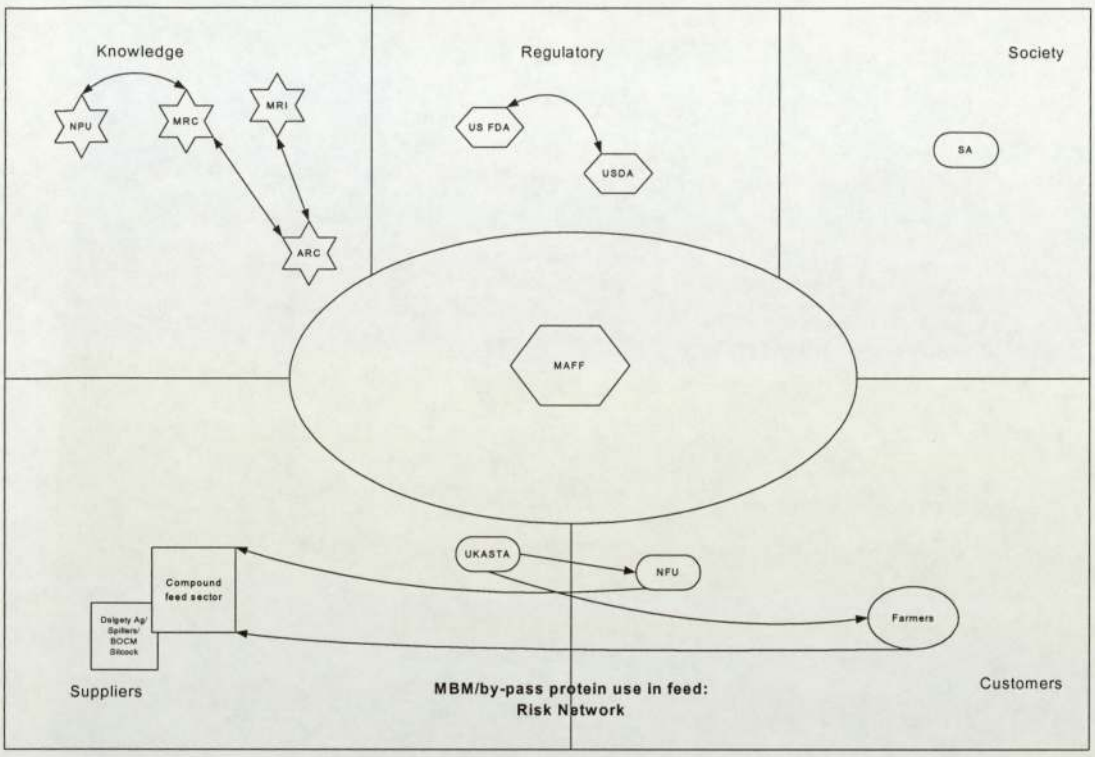
4.3.1.3 The Soil Association: Banning MBM from ruminant rations, *prior to BSE*

The scrapie concern is important in terms of its potential threat to the use of MBM in animal feed. However, this threat was subdued by UK policy-makers. The activities of the Soil Association posed a second possible threat. In 1983 this organisation banned MBM from cattle and sheep rations. Reflecting the interests of organic farming, the Soil Association has represented organisations seeking to promote sustainable agriculture since 1946 and its decision to ban the practice of feeding ruminant animals has been explained as exemplifying a precautionary approach to policy-making (Holden, 1999; Soil Association, 2001; Holden, 24/1/01). Therefore, whereas economic and regulatory actors were willing to permit the use of MBM in animal feed (despite associated risks), the Soil Association was not. However, the action of this actor failed to challenge the national use of MBM in feed.

4.3.2 Risk summary

It is evident that arguments discussing the scientific value of by-pass protein were not accompanied by a commitment to a similar rational scientific approach protecting against MBM-related risks. This is shown through the inadequate labelling of MBM and the approach towards the scrapie risk. This latter risk in particular represented a closed policy domain which failed to approach risk assessment within a precautionary framework. Instead there was more tolerance of the risks being highlighted and there was an uncontrolled and unmonitored expansion of MBM use in animal feed. Actors involved in the risk debates are shown on the following network diagram.

Figure 3: The MBM/by-pass protein risk network diagram

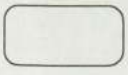


Network Key:

Research Organisation

Governmental Body

Representative Body for Individuals



Representative Body for organisations

Business Sector

Abbreviations used in this network: MRI, Moredun Research Institute; MRC, Medical Research Council; NPU, Neuropathogenesis Unit; ARC, Agricultural Research Council; US FDA, United States Food and Drugs Administration; USDA, United States Department of Agriculture; MAFF, Ministry of Agriculture, Fisheries and Food; NFU, National Farmers Union; UKASTA, United Kingdom Agricultural Supply Trade Association; SA, Soil Association.

4.3.2.1 The risk network

The *core* actor in this network is MAFF, the government department assigned the responsibility to regulate MBM use.

Actors involved in discussing technology-related risks are located in the *knowledge*, *regulatory*, *suppliers* and *customers* segments, though some are identifying risk and others represent responses to risk. The network mapping methodology allows for an understanding of the variety of social actors involved in risk discussions concerning technological innovations and within the SST paradigm such broad influences desire incorporation into the innovation process.

The Soil Association was an actor embodying general *society-related* concerns, hence its location in the society sector (upper half) of the diagram. However, the absence of any linkages emanating from the Soil Association illustrates how its action failed to establish MBM-related risks as an issue in the central policy domain.

The farmers and their representative body the NFU represent the concern over the labelling of MBM, illustrated through the relevant link with the feed sector. UKASTA's linkages with these feed actors illustrates the response to this risk.

The presence of non-UK actors, the USDA and FDA highlights how due to global trade relations, national innovations are not immune from international activity. In this context, UK authorities were forced to adopt regulatory measures in response to the scrapie risk, illustrated by the knowledge actors.

5 Low temperature continuous rendering technology: the innovation and its risk assessment

Following the emphasis upon MBM in feed, the rendering industry in the USA sought to adopt a technology which would fully exploit this renewed focus upon its product. In the 1960s therefore, a Los Angeles company pioneered an innovation which was to greatly increase MBM production (Rampton and Stauber, 1997). The innovation was continuous rendering systems, which compared to the by-pass protein concept was quite a radical product/process innovation in that a completely new element of technology was introduced (Abernathy and Utterback, 1978), making the original batch rendering technology largely redundant.

5.1 BSE: the role of low temperature continuous systems

Discussions regarding the role of rendering processes in the emergence of BSE have varied. Early arguments stated that the new rendering systems were operating at a lower temperature than the old batch systems and therefore failed to sterilise infective pathogens adequately, causing BSE to emerge (BSE Inquiry Report Volume 3, 2000). More recent arguments state that the change in technology is largely insignificant in explaining the outbreak of the disease (BSE Inquiry Report Volume 13, 2000). The Phillips Report has adopted the latter argument (BSE Inquiry Report Volume 1, 2000).

This analysis has located the technology as being a crucial factor in the emergence of BSE because though the pathogen may not have been completely destroyed by either the batch or the continuous systems, *certain* types of continuous systems had less effect upon disease destruction (Taylor et al, 1995; Taylor, 7/1/00; Haddon, 1998; BSE Inquiry Report Volume 1, 2000). The degree to which infectivity was reduced is very important as BSE has proven to be highly infectious. As little as 1 gram of infective material could cause death if ingested by other cattle (BSE Inquiry Report Volume 1, 2000). Furthermore, before the complete ban on MBM in 1996, this

highly infective pathogen was known to have contaminated non-ruminant rations (BSE Inquiry Report Volume 1, 2000). Therefore, any reduction in the infectivity potential of this disease agent is surely an important point. The UK Government's BSE Review Committee (2001) also emphasises this.

Due to some continuous systems proving to be less effective in reducing this infectivity, it is therefore a particular type of continuous system which is the focus of this analysis. This was the *Carver-Greenfield* technology. This technology belonged to a group of continuous systems which were *low temperature* technologies, as distinct from high temperature continuous systems (Fielmich, 1975). The patterns of innovation more specifically connected to this innovation will be discussed though as in the case of MBM/by-pass protein use, sometimes continuous technology in general will be referred to. This focus upon the Carver-Greenfield has been decided due to it being the least effective in destroying the BSE pathogen (Directorate-General for Agriculture, 1994).

Once again contradicting the argument that the emergence of BSE could not have been avoided or reduced by the choice of technology selection and/or more effective regulation, this analysis will reveal that during the installation of this innovation in the UK there were concerns expressed over the effectiveness of these systems in destroying infective pathogens. The discourse discussing the benefits of the technology was therefore paralleled by the discourse expressing concerns over related risks. However, it was the arguments favouring the technology which dominated, leading to regulatory acceptance of technologies which were posing a risk to animal health (and later human health) on a large scale.

5.2 Network of innovation actors

5.2.1 Business actors

Like in the use of MBM/by-pass protein in feed, business actors had economic incentives driving them to introduce lower temperature systems. These business actors were the suppliers of the technology which consisted of two companies - Anderson International Corp. and Stord Inc., and the renderers themselves. Prosper De Mulder was the dominant renderer in the UK and appears to be the largest privately-owned manufacturer of MBM in Europe (National Renderers Association, 1990). PDM's wide-scale adoption of the low temperature Carver-Greenfield awards it a prominent position in the innovation network.

5.2.1.1 The rendering industry

There has been an array of reasons identified for explaining the general technological change from batch to continuous systems (Rose, Downs & Thompson Limited, 1975; Monopolies and Mergers Commission, 1985 and 1993; Bacon, 1998a). These include lower energy and labour costs which indicate this technology to be more of a process innovation where seeking to reduce production costs is the prime reason for innovating (Laage-Hellman, 1987). This analysis has identified a further explanation, namely that the continuous technology allowed for larger MBM production which would meet the demands for by-pass protein. This renewed desire to increase MBM sales significantly encouraged the rendering industry to discover more efficient means of production.

By the 1960s rendering in most countries had become an established industrial sector forming a crucial link in the meat processing cycle. European comparisons have identified a common trend of rationalisation in the sector where there was an increasing drive to become more economically efficient (Krenk, 1991a; 1991b). In the UK the industry was more commercial than in other European countries where rendering was perceived more as a waste disposal process (Institution of

Environmental Health Officers Working Party, 1987), and so inexpensive means of production were especially sought.

5.2.1.2 Suppliers of continuous rendering systems

Though the innovation was first conceived in the USA, European countries were quick to imitate the technology resulting in a variety of continuous system processes available on the supplier market, especially from Germany and Scandinavia (Jobling, 1998). The Stord Bartz system was designed in Norway and the Carver-Greenfield in the USA, in Cleveland, Ohio (Wilesmith et al, 1991).

Suppliers of continuous systems were the main actors in spreading knowledge about this technology and they emphasised the economic arguments for technology adoption (Stord Bartz Review, 1979). The means by which these actors sought to influence technology selection was through a re-representation of the rendering sector: from an old, unsophisticated industry to one which had become highly modern and technically advanced.

5.2.1.2.1 Establishing rendering as a highly technical process

When promoting these systems continuous rendering technology was presented as being extremely modern and sophisticated, transforming the previously untechnical rendering industry (Feed and Farm Supplies, Feb. 1971; Fielmich, 1975; Nesse, 1983; Rose, Downs & Thompson Limited, 1975; Stord Bartz Review, 1979). Described as *'larger and more sophisticated and automated'* (Kvam, 1983; page 10), arguments exposing the technological modernisation of the innovation were repeated. This was often contrasted to the *'old fashioned'* practices of the traditional batch renderers (Nesse, 1983; page 1; Kvam, 1983).

This technological modernisation discourse also emphasised the capacity of continuous systems to operate on reduced amounts of fuel; fuel being a high cost to the industry (Nesse, 1983). The Carver-Greenfield was particularly favourable in this aspect, due to the addition of a vacuum process (Institution of Environmental Health

Officers Working Party, 1987). A diagram of the Carver-Greenfield technology and inclusion of its vacuum stage is shown in Appendix 6.

The efforts of the supplier organisations in promoting continuous systems abstracted the need for UK renderers to become directly involved in persuading other actors in the MBM innovation network that the technical change was beneficial. Where they did, they continued the discourse of supplier actors, discussing the sophistication of the new systems (Dyer, 1976).

With such benefits it is of little surprise that by the 1980s continuous cookers increasingly became the standard in Western rendering industries (Rampton and Stauber 1997). Wilesmith et al (1991) recorded that by the early 1990s, 3/4 of all raw material in the UK was processed through various continuous systems identified in Appendix 2. Appendix 3 illustrates the increase in the amount of MBM manufactured by the continuous process in the UK.

5.2.1.3 Prosper De Mulder (PDM) and the Carver-Greenfield technology

An important factor which assisted this technological trajectory in the UK was the monopoly position of Prosper De Mulder (Monopolies and Mergers Commission, 1985; Wilesmith, 1988b). PDM was the company leading the modernisation of the rendering industry in the UK (The Feed Compounder, November 1987), installing its first continuous rendering system, a Carver-Greenfield machine, in its Nuneaton plant in 1972. It continued to adopt other such systems throughout the 1970s and early 1980s (see Appendix 4).

Though it belonged to the lower temperature group of continuous machines, the temperature levels reached in this technology were particularly reduced due to its vacuum stage. Savings on fuel were vast and so PDM's favourable adoption of the Carver-Greenfield system signifies direct economic incentives. Appendix 4 reflects PDM's preference for this technology and how these machines processed the great majority of UK animal waste in the years preceding BSE. The economic dominance of PDM was strengthened in the years following the adoption of this technological

innovation. The company increased its turnover from £16,744 to £58,416, during the period from when the first continuous system was adopted to when the last one was installed (Monopolies and Mergers Commission, 1993). Transition to the continuous technology resulted in the company controlling 75% of the animal waste market in Great Britain in the 1990s (Rimmington, 1994).

5.2.1.4 The closure of many smaller rendering companies

One consequence of the introduction of continuous systems was the closure of many smaller rendering companies who could not afford such technological investment (The Monopolies and Mergers Commission, 1991). This was particularly important in relation to the new technology required to meet environmental standards as discussed in section ***5.2.2.2***. The role continuous systems played in making existing batch rendering technology largely obsolete, identifies this innovation (both in product and process terms) as being *revolutionary* (Abernathy and Clarke, 1985).

However, rather than protecting their interests with any sophistication, the traditional small rendering companies, through their trade association, UKRA (United Kingdom Renderers Association), adopted arguments based on desperate pleas for governmental assistance (Raw Fat and Bone Processors Association Limited, 1974; Dyer, 1976; MAFF, 1980a; Llewellyn, 1980; Dyer, 1981). No advantages were offered over larger firms like PDM and the discourse solely consisted of fear from takeover by the larger companies, namely PDM. Therefore, whereas the modernising arguments were combined with great effect by continuous system suppliers, the survivalist discourse of the small firms appeared narrow, self interested and backward looking, doing little to protect small company closures and even less to hinder the growth of PDM.

5.2.2 Regulatory actors

Conscious of the transformation of the rendering industry MAFF was keen to encourage modernisation of the industry. Through re-establishing the industry as the

animal protein processing sector the government body fully supported the technological change to continuous processing in general. The DoE also provided official approval as due to the closed design of the systems, the innovation promised to better control environmental pollution emitted from rendering systems.

5.2.2.1 MAFF: encouraging rationalisation of the rendering sector

MAFF was unsympathetic to the concerns of small rendering businesses and argued that technological modernisation of the sector would provide the most effective controls (MAFF, 1974). In contrast, the batch rendering plants were viewed by MAFF as *'dirty, unhygienic and dangerous'* (Watson, 1978; page 2).

5.2.2.2 Department of Environment

The rendering industry in the UK (and in other countries) has always been associated with problems of local environmental pollution. The 1936 UK Public Health Act designated the rendering process as an *'offensive trade'* and since then the industry has been covered by many pieces of environmental legislation. Increasing attention to environmental issues in the 1970s-1980s, gave further prominence to the very visible environmental problem of rendering pollution.

The DoE has been the key regulatory actor in managing rendering-related environmental risk (Department of the Environment and MAFF, 1976; Department of the Environment, 1977; Institution of Environmental Health Officers Working Party, 1987). Aided by bodies including the Warren Springs Laboratory (WSL) and the Institute of Environmental Health Officers (IEHO), the DoE sought to minimise environmental pollution. Pressure on local councils by local action groups and *'active local personalities'* (Institution of Environmental Health Officers Working Party, 1987; page 29) led to environmental pollution as being a significant problem for regulatory actors (Dyer, 1976; Department of Environment and MAFF, 1976).

Continuous systems offered a means to greatly improve the social problem of environmental pollution (Feed and Farm Supplies, March 1971, April 1971 and November 1971; Fielmich, 1975; Kvam, 1983; National Renderers Association, 1986-87). The technology was therefore encouraged by the DoE (Feed and Farm Supplies, April 1971; Department of the Environment, 1977; The Monopolies and Mergers Commission, 1985). Furthermore, because the technology was larger, pungent raw material could be processed more quickly thereby reducing odour pollution during storage of material (Meat Trades Journal, 1976). The MMC reports reveal that ideally offal should be rendered within eight hours of slaughter (Monopolies and Mergers Commission, 1985; 1993) and the continuous systems were more able to achieve this time scale compared to the smaller batch processes.

Because of the immediacy of the problem, environmental problems were a priority and problems which had not materialised (but very well could do) were not. In short, regulatory actors only regulated where a risk was visible, and precautionary measures were not a favoured policy option. Instead, the continuous low-temperature rendering systems in the UK, were *'usually regarded as the ideal process'* (Gracey, 1986; page 98).

The discourse of modernisation was very powerful and lower temperature systems like the Carver-Greenfield were deemed to be more superior than batch systems, mainly because of their better capacity to control environment pollution. However, focus upon environmental pollution led authorities to be oblivious to its neglect to possibly meet standards in other areas, namely effective sterilisation of animal waste.

5.2.2.3 The Monopolies and Mergers Commission (MMC)

Assigned the responsibility to monitor excess economic dominance by any single or group of companies, the Monopolies and Mergers Commission (MMC) investigated the exponential growth of PDM three times during 1985-1991 (The Monopolies and Mergers Commission, 1985; 1991; 1993). However, each time it argued that the expansion of the company was in the public interest, identifying the technological advances of the business group as being very important. The fact that the creation of

a monopoly is illegal in the UK and that a 25% share of a market indicates a monopolistic position (Monbiot, 2000), the failure to recognise PDM's market share signifies the failure of the MMC to investigate the possible problems related with a company seeking such economic expansion. PDM's market share was twice as high as this 25% limit during the 1980s and almost three times as high during the 1990s (Monopolies and Mergers Commission, 1985; Rimmington, 1994).

Like Shaoul (1997a; 1997b), this analysis will strongly argue that the technological selection made by PDM was definitely not in the public interest. However, regulatory actors in the years prior to BSE failed to realise the need to monitor this technological development which was responsible for manufacturing a widely disseminated product.

5.2.2.4 The Meat and Livestock Commission (MLC)

Representing the interests of the meat industry, the MLC performs a supervisory role in ensuring that all those involved in the livestock industry, be it suppliers, users or customers, are exploiting the opportunities to make the meat sector profitable. The MLC therefore sought to protect the economic interests of the rendering industry and realised that the new continuous systems would greatly improve the production efficiency of this sector (Meat and Livestock Commission, 1976).

Acting as a representative body for related industries, the rendering sector sometimes used the MLC as a mechanism through which to discuss and promote its technological advances (Dyer, 1976).

5.2.3 Continuous technology in other European countries

Just as the use of MBM in feed was common practice in Denmark and to an extent in France, so too was the adoption of continuous rendering systems and a modernisation of the rendering sector (Hansen, 2000; Lemarie, 2000). However, the types of continuous systems did not include the Carver-Greenfield and instead continuous systems in these countries operated at higher temperatures.

5.2.3.1 The UK rendering industry

The Carver-Greenfield technology was mainly adopted in the UK and the US (Meldrum, 1994; Meldrum, 18/1/00; Wilesmith, 14/3/00). The temperature attained by the Carver-Greenfield has been identified as varying between 60°C-126°C (Smith, 1988; Animal Health A, 1988a; Lamming Committee, 1992; Hansen, 1998c). Compared to some international continuous rendering systems, the dominant UK system was operating at a much lower temperature (Hansen, 1998c).

5.2.3.2 The French rendering industry

French renderers tended to adopt high temperature continuous systems such as the Stork Duke (Lemarie, 2000) reaching temperatures of between 135-145°C (Smith, 1988; Animal Health A, 1988a; Lamming Committee, 1992; Walker, 1998b; Lemarie, 2000).

Even the lower temperature continuous systems in France such as the Stord Bartz technology, reached temperatures between 100-145°C (Lamming Committee, 1992; Lemarie, 2000). Some of the Stord Bartz systems in the UK, however, were sometimes operating at below 100°C (Smith, 1988).

5.2.3.3 The Danish rendering industry

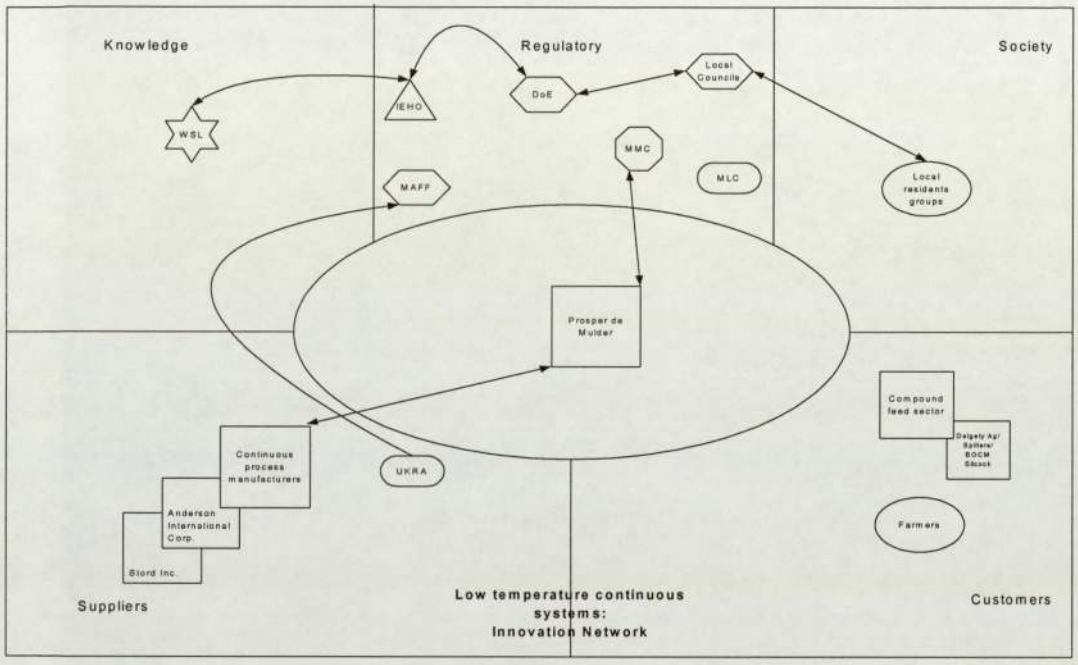
The Danish technology selection was commonly the Atlas system which at 125°C , also operated at higher temperatures compared to the Carver-Greenfield (Hansen, 2000). Also, Danish material had to be further processed in a pressure containing vessel (Hansen, 2000) which exposed the material to further heat treatment. Pressure melters were never very popular in the UK (Rogers 1998), though it is now known that the conditions required to kill the BSE agent can only be attained under pressure systems.

Why there was such a difference in technology selection between the UK and other European countries is explained in section ***5.3.4*** and relates to the regulatory regimes monitoring animal waste processing in these countries.

5.2.4 Innovation summary

Positive influences upon the introduction of low temperature continuous systems in the UK is illustrated in the innovation network below:

Figure 4: The low temperature continuous rendering innovation network diagram

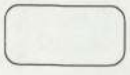


Network Key:

Research Organisation

Governmental Body

Representative Body for Individuals



Representative Body for organisations

Business Sector

Professional Organisation

Abbreviations used in this network: WSL, Warren Springs Laboratory; IEHO, Institute of Environmental Health Officers; DoE, Department of Environment; MAFF, Ministry of Agriculture, Fisheries and Food; MMC, Monopolies and Mergers Commission; MLC, Meat and Livestock Commission; UKRA, United Kingdom Renderers Association; Dalgety Ag, Dalgety Agriculture.

5.2.4.1 The innovation network

Unlike the MBM/by-pass protein use in feed innovation network, the wider social influences upon technology selection in this innovation network represent more direct social interactions regarding technology selection.

The economic dominance of PDM allowed it to form close links with the technology *suppliers,* namely Anderson International Corp. Support for the technological changes was predominantly derived from the *regulatory* sphere where a whole array of actors, from the government, public, professional sectors sought to highlight the benefits of low temperature rendering. The only *Society* actors are the local residents groups who were expressing extreme dissatisfaction with odour pollution being emitted from rendering plants. Along, with the Local Councils, though these actors do not present arguments for low temperature continuous systems (or continuous systems in general), they were the reason behind the DoE's encouragement of the continuous systems.

Actors located in the *customer* segment are the compound feed sector and the farmers. Though these actors did not express a preference for low temperature continuous systems, they were likely to have been in favour of systems which were producing increased MBM at a lower cost. PDM's transfer from batch to low temperature continuous technology was therefore likely to have been approved by these actors.

Those more forthcoming about the benefits from technical change were the suppliers themselves, and the regulatory actors, the DoE and MAFF, who repeated arguments concerning the advantages of such technological modernisation, especially in relation to controls against environmental pollution. The public organisation, the MMC, joined in the arguments discussing technological modernisation and viewed the expansion of PDM as being in the public interest. The MMC's direct relationship with PDM signifies the important role that this actor played in presenting PDM's technology selection as not presenting a public risk. The MLC emphasised the importance of technology which would allow an exploitation of animal by-products,

which the Carver-Greenfield certainly did. The MLC also provided a means through which rendering actors could promote technological change.

The presence of UKRA is extremely significant. Though it was the trade association for the rendering industry, its involvement in discussions about the continuous rendering systems did not reinforce the benefits of the technological advances being made. Instead, UKRA's agenda was very different from that of PDM who was seeking economic growth at a rapid pace through adopting these technical changes.

How this government-approved technology was associated with significant risks will now be discussed.

5.3 Network of Risk Actors

A crucial role of the rendering process has been to ensure that disease pathogens in the raw material do not transmit disease to either animals or humans through the MBM product. The 1975 Zoonoses Order protecting against human salmonella was the first such legislation ensuring that human health was protected from unsterilised MBM (MAFF, 1975a). The risk network therefore centres upon the regulation of the rendering industry and how this provided ill means for animal and consumer protection.

The Phillips Report concludes that the pre-BSE regulatory regime for rendering does not deserve condemnation (BSE Inquiry Report Volume 13, 2000), stating that the 1981 Protein Processing Order (PPO) *'laid down a mandatory sampling regime designed to ensure that the rendering process inactivated all conventional viral and bacterial pathogens'* (BSE Inquiry Report Volume 1, 2000). However, many have argued that this Order was a poor regulatory framework and the outcome of deregulation policies of the 1979 Conservative government (Jasanoff, 1997; Bartlett, 1999; Miller, 1999). This analysis agrees that the regulatory framework for the rendering industry could have been more stringent, and acknowledges the effect of deregulation upon the final PPO (Watson, 1980; Pizzey, 1980b; MAFF, 1980b). This

research opposes the conclusions of the Phillips Inquiry in relation to the adequacy of the Order in ensuring protection against disease pathogens.

However, this analysis does not solely explain the weakness of the PPO in terms of a change in political parties but in terms of the interests and actions of an array of actors involved in discussions about regulating the rendering industry.

5.3.1 MAFF's concern over Foot and Mouth Disease

Along with its various sub-departments, which primarily included the State Veterinary Service (SVS), MAFF was responsible for controlling the risk of disease transmission from recycled animal waste.

Risks associated with the manufacture of animal waste into feed can be traced back to at least the 1920s in the UK, from when protection measures against Foot and Mouth Disease (FMD) began to be enacted. FMD was a serious animal health issue and the use of recycled animal waste (containing FMD pathogens) in animal feed was identified as a key route for spreading the infection. Therefore, various legislative measures spanning the 1920s-1970s period required that all animal waste which was to be included in animal feed, had to be processed according to certain time and temperature standards. It had to be boiled for at least one hour, at a temperature of 100°C (MAFF, 1928a; MAFF, 1928b; MAFF, 1932; MAFF, 1938; MAFF, 1940; MAFF, 1947; MAFF, 1957; MAFF, 1973). Having experienced repeated cases of FMD and the country's worst epidemic in the 1960s, the regulatory authorities continued to seek means of eliminating this very virulent animal disease and adopted various precautionary measures.

Though the BSE Inquiry, through considering the evidence of rendering and regulatory actors (Bacon 1998b, Handisides, 1998; Menzies, 1998; Foxcroft, 1998; Attridge, 1998; Smith, 1998), has concluded that all these Orders were for the swill industry where animal waste (mainly catering waste etc.) is fed to pigs, this analysis has extracted a different meaning from these regulations. Apart from the 1973 Waste Food Order which specifically excluded application to the animal protein industry

(MAFF, 1973), all the previous measures applied to the whole animal waste processing industry, including renderers. The following extract from the 1957 Order signifies this:

Meaning of "waste foods"

The waste foods to which this Order applies are-

(a) any meat, bones, offal or other part of the carcase of any animal or of any poultry

(b) any broken or waste foodstuffs (including table or kitchen refuse, scraps or waste)

Source: MAFF (1957).

Therefore, though (b) indicates the material used by swill manufacturers, (a) clearly indicates the material used by renderers. (Walker (1998a), the counsel to the BSE Inquiry committee, also extracted the same meaning from these regulations as this analysis).

5.3.2 Regulating the animal protein industry

It was only in the 1970s, when the regulatory actors realised that the lower temperature systems being introduced into the country would not meet this processing criterion that discussions for a separate Order began (MAFF, 1975d), making the 1973 Waste Food Order specific to the manufacturers of swill. Though Meldrum (1998b) states that the recommendation to regulate animal protein processors came from the government's 1960s Northumberland committee examining the FMD epidemic, consultation of the Northumberland Report has failed to identify this (MAFF, 1968a, 1968b). Instead, the Report referred to animal waste processors as a single entity. Therefore, the decision to introduce separate legislation for the animal protein processing industry was a decision made by MAFF, realising that the rendering systems in this sector would not meet the time/temperature standards of the Waste Food Orders.

Having been preoccupied with measures against FMD, MAFF actors were well aware of the potential animal health dangers from inadequately sterilised animal dietary material. They were also well familiarised with potential dangers to human health from this same means, as was being experienced by human salmonella cases. In light of such knowledge it is reasonable to assume that regulatory actors would have wanted to seek legislative measures for the animal protein sector which like the Waste Food Orders, would ensure that disease pathogens in the animal feed chain were as minimal as possible.

During early discussions about the Protein Processing Order, such intentions undisputedly existed as the new Order aimed *'to ensure effective processing of any matter of animal origin to destroy the causal organisms of both viral and bacterial disease in animals'* (Animal Health Division I C, 1974; page 1). However, the final PPO failed to reach such processing standards and represented a minimalist regulation (Nisbet, 1979b; Gracey, 1986).

5.3.2.1 The PPO: setting standards for easy compliance

Early discussions regarding the PPO stated that the standards of processing for the animal protein processing sector would be the same as that of the 1973 Waste Food Order i.e. processing material for at least one hour and at 100°C (Animal Health Division I C, 1974). Some in MAFF viewed a time and temperature standard in regulating the animal protein processors as vital:

'there must be a means to ***show*** *that the processed animal protein has been maintained at the required temperature for the requisite period of time.....(This is a higher standard than that necessary for waste food processing plants but here we are dealing with a factory producing an end-product for wide scale dissemination)* (Meldrum, 1975; page 3).

However, this time and temperature criterion was rapidly dropped in the PPO discussions between regulatory and business actors (MAFF, 1975b; MAFF, 1975c). This was because of the impossibility of ensuring that all the different continuous

systems being introduced met this standard (MAFF, 1974; MAFF, 1975d; Eddy, 1978). Appendix 2 identifies the different varieties used in the UK.

MAFF's main concern was the poultry manure driers (MAFF, 1974; Meldrum, 1974; Meldrum, 1975) who through the adoption of the new technologies, would not have met this specified processing standard. Because dried poultry manure as a feed ingredient, was increasingly being encouraged by MAFF, the government department did not in any way want to jeopardise such use of animal protein (Meldrum, 1974; Brown, 1975). In short, a standard to which all animal protein processors could comply was selected. *'It [therefore became]...appropriate to change the requirements from one of simply temperature to cover other standards'* (Eddy, 1978; page 26).

Therefore, even though the disease risks from poultry manure use in feed were well known amongst regulatory actors (Meldrum, 1974; Brown, 1975), MAFF preferred to tolerate such risks and instead minimum standards were sought. So that such innovative practices could continue, a policy option which ill provided for the destruction of such pathogens (Department of the Environment, 1983; MAFF, 1981) was selected.

5.3.2.2 The PPO: focus upon salmonella destruction

During the 1970s salmonella became a major agricultural problem, as well as a human health problem (Sojka et al, 1977; Saunders, 1978). Because the cause of salmonella was increasingly being identified as animal feed (Williams, 1975), regulatory efforts to set optimum measures for the animal protein sector resulted in measures which would only destroy salmonella contaminants (and pathogens less resistant than salmonella). This also resolved the complexity of setting time/temperature standards as salmonella was a pathogen which was not very heat resistant (Bacon, 1998b), abstracting the need to specify time/temperature standards in the regulation.

The official reaction to the salmonella problem has therefore been categorised as a response to current problems (as in the case of environmental pollution) (Watson,

1977). Consequently, MAFF's regulatory focus shifted from protecting against future risk possibilities to protecting against this immediate and visible problem (Watson and Brown, 1975; Watson, 1978; Nisbet, 1979b).

Knowing that MBM contained a number of disease pathogens, to consider it safe as long as salmonella was destroyed represents ill judgement by government actors. Criticism is particularly deserved due to government actors knowing that the new continuous rendering systems were unable to destroy certain infective pathogens (e.g. in poultry manure). Therefore, though government actors had established significant salmonella control through the 1981 PPO, general MBM safety measures remained weak.

Instead, MBM which was possibly infective, was being processed in large quantities and was being widely disseminated throughout the country. Following the introduction of continuous systems in the UK MBM production rose significantly throughout the 1980s to the 1990s (Wainman and Dewey, 1985; The Monopolies and Mergers Commission, 1985; UKRA, 1998), from 200,000 tonnes to 400,000 tonnes. Rather than achieve stringent regulatory controls over a sector which was representing significant technology-related risks, the rendering industry was deregulated (Association of District Councils, 1980; Pizzey, 1980a).

5.3.2.3 Significance of a weak PPO

Post-BSE, time and temperature standards have been identified as having an important impact upon the destruction of certain disease pathogens and in hindsight their abandonment appears to have been a costly misjudgement by the Labour administration of the 1970s. Therefore, whereas most BSE commentators have blamed the 1979 Tory government for relaxing controls for rendering, this analysis would argue that though this change in political parties certainly meant that many of the constructional specifications of the draft PPO had been abandoned, the most significant alterations had been made under the Labour regime of the 1970s.

5.3.3 Actors in opposition to MAFF's regulatory measure

Unlike the risk network of MBM/by-pass protein use in feed, the policy network over regulation of the rendering industry did consist of significant interaction between the regulatory body MAFF, and those actors identifying a risk. There were several actors who wanted regulatory action to have been tighter but they were persuaded by the dominant voices in MAFF that there was no reason to be concerned over the safety of animal feed. MAFF argued that the form of the final PPO was all that was possible in the changing political climate where deregulation was the new policy paradigm of the 1979 elected Conservative party.

5.3.3.1 Keith Meldrum

Once salmonella became the official marker for sterilisation under the 1981 PPO (Watson, 1978), there was some concern within the State Veterinary Service (SVS) division of MAFF, chiefly voiced by the then Divisional Veterinary Officer Keith Meldrum. In various correspondence to the then Regional Veterinary Officer for Tolworth (where MAFF was based), Meldrum expressed strong sentiments highlighting the failure of the PPO to function as an adequate precautionary measure against disease transmission (Meldrum, 1980a; 1980b). Meldrum's arguments represent the dominant precautionary discourse in this risk network.

He stated that the emphasis upon salmonella meant that the PPO would no longer assure the destruction of highly resistant diseases such as FMD, or other disease pathogens which had been the key objective of the Order (Meldrum, 1980b). Because of this he anticipated *'a significant disease hazard'* (Meldrum, 1980a; page 1). BSE certainly was a significant disease hazard.

However, the majority of MAFF officials were willing to accept less stringent measures where salmonella became the 'guarantee' that most infective pathogens would be destroyed.

5.3.3.2 Other precautionary actors in the regulatory arena

The Scottish Office of Agriculture was another quite vociferous actor who joined in the discourse of making the PPO more of a precautionary measure (Drummond, 1975), as was the Association of Metropolitan Authorities (AMA) (Humphreys, 1978; Eddy, 1978).

Some have commented upon a report by the Royal Commission on Environmental Pollution (RCEP) as warning against the feeding of animal protein to livestock due to the risk of spreading disease (Currie, 1998; D'Silva, 1998). However, this was a warning from the DoE about the risk of disease transmission from using dried poultry manure (DPM) in feed (Department of the Environment, 1983; page 21) and the RCEP in fact accepted the practice as being a good means of recycling such waste. The RCEP did not warn against the use of MBM (House of Commons Agriculture Committee, 1990; Barclay, 1998).

5.3.3.3 Actors expressing concern in the business sector

The feed industry was particularly concerned about the possible risks from infective MBM and the effect upon livestock, hence the impact upon its customers, the farmers (MAFF, 1974; Eddy, 1978). Represented by its trade association the United Kingdom Agricultural Supply Trade Association (UKASTA), the feed industry voiced its concerns about the final PPO (UKASTA, 1978).

Representing the interests of poultry farmers (as well as the poultry manure driers), the British Poultry Foundation, recognised the potential for an increasing market for the use of DPM in animal feed and it did not want poor operating standards to jeopardise this potential market. This concern made the trade body quite vociferous in the PPO discussions (MAFF, 1974; British Poultry Federation, 1980) where it *'suggested that a minimum time and temperature for any process should be specified in the Order'* (MAFF, 1974; page 5).

5.3.4 Risk assessment in France and Denmark

Identification of more stringent regulatory measures protecting against disease pathogens in other countries has raised the question of whether European countries discouraged the introduction of lower temperature systems like the Carver-Greenfield. Kvam (1983) reports on how Anderson International Corp. faced problems in adjusting its equipment and process to fit the conditions outside of the USA, and regulatory processing requirements in some European countries seems to have been one of these conditions.

The different continuous systems adopted throughout Europe have been highlighted earlier. However, it was only after BSE that the superior nature of Continental technology choices, in terms of sterilisation of animal waste material, was realised. A government note commenting on processes to deactivate the BSE agent reports on how the *'"safest" option would be the Continental-style high pressure cooking methods'* (Rimmington, 1994; page1), implying that other systems in Europe were more effective in the destruction of disease agents. Hansen (1998c) from the Danish Meat Research Institute further confirms this.

From conducting research into rendering processes in Denmark and France, it has been revealed that MBM manufacture had to legally destroy Clostridia through the use of higher temperatures (Hansen, 1998c; Hansen, 2000; Lemarie, 2000). Because rendering in most European countries served primarily as a public waste disposal service rather than representing a commercial sector (Shaoul, 1997a; The Monopolies and Mergers Commission, 1991; BSE Inquiry Report Volume 13, 2000), tight regulatory control was enforced. Therefore, high temperatures and high-pressure cooking was often used to eliminate resistant and notifiable (high risk pathogens which have to be reported to the regulatory authorities) disease agents in other countries (National Renderers Association, 1997; BSE Inquiry Report Volume 13, 2000). These features have now been identified as providing the only effective means of destroying the BSE agent.

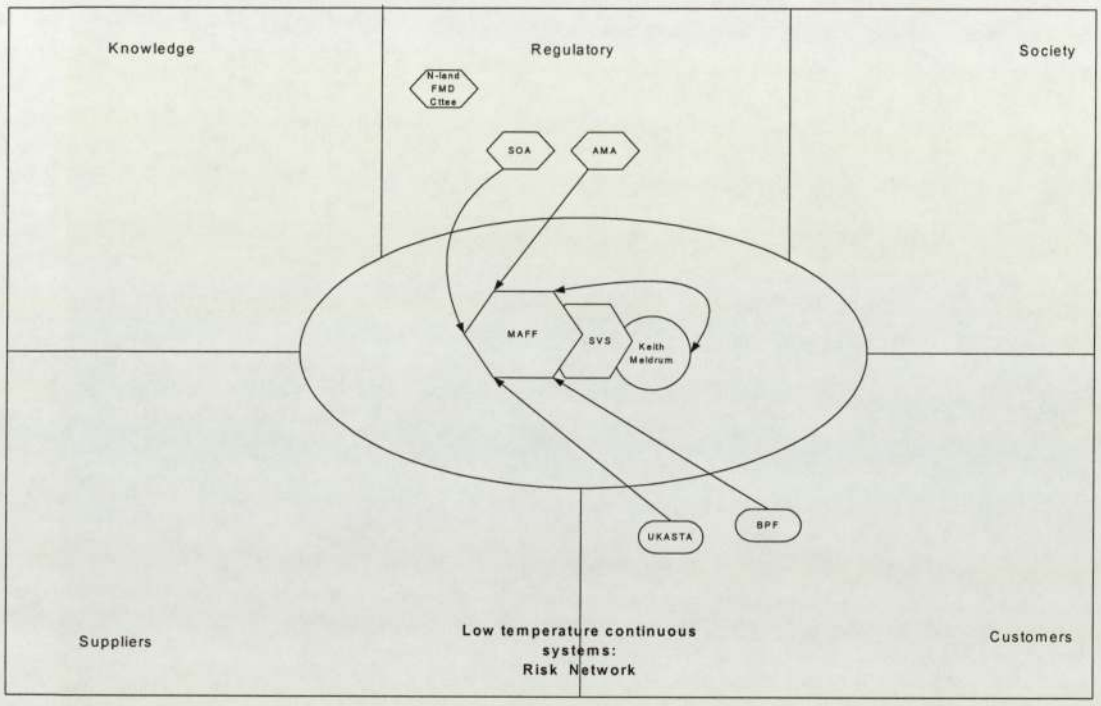
Clostridia destruction and the elimination of notifiable disease agents were not required under the UK 1981 PPO and so there was no legal reason for the UK rendering industry to use high temperatures in their processes. PDM therefore did not. Consequently, UK MBM contained a number of disease pathogens and the PPO was no assurance that they would have been adequately destroyed. In hindsight, the former Chief Veterinary Officer Keith Meldrum has commented that a time and temperature standard to destroy BSE *could* have had a dampening affect upon BSE (Meldrum 1998b; House of Commons Agriculture Committee, 1990). This exposes the extent of regulatory failure during the pre-BSE era.

Therefore, though the benefits of continuous systems such as lower energy/labour costs and better management of environmental pollution, were perceived throughout Europe, unlike in the UK, this was balanced with effective risk management in other European countries.

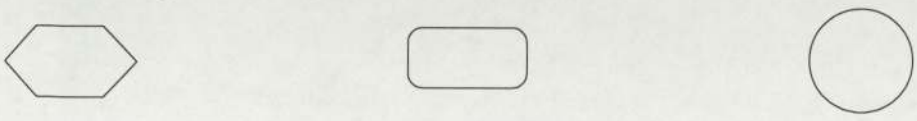
5.3.5 Risk summary

The risk network below represents the concerns of actors over the survival of disease pathogens in recycled animal waste, with MAFF as the actor responding to these risks.

Figure 5: The low temperature continuous rendering risk network diagram



Network Key:



Governmental Body

Representative Body for organisations

Individual

Abbreviations used in this network: N-land FMD Cttee, Northumberland Foot-and-Mouth Disease Committee; SOA, Scottish Office of Agriculture; AMA, Association of Metropolitan Authorities; MAFF, Ministry of Agriculture, Fisheries and Food; SVS, State Veterinary Service; BPF, British Poultry Foundation; UKASTA, United Kingdom Agricultural Trade Supply Association.

5.3.5.1 The risk network

MAFF as the regulatory actor responsible for the rendering industry is located as the *core* actor. However, within this core the sub-division of MAFF, the SVS, has been identified as within this Keith Meldrum repeatedly expressed a precautionary discourse. This is expressed through the relevant dyad. However, even though Meldrum's presence in the core policy arena allowed for quite an interactive discussion of his concerns, his discourse failed to significantly influence the dominant actors in MAFF.

Other *regulatory* actors indicating that the 1981 PPO was an inadequate safeguard against future disease transmission through MBM were the SOA and the AMA but unidirectional dyads signify the failure of MAFF to adequately consider the concerns of these actors. Similar isolation from the core policy arena is expressed by the attempts of the feed actors, UKASTA and BPF, to represent their concerns. Though the risk issue in this network reached the core policy arena, the policy network resembles a very closed policy forum in which the risk issue was insulated within MAFF. The absence of *society* actors where a more public discussion of the risks failed to materialise, signifies the success of MAFF in secluding this risk issue.

The presence of the 1960s Northumberland Foot and Mouth Committee represents the important turning point whereby the potential of transmitting disease through infective animal waste material was awarded a high priority, due to the 1960s FMD epidemic. However, by introducing a regulation which allowed the rendering industry to continue producing infective MBM, MAFF's action represents a neglect of the precautionary action emphasised by the Northumberland Committee.

Greater analysis of chapters 4 and 5 will be examined in the following chapters.

6 Discussing the impact of social arguments upon policy-making

Chapters 4 and 5 have identified the social shaping of the BSE technologies as expressed through the respective network diagrams. Within this there has been an exposure of the regulatory approach to technology-related risk assessment. How the innovations became established in a permanent network of social interactions will be examined. In contrast, how the concerns of risk actors failed to acquire recognition in the policy network will also be analysed. As identified in Chapter 2, it is the social arguments of the actors which made them either powerful or weak influences in the policy domain; either strengthening the MBM trajectories or failing to persuade policy actors that this trajectory required modification to provide better protection against associated risks. In order to extract the core meaning from the amalgamated innovation and risk networks, only direct interactions have been explored in this chapter to visibly illustrate the common separation of the innovation and risk processes.

6.1 The policy network approach: allowing for the exposure of the dominant discourses

This network analysis of innovation has explored the varying social influences upon the introduction and development of the BSE technologies. Through identification of actor-specific narratives, the interests of various actors has been determined, all seeking particular benefits from the technologies. Furthermore, the innovation narratives represented powerful arguments in the policy arena, presenting the innovations as scientific and technological progress. Such discourse was greatly approved by the regulatory bodies. In contrast, the discourse of risk sometimes even failed to gain regulatory recognition.

Attempting to bridge the gap between new technologies and the role of society, this analysis has used the BSE crisis to epitomize the intertwined nature of technological

innovations and society. Because the introduction of new technology often involves a variety of social actors, this variety also tends to be accompanied by the indication of technology-related problems. The innovation actor-world is therefore paralleled by the risk-actor world, identifying the concept of competing actor-worlds (Jørgensen and Sørensen, 1999). However, within the pre-BSE policy networks, technological development was prioritised over effective risk management. Through simultaneously mapping risk actors alongside the innovation actors, the neglect of risk during the innovation process will be succinctly illustrated in this chapter.

6.1.1 Policy network analysis for MBM/by-pass protein use in feed

6.1.1.1 Innovation narratives

The following narratives promoting or encouraging this technology have been identified:

- *Scientific Agriculture*: actors who described by-pass protein as a new innovation through adopting a scientific discourse
- *Economic Return*: actors who sought to gain economically through MBM/by-pass protein use in feed
- *Environmentally-friendly*: actors who favoured the use of MBM in feed because it was a good means of recycling animal waste

Examples of these narratives are represented below, indicating the actor and the text from which the narrative was extracted. For the sake of simplicity, examples of narratives listed in this chapter display only one example of text for each actor adhering to a certain narrative. It must be noted that it was repetition of such narratives which influenced (or failed to influence) policy action.

Table 4: Examples of MBM/by-pass protein in feed innovation narratives

Actor	Narrative	Text
Compound feed sector	Scientific Agriculture	*'Recent understanding of the ruminant digestive system is leading researchers to the development of ways to improve protein utilisation.....By-pass protein is now receiving increased attention as a method of improving the performance of ruminants and particularly high producing dairy cows'* (The Feed Compounder, June 1981; page 26-27).
Rendering sector	Scientific Agriculture	*'Soybean meal (SBM), the staple of the feed industry, is...degraded to a greater extent and less SBM bypasses the rumen when compared to certain more slowly degraded proteins. Among these are meat/bone meal'* (National Renderers Association, 1981; page 4).
Rendering sector	Economic Return	*'Our first job is to promote the use of all animal by-products and to develop new uses and applications'* (National Renderers Association, 1981; page 1).
Knowledge sector	Economic Return	*'if the attitude of the USA were to spread it would place the industry in considerable jeopardy'* (Agricultural Research Council, 1977; page 4).
Regulatory sector	Environmentally-friendly	*'Local authorities will appreciate the importance of the industry's waste disposal role.....it remains...the only really satisfactory method of disposal'* (Department of the Environment and MAFF, 1976; pages 3-4).

6.1.1.2 Risk narratives

The following narratives identify a technology-related risk and responses to these raised risks:

- *Precautionary*: actors who initiated action against MBM use in feed or who wanted to improve the way in which MBM for inclusion in feed was marketed
- *Tolerance*: actors who preferred to tolerate raised risks rather than act towards allaying concerns
- *Responsive*: actors who acted towards a current risk, though more as tokenism rather than as a genuine attempt to protect against the risk

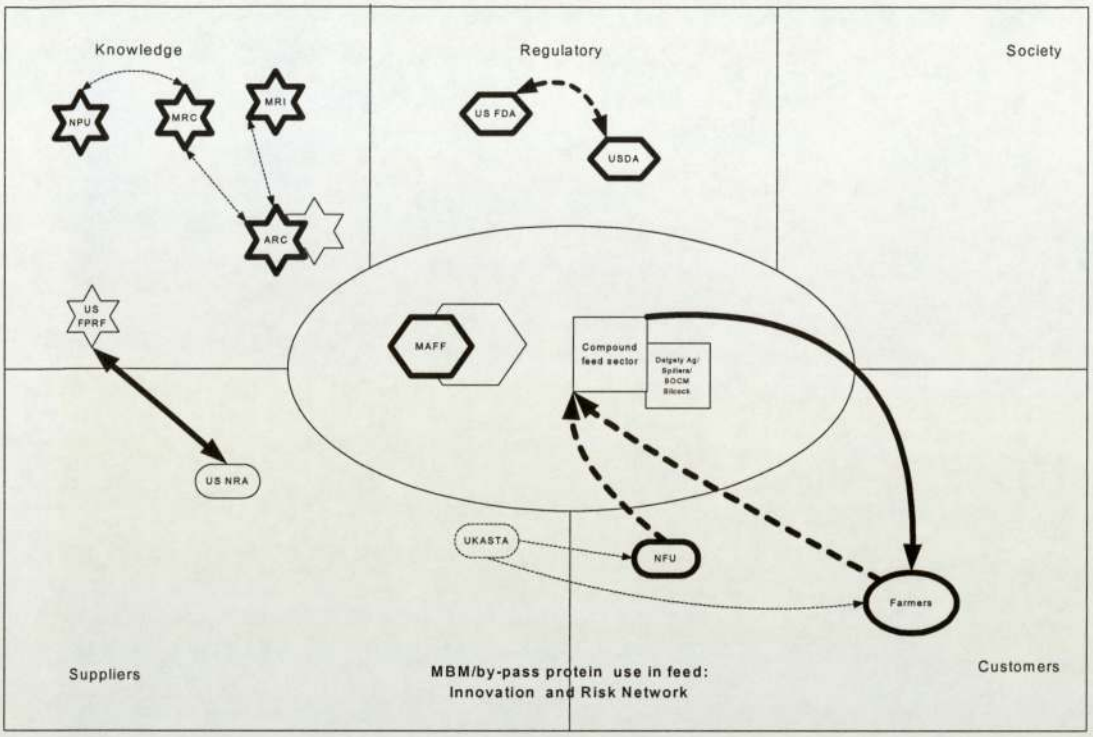
Table 5: Examples of MBM/by-pass protein in feed risk narratives

Actor	Narrative	Text
Raising risk		
Farming sector	Precautionary	*'the NFU feels that the opportunity to declare ingredients should be taken by the UK Government.....Farmers view the present statutory system as allowing inadequate protection for purchasers of compound feed and therefore feel that they have a right to know more about the product'* (National Farmers Union, 1983; pages 1-5).
US regulatory sector	Precautionary	*'The Department has long been concerned.....by the possible human health hazard of processing scrapie-bloodline or scrapie-exposed sheep.....the Department...proposes to eliminate such salvage'* (Chaloux, 1975; page 25829).
Responding to raised risk		
Feed sector	Tolerance	*'This* [knowledge about what is included in feed] *is well known to the farmers/customers'* (UKASTA, 1981; page 1).
Knowledge sector	Responsive	*'Now that there is a serious suggestion that man might be affected by scrapie there are putative public health considerations. Even if the hypothesis is ill-founded, there will be a public demand for action'* (Agricultural Research Council, 1976d; page 8).

The variety of discourses highlights the multiple arguments employed by actors during the innovation process; either concerned with innovation promotion, risk identification or risk response. The network approach allows for the analysis of the multiple patterns of communication and the graphic mapping of networks allows depiction of these arguments onto a single network, as is to be shown.

The innovation actors are identified by a thin outline and risk actors by a thick outline. The linkages between innovation actors represents the promotion of technology, illustrated by a thick solid dyad. The linkages between risk actors represents a technology-related discussion. The identification of a risk is represented by a thick broken line. To identify the ineffectiveness of such discussions in modifying the technological trajectory, responses to the risk have been presented as a thin broken dyad. Whether the interaction was a one/two-way process, particularly in terms of risk assessment is represented by a one/two-way headed dyad.

Figure 6: The MBM/by-pass protein in feed innovation and risk network diagram



Network key:

(see earlier sections for key to nodal shapes)

Promotion of innovation

Risk identification

Weak response to risk

One way interaction

Two-way interaction

Innovation actors

Risk actors

Abbreviations used in this network: US NRA, United States National Renderers Association; US FPRF, United States Fats and Proteins Research Foundation; ARC, Agricultural Research Council; MAFF, Ministry of Agriculture, Fisheries and Food; MRI, Moredun Research Institute; MRC, Medical Research Council; NPU, Neuropathogenesis Unit; US FDA, United States Food and Drugs Administration; USDA, United States Department of Agriculture; NFU, National Farmers Union; UKASTA, United Kingdom Agricultural Supply Trade Association; Dalgety Ag., Dalgety Agriculture.

6.1.1.3 Discussion of network

The network illustrates the often dual role of government actors who on the one hand need to stimulate innovation and on the other hand, have to regulate new technology. In this network, the absence of linkages between MAFF and any of the other risk actors, signifies the complete absence of regulatory intervention in monitoring MBM-related risks. Instead MAFF was extremely tolerant of MBM-related risks, and was more active in promoting the innovation, along with the core business actor, the feed sector.

The US FPRF was a significant influence in defining MBM as a new scientific innovation due to economic support from the US NRA, an economically powerful trade association. The related dyad represents this important innovation interaction. However, this isolated dyad between these US actors exposes how key actors in the promotion of MBM were not involved in any of the risks debates centred upon their core product, MBM. This succinctly presents the separation of the innovation and risk assessment process.

Rather than in the core regulatory arena, responses to highlighted risks occurred in the knowledge sector (ARC) and the business sector (UKASTA), where the narratives of tolerance and responsive, rather than precautionary, were adopted, expressed by the thin risk dyads. Therefore, the *knowledge* interactions between a number of UK research organisations depicts the weak UK responses to the scrapie problem, where rather than representing genuine steps to safeguard against technology-related risk, the UK authorities were forced into adopting some measure (however minimalist this was). Furthermore, it was initiated by the ARC, a research organisation, rather than by MAFF exposing the total absence of regulatory involvement.

The ARC was both an innovation actor, through promoting the by-pass protein concept, and a risk actor, in 'managing' the scrapie risk. This is a good example of how effective control of technology is not achieved when both the promotion of an innovation and its risk assessment is the responsibility of a single actor, as there will be a conflict of interests. It is often the innovation promotion interests which are

prioritised, strengthening the argument for actors unrelated to such interests to be involved in the risk debates.

The concern over labelling was expressed to the feed industry, by the farmers and the NFU. However, the unidirectional dyads illustrate that the feed industry failed to respond to this risk. The innovation dyad emanating from the feed sector illustrates that its only concern was promotion of the technology. Though the feed actors were keen to encourage use of MBM they were not as forthcoming as regards to protecting against possible risks from the technology illustrating how business actors often fail to adequately include risk assessment during the innovation process. Instead, the feed actors transferred responsibility of responding to the risk to UKASTA, its trade association. However, both the weak and unidirectional dyads from UKASTA illustrate that the NFU and the farmers were not reassured by UKASTA's response. This lack of constructive interaction provides some insight into why this risk issue failed to emerge as a predominant area of concern in the core policy arena, where MAFF may have been forced to respond to the risk.

The only translation of risk concerns into policy occurred in the US where US regulatory actors adopted precautionary measures in relation to scrapie. However, this did not emerge as a policy issue within MAFF. Whereas US regulatory authorities translated their joint concerns into policy action, UK regulatory actors shared arguments over the advantages of the innovation and related risks were not considered.

Smith (1993) indicates that state actors are often seeking organisational interests in adopting certain policy decisions. In this context, MAFF is likely to have recognised that increased use of MBM would mean that increasing animal waste resulting from intensive farming would be adequately managed, reducing the possibility of an environmental problem. The development of the innovations was therefore particularly strengthened by state support. MAFF did not regard the possible risks from using MBM/by-pass protein in feed as warranting regulatory intervention and instead promoted the technology. This weak regulatory participation with regards to risk assessment was duplicated in the manufacture of MBM, as discussed in the following section.

6.1.2 Policy network analysis for low temperature continuous rendering technology

6.1.2.1 Innovation narratives

The following narratives promoting or encouraging this technology have been identified:

- *Technology Modernisation*: actors who described continuous rendering systems, especially low temperature machines, as more sophisticated and technical
- *Economic Return*: actors who sought to gain economically through use of the new low temperature technology
- *Environmentally-friendly*: actors who favoured continuous systems, especially low temperature machines due to their better control of environmental pollution
- *Economic Survival:* actors who were threatened by the growth of PDM and could not join in the transition to new technology

Table 6: Examples of low temperature continuous rendering innovation narratives

Actor	Narrative	Text
Rendering sector	Technology Modernisation	*'the trade has become much more professional in its own attitudes to technology'* (Dyer, 1976; page 28).
Regulatory sector	Technology Modernisation	*'If a handful of small producers are put out of business I would suggest that this is the price which must be paid for effective controls'* (Watson, 1978; page 2).
Rendering sector	Economic Return	Low temperature rendering was said to offer *'valuable by-products.....Fuel saving; less electricity; reduced personnel costs'* (Stord Bartz Review, 1979; pages 1-2).
Regulatory sector	Environmentally-friendly	*'Consider the installation of equipment for continuous processing. It reduces the risk of smell emission through both the steady level of operation, which ensures that the material is exposed for the shortest possible time, and the smell prevention measures that can be incorporated'* (Department of the Environment, 1977; page 9).
Rendering sector	Economic Survival	*'members being faced with large capital investments to improve their environmental controls have opted out, and sold their businesses...the result is that the business is absorbed by bigger companies, and already we have a situation where the position of one company is already considered by many in the meat industry to be too powerful'* (Dyer, 1981; page 2).

6.1.2.2 Risk narratives

The following narratives raising a technology-related risk and responses to these raised risks have been identified:

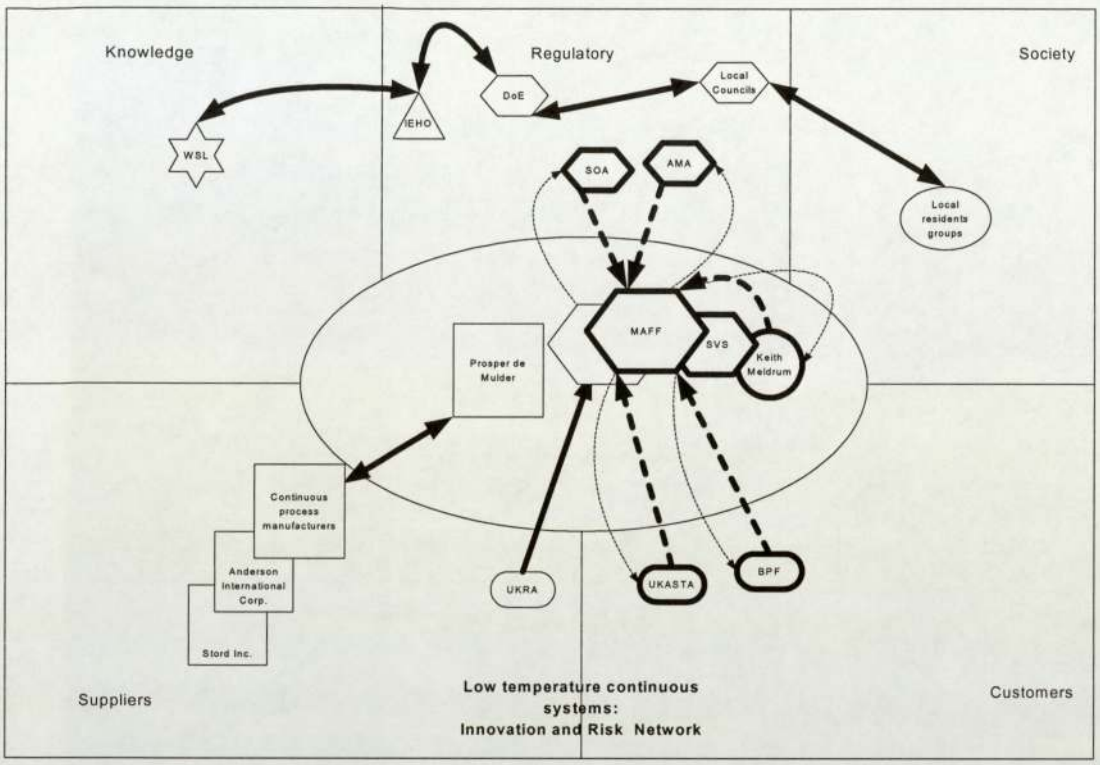
- *Precautionary*: actors who wanted the 1981 Protein Processing Order to eliminate disease pathogens other than just salmonella
- *Tolerance*: actors who preferred to tolerate raised risks rather than act towards allaying concerns
- *Responsive*: actors who attributed greater attention to a current risk
- *Compliance*: actors who preferred to set standards to which business actors could most easily comply

Table 7: Examples of low temperature continuous rendering risk narratives

Actor	Narrative	Text
Raising risk		
Regulatory sector	Precautionary	*'we have gone a long way from our original concept of controlling the possibility of recycling disease pathogens through animal feed'* (Meldrum, 1980b; page 1).
Feed sector	Precautionary	*'an industry such as ours……will continue to be in a position in which it is at risk because its suppliers* [i.e. renderers] *are left with a loose system of surveillance'* (British Poultry Federation, 1980; page 1).
Responding to raised risk		
Regulatory sector	Responsive	The PPO was not going *'to strengthen the* [processing] *standards beyond those necessary to kill salmonella'* (Nisbet, 1979b; page 1).
Regulatory sector	Compliance	It *'would probably prove impossible'* to have one time/temperature standard *'because of the variety of processes in use'* (MAFF, 1974; page 5). Because of such *'complexities of devising suitable controls for the animal protein industry'* (MAFF, 1975d; page 1), MAFF preferred an option which would *'cover a wide range of procedures'* (Eddy, 1978; page 9).
Regulatory sector	Tolerance	*'it was impossible to ensure that processed animal protein was pathogen free'* (MAFF, 1974; page 1).

The introduction of continuous rendering systems also consisted of a variety of arguments including those promoting the innovation and those involved in the discussion of associated risks. Responses to risks were again weak, once more allowing the innovation narratives to dominate the policy arena.

Figure 7: the low temperature continuous rendering innovation and risk network diagram



Network key:

(see earlier sections for key to nodal shapes)

Promotion of innovation

Innovation actors

Risk identification

Risk actors

Weak response to risk

One way interaction

Two-way interaction

Abbreviations used in this network: WSL, Warren Springs Laboratory; IEHO, Institute of Environmental Health Officers; DoE, Department of Environment; UKRA, United Kingdom Renderers Association; SOA, Scottish Office of Agriculture; AMA, Association of Metropolitan Authorities; MAFF, Ministry of Agriculture, Fisheries and Food; SVS, State Veterinary Service; BPF, British Poultry Foundation; UKASTA, United Kingdom Agricultural Trade Supply Association.

6.1.2.3 Discussion of network

The network again specifies MAFF's dual role in encouraging the innovation whilst also being responsible for ensuring that disease pathogens did not spread through inadequately manufactured MBM. Once more, MAFF played a more active role in assisting the development of the innovation rather than providing adequate safeguards against it. PDM, as the key adopter of the Carver-Greenfield system, has been located as the core business actor.

Though MAFF's encouragement of the technologies in both networks was through indirect means, in this network the interaction with UKRA visually represents MAFF's support for the low temperature continuous innovation. The persistent arguments of UKRA express concern over the concentration of the sector and the threat posed by this radical innovation. However, UKRA's concerns were sidelined due to MAFF's support for the modernisation of the rendering industry, representing encouragement of the innovation in quite a direct way. The failure of UKRA to influence MAFF in adopting its concerns is represented through a uni-directional dyad.

Compared to the MBM/by-pass protein technology, there are more interactive relationships existing to promote the technology. These include the dyads between process manufacturers and PDM, and between actors at the top end of the network where more social reasons for technology selection are expressed through the concern over environmental pollution. The management of the environmental problem is a good example of regulatory actors managing a current and visible risk rather than implementing measures safeguarding against possible future risks. The separation of these innovation interactions from any of the risk interactions again illustrates the separation of the innovation and risk assessment processes.

Unlike the network for the MBM/by-pass protein in feed network, in this network MAFF was involved in the discussion of risks. Furthermore, within the core policy arena, Meldrum's presence signifies how a primary actor was adopting a precautionary narrative, seeking policy action which would ensure the destruction of

all disease pathogens, whether or not they were proving to be a current risk. However, Meldrum's arguments were responded to by a collective group of actors in MAFF who argued that the 1981 Protein Processing Order was an adequate enough safeguard, adopting the responsive, tolerant and compliance narratives, represented by the weak dyad between MAFF and Meldrum.

The compliance narrative in particular demonstrates how state actors sometimes enact measures which are more convenient (Smith, 1993). The 1981 PPO was a legislative measure to which the animal waste industry as a whole could most easily comply. Implementation of this less complex regulation would avoid a possible reduction in the use of ingredients such as MBM and DPM which MAFF did not want. The collective narratives of the actors in MAFF therefore led to the marginalisation of Meldrum in the State Veterinary Service. This suggests that presence as a *primary actor* itself does not guarantee influence upon policy. In this case, there is an argument for suggesting that the single voice of Meldrum was insufficient to redirect policy and instead an actor coalition would have been more influential.

Potential actors for this coalition were the regulatory bodies, the SOA and the AMA, and the business actors, the BPF and UKASTA who had similar concerns to MAFF with regards to the ineffectiveness of the PPO in ensuring that MBM was pathogen free. This is illustrated by the risk identification dyads linking these actors to MAFF. However, these actors were kept outside of the core policy arena where as *secondary actors*, their input into the policy process could only have been limited. This is illustrated by MAFF's response to their concerns, as shown by a weak dyad. The unidirectional linkages in this risk debate demonstrates how risk actors were unable to bring about a constructive discussion regarding their concerns. Therefore, though MAFF was involved in the risk issue of ensuring the elimination of disease pathogens in MBM, the regulatory actor did not side with the risk actors. Instead, the low temperature continuous systems of PDM were widely welcomed and a minimalist regulation to which the rendering sector could most easily comply was enacted.

A further explanation for the neglect of risk is the focus by MAFF upon salmonella where once again the approach to risk was more responsive rather than precautionary. The consequence was weak protection against other pathogens, known and unknown,

which may have been more resistant (as proven by the BSE pathogen). This over-emphasis upon certain problems seems quite unacceptable, especially as there were other known risks related to MBM: Foot and Mouth Disease, poultry manure pathogens and the possible risks to human health from scrapie-infected MBM. Instead, during this period of risk and during a period of very rapid technological transformation, the animal protein processing industry underwent deregulation.

The regulations regarding animal waste processing have been poorly designed or inadequately modified since the pre-BSE period right up to the present day. As a possible cause of spreading the current Foot and Mouth crisis, feeding swill to pigs has recently been banned (The Guardian, 27/3/01) though why this practice was not made illegal in 1996 when MBM was banned from all animal feed raises a valid criticism against the authorities. After all, the principle of recycling animal species and feeding it to animals was the same. Responding to this criticism, a SEAC (Spongiform Encephalopathy Advisory Committee) member has stated that in 1996 there was much uncertainty regarding the regulations governing swill or even whether the practice still existed (Kimbell, 27/3/01). Apart from depicting those charged with responsibility for monitoring animal waste processing as highly incompetent, this example indicates how the adoption of precautionary measures tends to remain a low priority for those regulating the agricultural sector.

6.2 Marginalisation of pre-BSE risks

The policy networks for the two technologies represent the *policy community* model, centring upon regulatory and business actors. The differentiation between the *primary* and *secondary* actors in the policy arena is represented by the majority of the risk actors being located outside of the central ellipse in the risk network diagrams This prevented risk issues from emerging in the wider social arena. However, even within this insular management of technology-related risks, there was a dominance by the a single *primary* policy actor, MAFF, in deciding upon how technology-related risks were to be approached.

It is generally the case that discourse about risk is subsided by the discourse of technological innovation, often viewed as progress and good for society. This is

especially the case if scientific knowledge forms a part of the innovation discourse (Fairclough, 1996) where scientific data is argued to be undisputed. In studying the BSE technologies this observation remains valid. Risks related to the manufacture and use of MBM in feed were sidelined by the dominant discourse of technological and scientific modernisation of MBM manufacture/use in feed. This relates to the model of Billig (1987) where he states that for arguments to be accepted there needs to be an agreeable audience present. At the time of the pre-BSE technologies there was more momentum in the policy arena for agricultural related technological innovations rather than for precautionary action, further explaining why the precautionary discourses were not prioritised.

6.3 BSE: changing the role of regulatory actors towards MBM production and consumption

The BSE controversy transferred the MBM technology from being a technology about which there was little public discussion and regulatory supervision, to one which began to be frequently discussed in the national media and which now demanded stringent regulatory intervention, at both national and European level.

6.3.1 Policies on continuous rendering systems

Though the UK banned MBM from ruminant rations in 1988, other EU Member States continued this practice until 1994 (European Community, 1994) as shown by Appendix 1. Furthermore, it was used for pig and poultry rations in the UK until 1996 and until 2000 in the EU. Therefore, EU policy-makers spent much of the 1990s regulating the manufacture of MBM to ensure that the BSE pathogen was not continuing to pose a risk through the use of MBM.

The first such legislation was the 1990 Animal Waste Directive (European Economic Community, 1990) which set out to harmonise EU rendering systems. This set minimum processing standards where material had to be manufactured at a core temperature of 133°C for 20 minutes. However, the emphasis was upon attaining

microbiological cleanliness, using Clostridium perfringens as the standard for measurement (European Economic Community, 1992). As earlier analysis of the French and Danish rendering regulations have shown, some European countries were already meeting this criterion.

Standards which would ensure the destruction of the BSE pathogen were set in 1996. By this time information regarding processing requirements for this disease agent was made available following the 1989-96 deactivation studies conducted by a number of actors: European Renderers Association, UKRA, MAFF and the BSE/Rendering Processes Subgroup of the European Commission's Scientific Veterinary Committee (Taylor et al, 1995). The findings of these experiments resulted in the 1996 Commission Decision which placed an additional requirement upon renderers whereby material had to be *pressure cooked* (European Community, 1996). Again, this was already an established process in some European countries.

6.3.2 Policies on MBM use

Post-BSE the whole question of MBM use in animal feed was given a tremendous public profile across Western societies, leading to popular arguments that the practice should never have been allowed. Therefore, though MBM was used in most European countries since the early twentieth century, it has now been banned from inclusion in all animal feed in the UK (MAFF, 1996) and in the EU (DEFRA, 2001b).

The MBM technological trajectory has therefore come to a complete end and related industries in the UK are currently investigating possible uses of MBM other than inclusion in feed (Grantley-Smith, 18/1/00). Therefore, the MBM innovation networks shown in Chapters 4 and 5 and further discussed in this chapter, illustrating MBM stability and permanency, have because of BSE, been transformed into a network illustrating the breakdown of previously established actor relations, showing innovation networks to present both stability and instability (Håkansson, 1987).

7 BSE: challenging the policy community model and emphasising the importance of an issue network model

Earlier chapters have identified how risk concerns were quashed due to other social interests dominating the policy arena. The BSE controversy has very visibly shown the possible consequences of neglecting risk concerns related to technological innovation and gives further impetus to the demands for precautionary action.

Nevertheless, precautionary voices are still known to struggle in becoming fully embedded in the policy arena, as will be demonstrated by examples from the post-BSE policy-making arena. The fundamental reason for this is the continuing differentiation between *primary* and *secondary actors* in the policy community model. However, it will be argued that a more democratic approach to risk assessment requires more than a transition from a closed to an open model of policy-making. This will emphasise the need for risk actors to successfully represent their interests, through formulating *actor coalitions* where *discourse coalitions of risk* will be better able to compete with the *discourse coalitions of innovation.*

7.1 Technological innovation: shifting the emphasis from progress to precaution

Though desires for new innovations remain strong in our contemporary world, this is increasingly being diluted by arguments which want technology to be socially shaped so that social risks are minimised, if not eliminated. This represents a transition to the precautionary paradigm by social actors who want risk assessment, either immediate or long-term, to be increasingly emphasised.

Post-BSE a fresh debate discussing natural/traditional agriculture emerged counteracting the dominating pre-BSE debate centred upon scientific and technical agriculture. Regulatory actors could no longer view MBM only as a technical process and sideline related risks/precautionary voices. This resulted in the adoption of

regulatory measures to monitor the manufacture of MBM for inclusion in feed, and eventually the ban on all MBM use in animal feed. The story of MBM therefore serves as a good example of the challenges being made to technical progress as the dominant paradigm and science-based discourse as the dominant discourse.

7.1.1 Increasing influence of special-interest groups

Post-industrial theory suggests that public interest groups are social forces who have the potential to influence and direct policy towards the interest of general society. Green (1992) discussed how the acceptance of the rBST (recombinant Bovine Somatotropin) technology, a hormone which increases milk yields, has been thwarted due to the lobbying of organised social groups from the animal rights and consumer welfare sectors. Consequently, no country apart from the US, from where the technology emerged, has licensed rBST (Monbiot, 2000). The occurrence of BSE has been a significant influence in further encouraging such social groups to seek entry into core government policy-making circles in relation to technological change.

7.1.1.1 Consumer policy networks

BSE highlighted the innovative practices in agriculture which can be concealed from the public arena. The public exposure of MBM use (and less so its means of manufacturing) has resulted in demands to know exactly what is included in animal feed. This has resulted in legislation permitting farmers to identify what they are feeding their animals (MAFF, 1998), a request which they have been forwarding since the 1970s at least. There have also been discussions about regulating animal feed containing genetically modified ingredients (MAFF, 1999).

Repeated incidents of failures in food safety, for example, salmonella, listeria and E-Coli 0157, and more recently BSE and GM food, all demand a renewed approach to food management (Shaw, 1999) akin to the *issue network* rather than the *policy community* policy model of policy-making. Continuous and constructive interaction between industry, government and social groups is likely to ensure that areas of risk are not so conveniently sidelined.

MAFF has often been blamed for the failure of risk issues receiving insufficient risk assessment. Having been responsible for agriculture and food since 1955, MAFF had to a great extent controlled food-related issues, limiting the involvement of other departments and outside groups. However, an increase in consumer power due to failures in regulating technologies, has led to various changes in food policy and management in the UK. Following Labour's election victory in 2001, MAFF as a separate department has been abolished, replaced by the more integral Department for Environment, Food and Rural Affairs (DEFRA). Furthermore, the Food Standards Agency (FSA) promises much in independent supervision of the food production process.

The increasing focus upon the consumer suggests the importance of considering the views of consumers during periods of technological change. This signifies how the dominant influences shaping technological innovations have transferred from largely being technology-push influences where consumers concerns tended to be marginalised, to equal attention being attributed to market-pull influences where consumers of technology are recognised as important contributors to technological change. Though pessimistic voices may argue that DEFRA represents a guise for departments which are still operating fairly individually and that the FSA represents a continuum of MAFF's historical problems, such regulatory changes rightly represent government attempts to allay consumer confidence in the food system which has seriously been damaged by events like BSE.

Important steps in managing risk alongside the innovation process are therefore being made. Examination of the GM food technology by the UK Advisory Committee on Novel Food and Processes illustrates this (Sanders, 1999). Food-related businesses have also established systems of technology control so that food products are safe once they are released into the market. Implementation of the HACCP (hazard critical control point concept) system in the food sector represent this. This practice has also been adopted by the rendering sector (Franco, 1996; National Renderers Association, 1998).

7.1.1.2 Increasing 'Scientific Citizenship'

Ineffective risk assessment due to the exclusion of wider interest groups has often been the result of a common assumption made by core policy-makers; that is, the public is incapable of understanding the intricacies of a scientific issue and will therefore behave irrationally and emotionally in any related debate. During the management of BSE the public were not told of the slight scientific differences between BSE and scrapie and how this may pose a risk to human health (Panorama: The Great British Beef Fiasco, 1996). Instead they were repeatedly informed that because scrapie had never harmed humans then neither would BSE.

Irwin (2001) has emphasised that government is the crucial force in transforming the innovation process to become more socially inclusive. A prerequisite condition to this is the recognition by the state that the general public want to know about science and technical change. In the UK this changing perception of government actors has been greatly realised, leading to the encouragement of *scientific citizenship.*

Irwin reports on how in 1997 the Chief Scientific Advisor of the UK government set out to make science more communicable to the public. The Royal Commission on Environmental Pollution initiated similar efforts for greater transparency in 1998. Furthermore, the 2000 report on 'Science and Society' from the House of Lords Select Committee on Science and Technology sought to restore public confidence in science after the BSE and GMO incidents. Greater public engagement is well demonstrated in the example of the GMO technology. Here the government-led Public Consultation on Developments in the Biosciences (PCDB) committee sought to build up a public assessment of the biosciences, involving society-oriented groups such as Greenpeace, Genewatch and the Church of Scotland. Though Irwin concluded that there were certain limitations on the extent of public influence in this case, it is such consultative procedures which will widen the framework of the innovation process and encourage better means of incorporating effective risk assessment.

At the forefront of such institutional and regulatory changes is the desire to discuss the concerns of risk actors. A main objective of risk actors is the incorporation of the

precautionary principle by policy actors. However, to what extent do the institutional changes like those discussed above achieve this objective?

7.2 The precautionary principle: its influence in real terms

Established as political agents since the 1960s and 1970s, expectations of special interest groups to achieve real influence in the policy arena has sometimes been disappointing. Consumer groups are particularly criticised for the failure in forming effective relations with government (Smith, 1993). How much of this failure is down to the groups themselves, and how much of it is down to the resistance to allow these groups into the core policy forum will now be discussed.

7.2.1 Actors demanding precautionary measures in the management of BSE

In the case of post-BSE management, the failure of such social groups was due to a closed policy framework. The policy community of MAFF, the NFU, government scientists and related industries prevented other actors from entering the primary policy arena. The majority of the dissenting voices, who were arguing for greater precaution, were therefore excluded.

Many scientists warned that BSE was a new type of disease which was showing to be scientifically different to scrapie. They therefore argued that government actors were wrong in emphasising that because scrapie had never harmed man, then nor would BSE (Animal Health A, 1988b; Animal Health A, 1988c; Animal Health A, 1988d; Panorama: The Great British Beef Fiasco, 1996).

Professor Richard Lacey is one UK scientist who became synonymous with wanting to actively adopt precautionary measures in the management of BSE. Along with Dr. Stephen Dealler these two scientists had numerous encounters with the government and through the national media and through their own publications, they argued against waiting for scientific evidence in efforts to protect consumers (House of Commons Agriculture Committee; 1990; Lacey, 1994; Dealler 1998a). However, they were accused of scare-mongering by government officials who refused to act

where the risk could not be quantified. Lacey and Dealler were therefore excluded from the core policy domain (House of Commons Agriculture Committee, 1990; Dealler, 1998a; Dealler, 1998b; Dealler, 3/12/99; Lacey, 1998).

Many social groups had also preferred to select precautionary measures but were informed by MAFF that these were not necessary. Members of the Women's Farming Union (WFU) have stated that in 1987 they lobbied MAFF to immediately make BSE a notifiable disease and to ban MBM from all feed, but their requests were ridiculed by certain Ministers (Berry and Smith, 1998). The Consumers in Europe Group (CEG) also expressed concern over the risk to other animals through recycling animal waste though the practice was in no way discouraged by government actors (Crampton, 1998). It was only once nvCJD was linked to BSE in 1996 that MBM was banned from all animal feed. Also, it is only in 2001 that the practice of swill where waste material of various sorts is recycled into feed for pigs has been banned in the UK, due to the recent Foot-and-Mouth epidemic (The Guardian, 27/3/01). Such examples illustrate that regulatory action in the UK is still reactive rather than precautionary.

Both the WFU and the National Consumer Council (NCC) (Simpson, 1998) had made strong pleas to introduce 100% compensation for farmers rather than the government's 50%, fearing that the latter amount would result in some farmers allowing BSE-infected animals into the human food chain, but their concerns went unheard and it was several years later that full compensation was granted (see Appendix 1).

To signify the importance of acknowledging precautionary actors it is necessary to note that many of the possible concerns which Lacey, Dealler and some of the consumer/environmental groups were expressing, though at the time were sidelined by actors in the core policy community, indicating the exclusion of such civil groups from the core policy arena., were in fact translated into policy action in subsequent years where their recommendations were eventually realised as being vital in the battle against BSE (McKechnie, 1998; Prentice, 1998; House of Commons Agriculture Committee, 1990). If core policy actors had attributed these precautionary voices with greater attention earlier, the incidence of BSE (and nvCJD) could have been reduced.

Therefore, though the Phillips Report has concluded that MAFF had not favoured industry concerns over consumer concerns (BSE Inquiry Report Volume 1, 2000), the latter certainly did not feature as a priority for MAFF. Instead, actors arguing for precautionary action in the interests of the consumer were marginalised.

7.2.2 Poor enforcement of regulations

Where legislation is enacted, poor regulatory implementation can jeopardise efforts to safeguard against risk. Precautionary action in this context achieves little. For instance, though there have been measures regulating the manufacture and distribution of swill for many years, these have been difficult to police and are likely to have been breached (Kimbell, 27/3/01), resulting in the recent Foot and Mouth epidemic. In relation to BSE, though UK MBM (likely to be contaminated by the BSE pathogen) was banned from inclusion in ruminant rations in this country, exports of this product continued after this date indicating failure to safeguard non-UK countries from the infective pathogen (BSE Inquiry Report Volume 10, 2000). This has subsequently resulted in foreign cases of BSE. Also, though the government constantly stated that all BSE risk material had been removed from the human food chain through the 1990 SBO (Specified Bovine Offals) ban, this measure was poorly enforced and implemented (Lamming, 1998; Panorama: The Great British Beef Fiasco, 1996). Therefore, infective material was likely to have been entering the human food chain for subsequent years. Precautionary policies therefore need to be followed through effectively to achieve genuine protection against risks.

7.2.3 Changing the dominant perception of innovation as progress

The increasing emphasis upon precautionary action in the sphere of technological change suggests that there is the potential to change the technological paths of problematic technologies. However, Russell and Williams (2000) have found that technology is still largely viewed by actors promoting innovation as following a deterministic route into society, connoting that innovation symbolizes progress and should not be hindered. This continuing perception of innovation presents barriers to making sound parallel innovation and risk policies.

Schumpeter's description of innovation as being the engine of wealth creation in capitalist society (Burton, 2001) has led the business and regulatory sectors to perceive technology as being generally good for society, potentially limiting the input of special-interest groups (Dahl, 1982). Thus, risk assessment can often be viewed by dominant business actors and regulatory actors as being a hindrance to technological progress, as indicated in an interview with a key member from the UK feed industry (Cooke, 5/1/00).

Instead, regulatory and business actors tend only to respond to a risk where there is scientific evidence exposing a risk. For example, in the pre-BSE risk networks MAFF responded in a precautionary way towards the salmonella risk which was supported by scientific evidence. However, the scrapie risk was poorly managed by the ARC because evidence of a risk could not be scientifically proven. Risks which lack scientific evidence are still predominantly disregarded in the policy domain. The failure to regulate the possible cancer risks from mobile phone technology demonstrates how waiting for science is still a rooted government philosophy. Such perception of risks is responsible for sidelining the precautionary voices in the policy arena.

7.3 (In)effectiveness of the issue network policy model

The inadequacies of the policy community policy model regards to risk management have been discussed. The suggestion is that a policy model featured on an issue network will provide more effective polices regulating technology-related risks. Though this is largely true, an open policy domain requires certain criteria before its system can be advantageously exploited to incorporate the precautionary voices. Actor resources and actor coalitions are essential elements in ensuring democratisation of the policy process.

7.3.1 Actor resources

The resources of actors (e.g. finance or expertise) plays a crucial role in attempts to improve risk management. Many special-interest groups who propose precautionary action often lack crucial resources, therefore limiting their influence upon policy decisions. No matter how accessible the policy arena, a lack of appropriate resources is likely to result in unequal representation in the policy arena (Smith, 1993; Bomberg, 1998). Risk actors with the necessary resources therefore, have a greater influence in the policy-making process (Renn, 1992).

Over the last several decades environmental pollution has become a social concern receiving much public, political and business attention (Caldwell, 1990; Groenewegen and Vergragt, 1991; Kempton et al, 1995). Establishing environmental issues as a social, political and economic priority has largely been achieved by social groups like Friends of the Earth and Greenpeace who because of their resource capabilities, have been successful in directing policy to reflect their concerns over environmental pollution. Because environmental lobby groups possess larger resources than most civil groups, their influence in the policy arena is also greater.

7.3.2 Actor coalitions

Kemp et al (1998) have examined how sustainable technologies sometimes fail to be selected due to the dominant technological paradigm of less sustainable technologies. This implies that risk actors need to partake in a struggle in order for their concerns to achieve any real influence. However, many risk issues fail in this due to a fragmented presentation of risk concerns resulting in the failure of establishing a competing discourse coalition (Hajer, 1995).

When risk actors are trying to seek modification of a technology which is supported by powerful actors, then the need for actor coalitions is particularly great (Steward, 1995). The MBM in animal feed technological paradigm was certainly a powerful one, and required an equally strong opposing actor coalition to ensure that the technology-related risks were adequately addressed and that technological alternatives

were adequately considered. However, the risk actor-world was fragmented and the actor relationships failed to add value to the policy network where the MBM technologies developed unchallenged.

Unlike the innovation narratives which tended to be shared and repeated by actors from the business, knowledge and regulatory sectors, the risk narratives represented risk concerns as if they were separate actor concerns, failing to achieve a meaningful response by MAFF. Though they had similar concerns, they failed to collectively represent their arguments. An absence of discourse coalitions of risk are therefore partly responsible for the dominance of the MBM innovation narratives.

For example, during regulation of the rendering industry, though Keith Meldrum was a member of the primary policy arena his single opposing voice was easily marginalised. A more effective response is likely to have been achieved if Meldrum represented his concerns with other actors who shared his concerns, i.e. the SOA, AMA, BPF and UKASTA. In relation to the MBM/by-pass protein risks, the farming community's concern over labelling may have forced a MAFF response, if the concern over MBM and scrapie links being identified in the US were also highlighted by these actors. Instead the only coalesced network of actors or clique (analogous to the innovation term), during the scrapie risk was the ARC, MRC and NPU but the absence of MAFF makes this risk response ineffectual.

Therefore, entry into the central policy domain alone will not yield affective policy influence. Resources and actor coalitions are also necessary assets.

Chapter 8

8 Concluding comments

8.1 Pre-BSE policy network analysis

8.1.1 The social shaping of MBM-related technologies

The social network analysis in this thesis has centred upon the *socio-centred* approach where all actor relationships are seen as important to the social activity being explored (DeBresson and Amesse, 1991; Scott, 2000). In this research, this includes actors introducing the technological innovations, actors identifying risks, and actors responding to the related risks. Not only does this expose the extent of wider social influences upon technological change, it also indicates where in relation to the central policy domain, risks issues were being discussed and managed.

Both the use of MBM and the continuous systems of rendering were technologies which were introduced into the UK following considerable impetus in North America. The established network of UK rendering, feed and farming actors was therefore modified to include US actors and the introduction of new technological ideas (Granovetter 1982). Due to the ensuing economic benefits for the related industrial sectors, a new stable network of business actors was established achieving considerable technological irreversibility (Coombs et al, 1992). Post-BSE the USA was slow to introduce a ban on MBM being fed to ruminants despite the ban by the UK in 1988 and the uproar caused by some US scientists over no equivalent action in the U.S.A. (Rampton and Stauber, 1997). One very likely explanation for this is that over the decades, the manufacture and consumption of MBM has resulted in a tight network of business actors whom would all have been (and consequently were) affected by a ban on MBM. The UK rendering industry itself employs about 1500 people and before BSE, made sales of £100 million a year (Beef Encounter, 2000).

Providing a useful framework for linking technology and society (Mackenzie and Wajcman, 1985), the SST theory has allowed for the examination of how a

combination of actor influences led to technological innovation. Within this, actor resources are key determinants in achieving innovation success (Freeman, 1991). It was the combination of the specific resources of these actors which established the MBM-related technologies as no single actor possessed all the needed resources to shape the technology.

Though the locus of innovation was the rendering sector, with the US NRA/FPRF identifying the by-pass protein concept, and a US rendering company adopting the first continuous technology, it was also the combined influence of other actors which led the two innovations to commercial success. The knowledge resource of the feed research actors established MBM as a new innovation through the by-pass protein concept, and represented the technology as a scientific development. The financial resources of the US NRA was equally important in developing this technology, through which promotion material on MBM and the by-pass protein discovery could be disseminated internationally. To ensure widespread use of MBM/by-pass protein in feed in the UK, the economic resources of the UK feed sector in promoting the technology was also essential.

By acknowledging the crucial role played by the feed and rendering actors in creating demand for the by-pass protein technology, this analysis addresses the criticism of Mackay and Gillespie (1992) who argue that social shaping of technologies studies often fail to attribute sufficient attention to how the creation of demand assists in the development and diffusion of technological innovation. This thesis has identified the feed and rendering actors as particularly active in this context, resulting in widespread approval of MBM/by-pass protein use in feed by farmers. In the adoption of low temperature continuous technology, PDM was supported by reliable production and delivery of the technology by supplier actors. The knowledge resource of the various actors who identified continuous systems as being more environmentally friendly was particularly important in establishing widespread regulatory approval of this technology.

Representing the resource dependencies of actors in these networks illustrates how social networks, where actors collectively represent a powerful force, add value to the

activity of which they are a part (Aiken and Hage, 1968; Marsden and Lin, 1982; DeBresson and Amesse, 1991; Håkansson, 1995; Castells, 2000).

The network graphics have captured all this complexity through the simplicity of their presentation, a core benefit of graphic network methodology (Bertin, 1983). As well as allowing for a detailed analysis of a relationship between two actors (e.g. US NRA and US FPRF), the network framework allows for the more holistic analysis of the multiple actor interactions (Jones et al, 1999). The graphic tool has also highlighted the importance of indirect influences upon technological change (Benson, 1978; Burt, 1982; Scott, 2000). For instance, the US FPRF and the UK ARC were major influences upon the UK feed sector's promotion of the by-pass protein concept. However, the absence of a dyad between these actors illustrates that this influence was indirect rather than direct. These knowledge actors have therefore been identified as *'information transmitters'* (Laage-Hellman, 1985). The network approach incorporates both direct and indirect influences upon technological innovation recognising that innovation ideas often originate from spheres of influence to which the core organisation does not necessarily have direct links (Laage-Hellman, 1985). However, this research project has identified the need for developing the network mapping methodology to represent indirect influences.

Despite the success of both the use of MBM/bypass protein in feed and low temperature rendering systems in the UK, there were competing technologies: vegetable protein and high temperature rendering systems. However, these failed to acquire sufficient actor support through the inability to adopt strong innovation narratives, becoming what Westrum (1991) terms *technology orphans.* In contrast, the MBM technological trajectories acquired significant momentum (Westrum, 1991) through the support of an array of social actors. The adoption of powerful innovation narratives ensured the establishment and stabilisation of these technologies, signifying how actors control a network to achieve their objectives (Knoke, 1990). Concentration in both the rendering and feed sector further strengthened the MBM technologies, resulting in increased standardisation of the processes of MBM production and use, representing technologies which became difficult to reverse. As Collingridge discusses (1980), it becomes very complex to control technology once, like MBM in the 1970s/1980s, it becomes embedded in the economic and social

fabric of society. The failure of risk actors to alter the technological path of MBM/by-pass protein in feed and lower temperature continuous systems, represents this very difficulty.

8.1.2 Incorporating risk assessment within the social shaping of technology framework

Extending the innovation network approach to include the social interactions over risk enhances the understanding of how social risks are being managed (Callon, 1995). This thesis has demonstrated how a network analysis of the pre-BSE risks provides for a greater understanding of how pre-BSE risks were managed. Using the argumentative model of Billig (1987) and Hajer (1995) it has been revealed that it was the innovation arguments that dominated the policy networks rather than the risk arguments.

Amalgamation of the innovation and risk networks has allowed for an analysis of where in the policy domain risk assessment was being conducted and whether this effected the quality of the responses to the risks. Both of the network diagrams represent a very closed policy domain, symbolising the *policy community* model of policy-making (Smith, 1993). Within this, MAFF approved and encouraged the technological innovations being adopted by industry actors, marginalising the various risk actors and enacting weak or no legislation. This supports the argument that the *issue network* model is more likely to lead to greater regulatory stringency (Bomberg, 1998). In relation to the risks related to MBM/by-pass protein use in feed, an interactive discourse between MAFF and the risk actors did not even emerge, signifying how the pre-BSE policy network failed to recognise the technology-society relationship. Consequently, society is being made to experience the negative impact of the technologies through cases of BSE and nvCJD.

Though Collingridge (1980) has emphasised that it is difficult to control technology in a certain way if there is an absence of a clearly identifiable risk, this thesis has argued that acceptance of these risks through their discussion in an open policy framework can lead them to influence technological change. The Constructive Technology

Assessment model provides the means of ensuring that such risks are exposed in the policy arena, encouraging effective responses to these risks (Rip et al, 1995b). Risk assessment therefore needs to shift from focusing upon risks experienced once the technology is established, focused upon by Collingridge, and needs to instead direct attention to the early stages of technological development where alternative, less problematic technological paths can be selected.

In this research there was an opportunity for MAFF to conduct risk assessment according to the CTA model. However, this was inhibited by MAFF's control of the policy network in relation to low temperature continuous technology, and a failure by MAFF to even acknowledge a risk in relation MBM/by-pass protein use in feed. By analysing the significant policy outcomes emerging from these policy networks, this thesis concludes that policy networks are more than simply a metaphorical tool (Marsh, 1998).

The success of the two technologies depended highly upon MAFF's indirect influence. Within the context of intensive agriculture, the concept of by-pass protein in feed made it a timely innovation. Likewise, continuous technology and its increased production of MBM/by-pass protein also made it a very acceptable technology to MAFF. However, though models of industrial agriculture were also being enforced in other European countries, the approach by foreign regulatory actors to risk management was more precautionary and the reluctance of MAFF to effectively regulate these two technologies is a good example of the general tendency of UK regulatory actors to adopt less stringent regulatory measures:

'[I]ndustry and government appear to act in a rather "hand-in-glove" manner, with little recourse to the general public, producing regulations often less stringent than their counterparts' (Rothwell and Zegveld, 1981; page 140).

The network analysis conducted by Hansen (2000) in Denmark and Lemarie (2000) in France, supports this observation. The regulatory institutions in these countries were instrumental in preventing the adoption of the Carver-Greenfield continuous technology. A technological reverse salient, where an institutional hindrance to a technology is introduced, was therefore achieved (Westrum, 1991). The use of

network graphics provides a useful means of conducting such comparative studies, identifying significant differences (Conway, 1997; John and Cole, 1998), as the network comparisons with Denmark and France have illustrated.

MAFF's failure to engage in constructive discourse with risk actors, is represented by these actors appearing as *isolates* in the policy network (Scott, 2000). Furthermore, the business actors who were exerting so much effort into promoting their technologies, equally failed to partake constructively in concerns over risk (e.g. the feed sector during the concern over labelling). Because of this, a distinct polarisation of the innovation and risk assessment processes has been identified in relation to both technologies; a core obstacle in managing technology-related risks effectively (Irwin and Vergragt, 1989).

However, there is also a case for arguing that the risk actors often failed to represent their concerns effectively, consequently failing to exploit the potential for negotiating a technology (Mackenzie and Wajcman, 1999). Whereas actor coalitions promoting the technology tend to coalesce successfully through their shared arguments, risk actors often fail to do so. A common reason for this is the absence or insufficiency of resources, such as finance or knowledge (Renn, 1992; Smith, 1993; Bomberg, 1998) whereas the industrial sector is often supported by economically powerful and very vociferous trade associations (Tukker, 1999). The US NRA is an example of such industrial support.

However, in relation to this analysis where the risk actors were mainly from the regulatory or business sector, the resource issue is not the most relevant explanation for the unsuccessful representation of risks. Instead it is the absence of actor coalitions which provides the most appropriate explanation, as has been examined in Chapter 7. The formulation of actor coalitions is extremely important if the benefits of an issue network are to be exploited and if less harmful technology is to be sought (Steward, 1995). This analysis has highlighted how policy outcome highly depends upon the strength and influence of an actor coalition and the strength of their argumentative discourse (Billig,1987; Hajer, 1995).

This analysis has argued that the marginalisation of these risks has been a contributory factor in the emergence of BSE. Consequently, the neglect of risk has resulted in the destruction of the technological momentum of the two innovations, due to the total ban on MBM from animal feed. The departure of the feed and farming actors from the innovation network illustrates how when actors have no remaining interest in the survival of a technology, it becomes obsolete (Westrum, 1991; Coombs et al, 1992). Networks are therefore not rigid and are sometimes forced to modify themselves or completely cease, according to changes occurring in the wider social arena (Håkansson, 1987; Coombs et al, 1992).

It is the rendering sector which has most greatly been affected by the repercussions of an MBM ban. The feed sector has been able to provide farmers with alternative protein sources and therefore is no longer an actor in the MBM innovation network. This demonstrates how an actor enters and exits an actor-world according to his own objectives and to suit his own purpose (Burt, 1982; Jørgensen and Sørensen, 1999). However, the rendering industry cannot detach itself from MBM and through employment of a narrative discussing the ecological benefits of rendering (National Renderers Association, 1992; Franco and Swanson, 1996; Fats and Proteins Research Foundation, 1999; UKRA, 1989) the UK sector is desperately continuing its search for new commercially viable MBM markets.

8.2 General technology/risk considerations

This research project has aimed to highlight the importance of integrating innovation and risk policy. As technological innovations have socially been perceived as a symbol of progress, voices identifying risks and seeking precautionary measures can very often fail to receive the necessary consideration in the policy arena. Though certain events (of which BSE is the most significant in relation to the food sector) are causing the innovation pendulum to increasingly swing towards more thorough risk assessment, transition to the precautionary paradigm in real terms is in its early stages (Caldwell, 1990).

The reason for this slow transition is that the innovation and risk processes remain polarised to a significant extent, largely due to the regulatory approach towards technological innovation being centred upon the closed technological determinist models of innovation. Furthermore, technology-related risks are often managed within the rational (rather than open) system of governance (Scott, 1992). Consequently, identified technology-related risks remain divorced, unthreatening the technological trajectories of problematic innovations.

Using the social shaping of technology arguments for transforming the innovation process to be more holistic in encompassing and addressing associated risks, this thesis provides a useful model to counter these traditional models of innovation and risk assessment. Demonstrating how pre-BSE policy networks representing the traditional approach to innovation and risk management is correlated with the BSE controversy, this research project recommends that BSE should signify the need to attribute greater attention in deciding *what* technologies are adopted. In the technological paradigms of modern societies where greater risk and uncertainty are connected to technological innovations (Beck, 1992), a more open risk debate is particularly important. However, unless the government plays a more active role in encouraging the innovation process to better incorporate risk issues then the integration of innovation and effective risk assessment will be limited.

9 References

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Appendix 1: Chronology of BSE events

- *November 1986:*
  Disease was identified by MAFF's Central Veterinary Laboratory

- *December 1987:*
  MBM identified as the only viable hypothesis for causing the spread of BSE

- *April 1988:*
  The government's Southwood Working Party was announced

- *June 1988:*
  BSE was declared a notifiable disease

- *July 1988:*
  The UK bans MBM for inclusion in ruminant feed

- *August 1988:*
  Slaughter scheme giving 50% compensation to farmers was introduced

- *February 1989:*
  Southwood Report published

- *November 1989:*
  Introduction of the Specified Bovine Offals (SBO) banning such material from human food

- *February 1990:*
  Slaughter compensation scheme was increased to 100%

- *April 1990:*
  BSE declared a notifiable disease to the European Commission

- *September 1990:*
  The ban on SBO material for inclusion in animal feed

- *November 1990*
  Introduction of the first EU regulation monitoring the rendering process

- *June 1994:*
  EU bans MBM from ruminant feed

- *March 1996:*
  - The Secretary of State for Health, Stephen Dorrell, announces a possible link between BSE and nvCJD
  - EU bans export from the UK of live bovine animals and meat of bovine animals
  - UK bans MBM from all animal feed

- *July 1996:*
  EU identifies rendering processes capable of destroying the BSE pathogen

- *June 2001:*
  EU bans MBM from all animal feed

Appendix 2: Types of continuous systems used in the UK

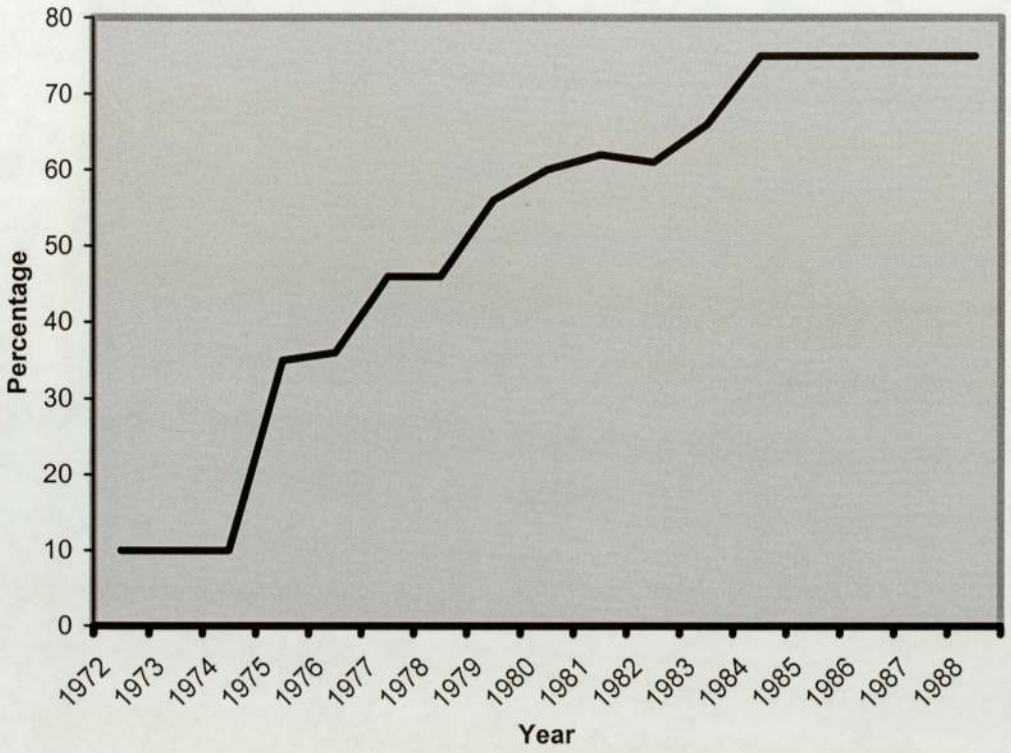
Continuous systems in the UK

Process	Number
Carver Greenfield	3
Stord Bartz	7
Stork Duke	4
Protech	2
Dupps	1
Mirinz Low temperature	2

Source: Wilesmith et al (1991).

Appendix 3: Increase in MBM manufactured by the continuous process in the UK

MBM produced by the continuous process in the UK, 1971-1988



Source: Wilesmith et al (1991).

Appendix 4: Prosper De Mulder's: main continuous processing plants for MBM manufacturing

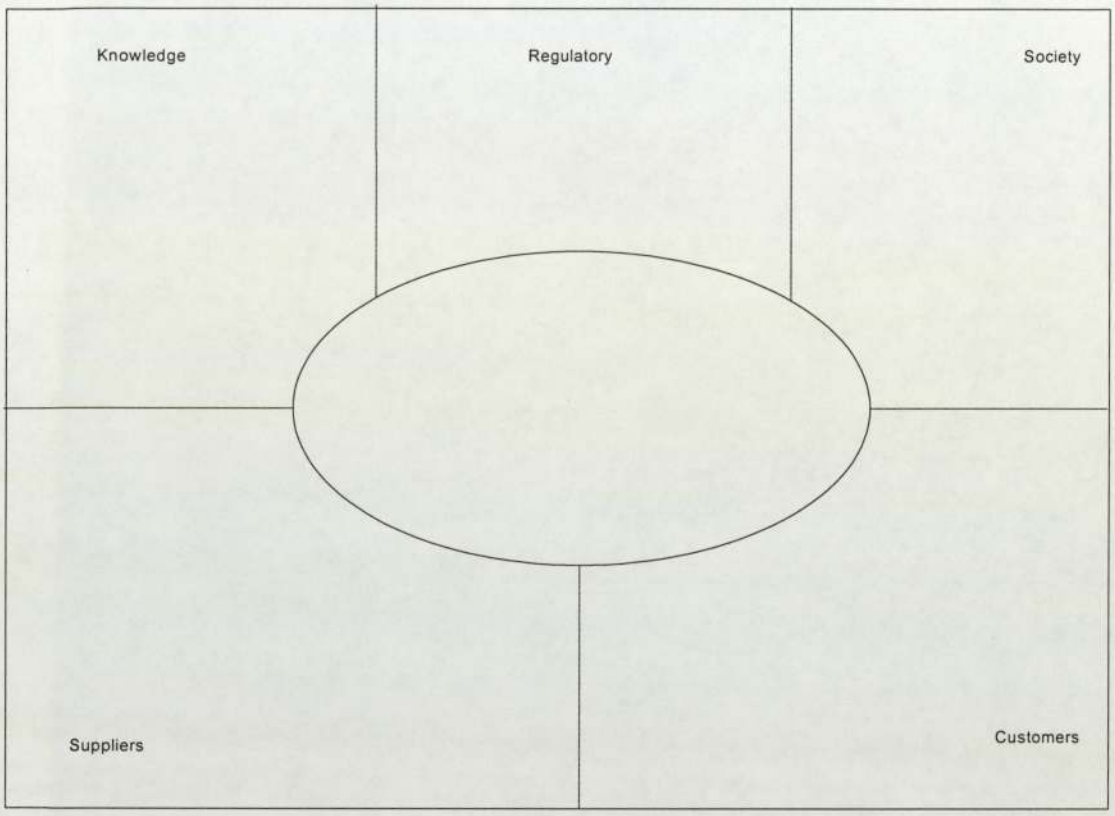
PDM's continuous systems

Year	Location	Capacity	Process
1972	Nuneaton	3700	Carver Greenfield
1975	Doncaster	2800	Carver Greenfield
1980	London	1500	Carver Greenfield
1980	Widnes	1500	Stork Duke
1982	London	1500	Stord Bartz
1984	Exeter	2000	Stord Bartz

Source: The Monopolies and Mergers Commission (1985, 1993).

Appendix 5: Network Template

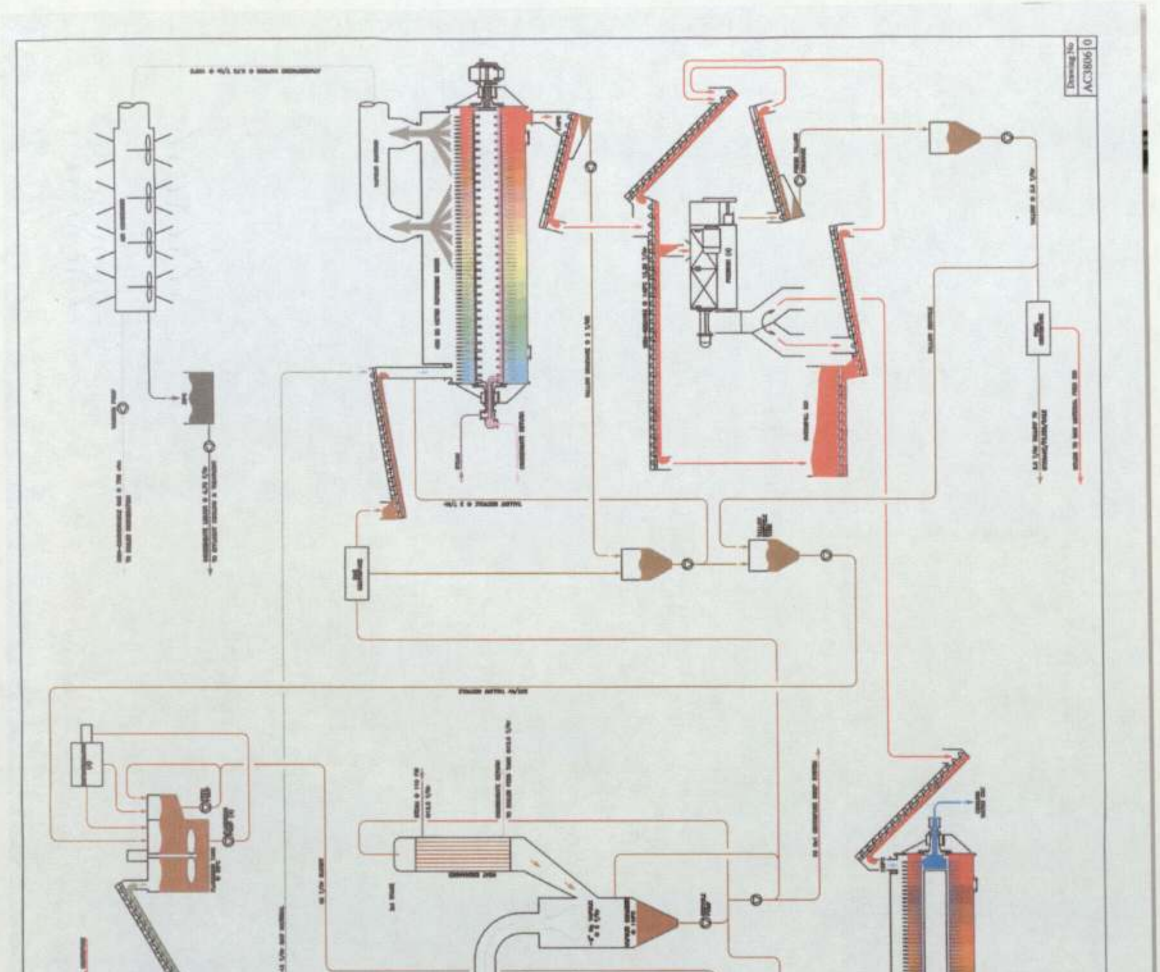
Network Template used in this analysis



Source: Conway (1997).

Appendix 6: The Carver-Greenfield technology

The diagram overleaf was provided by a member from Prosper De Mulder. It is an illustration of the Carver-Greenfield system which was popularly adopted by this company. The vacuum stage of this process is depicted on the diagram.


2 STAGE VACUUM EVAPORATION
& ROTORDISC PROCESS
PROSPER DE MULDER
LIMITED
Drawing No
AC3806 0