TESTING INCREMENTAL POLITICS : THE CASE OF NORTH SEA OIL

AUDLEY TERENCE GENUS

DOCTOR OF PHILOSOPHY

THE UNIVERSITY OF ASTON IN BIRMINGHAM

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THESIS SUMMARY

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In the quest to secure the much vaunted benefits of North Sea oil, highly non-incremental technologies have been adopted. Nowhere is this more the case than with the early fields of the central and northern North Sea. By focusing on the inflexible nature of North Sea hardware, in such fields, the paper examines the problems that the adoption of this sort of technology might pose for policy making.

More particularly, the following issues are raised. First, the implications of non-incremental technical change for the successful conduct of oil policy is raised. Here, the focus is on the micro-economic performance of the first generation of North Sea oil fields and the manner in which this relates to government policy. Secondly, the question is posed as to whether there were more flexible, perhaps more incremental policy alternatives open to the decision makers.

Conclusions drawn relate to the degree to which non-incremental shifts in policy permit decision makers to achieve their objectives at relatively low cost. To discover cases where non-incremental policy making has led to success in this way, would be to weaken the validity of the thesis that decision makers are best served by employing incremental politics as an approach to complex problem solving. However, to falsify such non-incremental successes would be to uphold the merits of the incremental approach.

Key Words: INCREMENTALISM; NORTH SEA OIL;
U.K. ENERGY POLICY; POLICY MAKING;
TECHNOLOGY POLICY.

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CHAPTER ONE

INTRODUCTION

1.1 The Direction and Scope of the Thesis.

The research presented here, has the aim of contributing to the improvement of policy making, where this must be undertaken in the face of complexity or uncertainty - or both. More particularly, it investigates the assertion that in order to be successful (i.e. to work in the interests of the agents involved), policy ought to be incremental, the notion of incrementality being associated with the degree to which a policy is 'flexible'. An important aspect of the study, therefore, involves the definition of 'incremental politics' as the prescriptive model which, if followed, will enable decision makers to adopt 'good' policies. In contrast, previous research has shown that to adopt rival, 'non-incremental' approaches is to invite failure. This thesis therefore, explores the claim that non-incremental or inflexible policies are unlikely to work in the interests of the agents, however these interests may be defined. [1]

Testing the prescriptive merit of incremental politics is thus an activity which involves the search for successful cases of non-incremental change. Such examples of policy which make great demands on information and expertise and which deviate greatly from the status quo yet still succeed, bolster the non-incremental prescription. The discovery of decisions which fall into this category would enhance current understanding of how decisions with potentially large-scale impacts should be made. This is particularly important since incremental politics suggests that policies of this sort, where the cost of errors may be catastrophic, should not be implemented. In this way, any potential benefits of non-incremental policy might have to be given up.

The dilemma which faces decision makers in the making of large-scale changes in policy, is perhaps best exemplified where there is a major technological component to policy. Here, the relationship between non-incrementality and inflexibility in policy may best be seen by reference to the physical features of the technology. Characteristics such as long lead time for the development of the technology, large unit size or high capital intensity may indicate how eventual costs are likely to outstrip initial estimates which appeared to be well founded. A further feature applies to the extent that a technology depends upon specialised techniques or equipment for its development. Yet, as in the case of British experience with nuclear power, the potential costs and benefits of technology are often taken as given or well understood. However, if one accepts that mistakes are to be expected and that circumstances are bound to change, the question posed by such dilemmas refers to how best technology can be adapted to respond to new information, values and the discovery of error. Hence this thesis takes a long-term view of the management of technology, although it is recognised that those charged with the making of policy may have their own shorter-term horizons and objectives.

Decisions involving troublesome technology are thus the vehicle for evaluating rival prescriptive models. In doing so, the thesis will focus on the hardware involved in North Sea oil policy. Whilst one would not wish to ignore the influence of political processes in technical choice, it is the nature of the hardware involved in technology which may make subsequent alteration or control difficult.

Hence:

> "it is much harder to alter technology through whatever political processes are open, than it is to alter policy in other areas ... the very nuts and bolts of a technology close options for the future, by making them hugely expensive and slow to be achieved, quite irrespective of who might actually favour these options now, or who might come to favour them in the future".[2]

So, the claim is advanced here that the physical characteristics of a technology provide a relatively objective base for evaluating whether the adoption of that technology represents incremental or non-incremental change. Thus the categorisation of North Sea technology as a non-incremental technical change is essential to this thesis. Taken together with an evaluation of its performance, which on prima facie evidence seems to suggest success, this appears to be a case which contradicts the message of incrementalism. Only if this apparent success can be falsified, will the thesis asserting that the adoption of inflexible technology leads to unhappy outcomes retain the same validity.

In considering the performance of North Sea fields, the evaluation is conducted by constructing a range of oil price scenarios and carrying out discounted cash flow calculations on the revenues derived from these. Actual historical and future estimated cash flows are another source of performance evaluation. Further the ease with which developments have been realised and the degree to which unforeseen circumstances have affected field performance, are also important aspects in the discussion of whether success in policy has been illusory, partial or due to factors outside of the decision makers' control. Should good performance be more a matter of luck than judgement, then the success of such a non-incremental policy may be considered to be falsified.

1.2 Conducting The Research.

In performing the test of the prescriptive validity of incremental politics, the thesis has the following structure. **Chapter Two** presents a review of the literature relevant to the research problem. The main function of such a chapter is to assess what progress has been made towards securing better prescriptive theories of policy making as might be applied to higher-order complex policy situations. Of particular importance is the extent to which incremental politics provides a prescriptive model warranting further attention and empirical testing.

The matter of constructing and laying down the ground rules for carrying out the test of incremental politics forms the main subject matter for **Chapter Three.** Here, an explanation of the methodology serves to facilitate an understanding of the nature of non-incremental technical change. In particular, the chapter considers the idea that testing the incremental prescription involves finding an empirical example of a successful non-incremental policy and attempting to falsify that success. It is here that the British North Sea oil case study is introduced.

Since the non-incremental nature of technology is at the heart of the study, **Chapter Four** is concerned with establishing the non-incrementality of North Sea oil technology. This appeals to certain criteria related to the capital costs, complexity and lead time involved in making North Sea oil technology operational.

Chapters Five and Six are mainly concerned with filling in the background to the adoption of North Sea technology, with particular emphasis on the initial development of North Sea oil resources. The first of these chapters considers various aspects of government policy whilst the second tackles the role that industry-related factors have to play in the adoption of particular technical solutions to the problem of oil field development. The nature of these agents' objectives and the manner in which these might differ from any notion of a 'societal interest' is also considered.

In the assessment of the performance of North Sea oil technology, the notion of `success' is used to apply to the costs incurred in obtaining the benefits of UK oil resources. The assumption is made that, at the very least, `rational' decision makers would seek to develop oil production facilities in a relatively flexible and cost-effective manner (though not necessarily an 'optimal' one). **Chapter Seven,** therefore, considers whether the technologies employed to develop North Sea fields in the UK sector demonstrate these qualities. In addition, the use of various oil price scenarios serves to indicate whether fields in the North Sea have been successful in micro-economic terms.

Chapter Eight presents the conclusions of the thesis, relating the performance analysis of the previous chapter to the question of how well incremental politics has stood up to the empirical testing of its prescriptions. Finally, no thesis would be complete without some statement of how the thesis has contributed to knowledge in relevant fields, or indeed without pointing to some future avenues for research.

The following chapter provides a review of the relevant literature.

NOTES.

1. See, for example, D. Collingridge, Lessons of Nuclear Power, U.S. and U.K. History, Energy Policy, vol. 12, no. 1, March 1984, pp. 46-67; D. Collingridge and P. James, Technology Organisations and Incrementalism: High Rise System Building In the U.K., Technology Analysis and Strategic Management, vol. 1, no. 1, 1989, pp. 79-97; J.G. Morone and E.J. Woodhouse, Averting Catastrophe - Strategies For Regulating Risky Technologies, University of California Press, Berkeley and Los Angeles, 1986; J.G. Morone and E.J. Woodhouse, The Demise of Nuclear Energy? Lessons For Democratic Control of Technology, Yale University Press, New Haven, 1989; and A.B. Lovins and L.H. Lovins, Brittle Power - Energy Strategies For National Security, Brick House, Massachusetts, 1982.

2. D. Collingridge, Controlling Technology (Response To Johnston), Social Studies of Science, vol. 15, no. 2, 1985, p. 375.

CHAPTER TWO

PRESCRIPTIVE THEORIES OF POLICY MAKING: A LITERATURE REVIEW

2.1 Introduction.

This chapter reviews the most influential prescriptive contributions to be found in the literature on public policy and strategic management. It also seeks to highlight some of the problems associated with the espousal of normative theories. In doing so, the discussion centres on the applicability of theory to real-life, complex policy making situations. This, in turn, invites more philosophically based questions concerning what constitutes `good' or `bad' theory or theorising. The chapter closes by drawing out from the review some implications for the conduct and direction of future policy making research.

The prescriptive contributions that have been made in the name of improving the understanding and/or practice of policy making in governmental or corporate decision making stem from apparently distinct academic disciplines. Thus work of equal validity and influence has emanated from economists, political scientists, administrative theorists and urban planners alike. Naturally, this diversity of backgrounds can serve to add to the richness of the literature and to the illumination of the subject. Yet this may also represent a source of confusion, as the plethora of terms applied to the description of overlapping areas of study indicates - `policy analysis', `business policy' and `planning', for example.

Initially, the nature and scope of areas relating to public policy and strategic management are considered. The view is advanced that theorising within the disciplines ought to pursue the aim of improving the ability of decision makers to deal effectively with the most complex of decision making situations. In general, the strategic management field for too long has suffered from the preponderance of rationalistic prescriptions which have mainly been applicable to lower-order problem-solving. Public policy research, on the other hand, has tended towards descriptions which have aimed to capture the true character of higher-order decision making, though often at the expense of prescriptive developments. The latter part of the chapter, therefore, considers the normative advances that have been made within the various sub-disciplines which make up the field as a whole. Such `partial' theories have contributed to knowledge directly through the development of new prescriptions, or through the novel application of existing ones to new situations (e.g. applying incrementalism to technology policy). In addition, various writers have made a more indirect contribution by pointing to the potential methodological pitfalls of normative theorising.

2.2 Public Policy and Strategic Management.

The literature with which this thesis is concerned involves at root a consideration of the nature of what, among other terms, has been labelled `policy making', `decision making' or `strategic decision making'. Where such terms are employed, in general as well as academic usage, they are variously either well defined or used interchangeably. Worse still, when they are more tightly defined, there is often little consistency to be found across competing definitions offered to readers. [1]

In this section, therefore, the aim is primarily to provide a fairly general understanding of the main activities and concerns at which the literature has been directed. This includes the consideration and comparison of differing views on this matter. None of these are given in the quest for the most comprehensive or accurate explanation of the nature and scope of policy making theory and practice. On the contrary, there is more value to be gained from getting a `feel' for the subject in this way, than there is from the attempt to secure `once-and-for-all' definitions of the subject.

In attending to these different views and aspects of the nature and scope of policy making, it will be useful to keep in mind the sub- heading for this section. This has been deliberately chosen as it reflects what, in the past at least, has represented the dichotomy between research aimed at policy making in the public sector and strategy making in the private sector. [2] Hence, on one hand the focus is on `public policy' literature, whilst on the other, the attention shifts to the strategic management arena.

One reason for such a distinction is that it enables the discernment of concerns, issues and approaches peculiar to, or shared by the areas of study. This, in part, reflects the nature and scope of the literature and its debates over the last twenty or thirty years. Thus strategic management can be viewed as utilising `rationalistic' models geared towards prescriptive theorising, having the goal of improving the substantive content of strategy. Alternatively, public policy research has become associated with the behavioural and socio-political contexts of policy and the conduct of research more descriptive in its orientation. Such work is said to have an explanatory function and focuses primarily on the workings of the policy making process.

There are two important questions emanating from the above distinction which merit particular attention. The first is, `is the dichotomy between public policy and strategic management justified or accurate ?' In other words, does research in the two areas fulfil distinct functions arising out of different conceptions concerning the nature and scope of policy making ? Further, is this or would this be in some way beneficial to the theory and practice of policy making ? It is proposed that these issues be tackled in the course of attempting to answer the second question, namely, `can policy making theory influence and improve the actual practice of policy making, and how ?' It may well be that beneath it all there are shared concerns, successes and perhaps failures which serve to link rather than separate public policy and strategic management. Some consideration of these issues might assist in the task of assessing the development of the subject to the present, providing an insight into future avenues of progress.

The division of the literature noted above can be traced to differing conceptions concerning the essence of policy making and the role of policy making theory. This discussion proceeds by confronting the issue as it applies to the literature on public policy and strategic management, though there is a measure of overlap between the areas. It begins by presenting some of the views to be found in the public policy research regarding the nature of `policy' itself.

Heclo sees the term `policy' as applying to "something `bigger' than particular decisions, but `smaller' than general social movements." [3] Etzioni's view of policy is similarly that of a more generalised form of decision making "in which whole sets of decisions are considered and the contexts for decisions are reviewed." [4] Braybrooke and Lindblom use `policy' to encompass both conscious decisions "and the course that policies take as a result of interrelations among decisions", including certain political processes. [5]

Heclo also cites purposiveness of some kind as being a second and essential element in most writers use of the term `policy', in that they seem to agree that, at its core, "policy is a course of action intended to accomplish some end." [6] Heclo's review further notes the ambiguity as to whether or not policy is more than the intended course of action. For some writers the actual behaviour implementing the intention provides one of the ingredients of policy. Thus both intended and unintended outcomes alike are occurrences which the notion of policy ought to be capable of embracing. In view of this, Heclo suggests that "policy should be operationally identified, not by its goals, but by the actual behaviour attempting to effect the goals." [7] Moreover, "a policy...can consist of what is not being done - for example, the inaction which prevents `costs' already affecting some groups from being removed." [8]

Thus, in a basic sense, `public policy' involves the courses of action (or non- action) pursued under the authority of governments. In addition, since public policy concerns in part the organisation of purposive action in society by state authority, it is involved with the making of "meta-choices, i.e. choices as to how others shall make choices in whatever sphere public authority is intervening." [9] However, Jenkins considers that one is not simply concerned with central government or elite groups of actors at the centre of the policy arena. "Rather the scope of analysis must embrace varying levels of government and a broadly defined concept of the political system." [10] This is so because as Hofferbert has stated:

"policy is made in a variety of contexts. Different contexts produce different policies...the level of government is one critical contextual variant for political activity. So is the national economic context."

Contextual changes thus lead to variations in the policies produced. [11] What levels are focused on will depend on the interests of the investigator. An interest in international relations might start by considering national versus international pressures, for example, while a concern with urban affairs might look at the interaction between central and local influences. [12] Finally, Anderson points to the dynamic nature of policy making. Thus "typically [it] involves a pattern of action extending over time ...involving many decisions." [13]

Turning to the strategic management literature, one finds that the dynamism referred to by Anderson is echoed by writers such as Mintzberg. Although he was discussing what he called `strategy formation' rather than policy making, Mintzberg defines strategy as a "pattern in a stream of decisions", where a decision is defined as "a commitment to action (usually a commitment of resources)." [14] For Mintzberg such a definition is required to combat the incompleteness of other competing definitions of strategy, something which has led to the neglect of certain areas of study. Moreover, within the management field these neglects are believed to apply to much research, save a few very important exceptions. Hence, to use Mintzberg's terminology, a substantial amount of research in the strategic management arena has fallen within the `planning' or `entrepreneurial' modes. [15]

The planning mode comprises the largest body of literature and depicts the process of strategy formation as "a highly ordered, neatly integrated one, with strategies explicated on schedule by a purposeful organisation." [16] In the entrepreneurial mode, powerful leaders take bold, risky decisions directed at some vision of the organisation's future. [17] What these modes have in common are definitions of strategy asserting that the process consists of deliberate and conscious sets of guidelines determining decisions into the future. [18] Thus definitions of strategy, whether they are found in military usage, Game Theory or management theory, all treat strategy as explicit, consciously or purposefully developed, and made in advance of the specific decisions to which it applies. [19]

In management theory, for example, Chandler is typical. Here, strategy is seen as "the determination of the basic long-term goals and objectives of an enterprise and the adoption of courses of action and the allocation of resources necessary for carrying out these goals." [20]

According to Mintzberg, the main sin arising from these `rationalistic' definitions of strategy, has been the neglect by researchers of strategies which are unintended, evolving or implicit in nature. Thus in the business context, the late development of research that would fit into Mintzberg's adaptive mode is notable. This is despite the start made by writers concerned with expressing or overcoming the bounds to rationality in decision making within public administration (e.g. Lindblom), or in traditional economic theory (e.g. Simon). [21] Here, the formulation of strategy as described above, is frustrated by the inadequacy of time, knowledge and other resources needed to arrive at a `rational' strategy. This situation may be exacerbated by conflicts of interest between the parties involved, which may necessitate bargaining over which strategy to implement. Either way, the process is much more `messy' and incremental than the `rationalists' would have it. Hence strategy can be viewed as being a matter of evolution and needs to be understood in terms of the activities managers undertake to cope with an uncertain and complex external environment, and a work context characterised by social and political considerations and action. [22]

One may discern the recent emergence of another mode of research in the strategic management field. This is the `interpretative' mode, in which strategy is seen as the product of individual sense-making about the organisation and the environment in which it operates. Here, "the emphasis is...on the cognitive and symbolic bases of [the] interpretation [of complexity] that characterise the lived world of managers." [23]

These research groupings do, of course, overlap in their views about the nature of strategy and what is perceived to be the proper focus for research in the area. However, in comparison with more traditional modes of research, the adaptive and interpretative schools can be said to focus on descriptions of the process of strategy formation and change. Their message is that it is only by first understanding the nature and workings of these processes that valid prescriptions can be generated. Classical theories of strategy, or policy for that matter, are therefore faulted for being empirically unrealistic. Conversely, the general criticism levelled at adaptive and interpretative models, centre on their claims to be normatively as well as positively useful. [24] This is an issue which is now considered in greater depth, with reference to the role of theories of policy and strategy and their relevance to the problems they claim to be addressing.

2.3 `Wicked' Problems.

The central concern of prescriptive theories of policy or strategy making is usually to secure improvements in their practice, especially where non-routine, complex or novel decision situations are involved. In the past, it has often been these `unstructured', `strategic' decisions that researchers of administrative processes have neglected, preferring instead to concentrate on routine operating decisions which are more accessible to description and quantitative analysis. The literature informing the analysis of these sorts of decision derives, mainly, from economic theories of `rational' decision making.

Camhis differentiates between two types of rational planning, the `rational - deductive' and the`rational-verificationist' (or inductive), on the basis of their different treatment of the way goals are formulated and their status in the planning process. [25] Briefly, the first type comprises the following elements:

1). The decision maker has laid out before him/her the whole set of alternatives from an action will be chosen.
2). To each alternative is attached a set of consequences.
3). At the outset, the decision maker has a `utility function' or a preference ordering that ranks all sets of alternatives from the most preferred to the least preferred.
4). The decision maker selects the alternative leading to the preferred set of consequences.

Charles Lindblom, in the course of espousing his theory of incrementalism describes another version of rational policy making. This corresponds to Camhis' second type. It emphasises the role of objectives, compatible with previously defined and ranked values. Thus the policy maker identifies all relevant options or means of achieving these objectives, and then calculates and compares all the consequences of these options. Finally, the option or combination of options which would maximise the values previously defined as being most important, would be selected. What Lindblom labels the `synoptic conception of problem solving', describes the main elements of the rational comprehensive approach to planning which has been basically identified with advanced decision making and the rational verificationist (or inductive) type of rational planning.

The underlying assumption of the rational comprehensive approach to policy making is that the decision maker's choice can or should be justified. Associated with this is, first, the idea that the problem solver has at his or her disposal all the necessary resources for understanding and analysing the problem at hand. Second, the assumption is made that there is little or no conflict between the decision makers over goals and values. These are known and capable of being quantified. Finally, the decision maker(s), usually an `entrepreneur', is given a range of discretion great enough to permit the consideration of an equally wide range of alternatives.

In business, the main criterion in such strategy making is considered to be the maximisation of profit, with strategic choice being fundamentally a matter of maximising return on investment, through the optimisation of a portfolio of either product lines or businesses. [26] In public administration, it is the maximisation of `benefits' over `costs', or of some previously stated values which provides the goal to be attained.

This `comprehensive' approach has been attacked, both for its descriptive weaknesses and its prescriptive inapplicability. The requirements of the approach are, according to Herbert Simon, "powers of prescience and capacities for computation resembling those we usually attribute to God." [27] Simply, human beings do not have the problem solving capabilities needed to adhere to the prescriptions of `comprehensive rationality'. It is with regard to these limits of human capacity in comparison to the complexities of the problems faced by individuals and organisations that Simon develops the concept of `bounded rationality'. This demonstrates how problem solvers, while intending to act `rationally', deviate from comprehensive rationality.

In particular the following variations from the ideal may be noted: [28]

1. PROBLEMS ARE FACTORED.

Problems are so complex that only a limited number of aspects of each problem can be attended to at a time. Thus individuals and organisations divide problems into smaller parts. Individuals then attend to the parts one by one, organisations allocate the parts to various organisational units.

2. SATISFICING.

In choosing, decision makers find a course of action that is `good enough' rather than consider all alternatives and pick the action with the best consequences. Moreover, the problem of search becomes critical, compared to the comprehensive approach where all alternatives have to be considered. Where the rule is to satisfice and the first `good enough' alternative is chosen, then the order in which alternatives are generated is an important factor to take into account. Hence the need for organisations to adopt relatively stable, sequential search processes.

3. UNCERTAINTY AVOIDANCE.

In the comprehensive approach, `agents' deal with the consequences of rival actions by estimating the probabilities of possible outcomes. In the real world, says Simon, people are reluctant to base their actions on estimates of an uncertain future. Accordingly, choice procedures emphasising short run feedback are developed.

4. REPERTOIRES.

Repertoires of action programs are developed by organisations and individuals, constituting the range of effective choice in recurring situations.

Similarly, Lindblom's incrementalist critique of the `synoptic' approach, focuses on the disparity between the requirements of the model and the capacities of the decision makers. Thus it recognises shortcomings of the synoptic ideal which include the following: [29]

1. The synoptic ideal is not adapted to man's limited problem solving capacities;
2. The synoptic ideal is not adapted to the inadequacy of information;
3. The synoptic ideal is not adapted to the costliness of analysis;
4. The synoptic ideal is not adapted to failures in constructing a satisfactory evaluative method;
5. The synoptic ideal is not adapted to the closeness of observed relationships between fact and value in policy making since "continued contemplation of alternative means is often empirically inseparable from continued

contemplation of values" ;

6. The synoptic ideal is not adapted to the diverse forms in which policy problems actually arise, or the openness of the system of variables with which it contends.

This latter point concerning the diversity of policy making problems provides a key to the understanding of the various functions theory may perform. Thus `tame' problems, such as those presented in Game Theory, are more amenable to exhaustive formulations which can be stated. This may contain all the information the problem solver needs for understanding and solving the problem. Yet such normative models of economics and management science have had an impact only on the routine work of lower levels in organisations. They have little relevance to the `wicked' problems faced by organisations at the higher, strategic level, where better decision making methods are most needed. These problems are `wicked' for several reasons, some of which are discussed briefly below. [30]

First, there is no definitive formulation of a `wicked' problem. Wicked problems are not easily dealt with in distinct planning phases. Hence,

> "one cannot understand the problem without knowing about its context; one cannot meaningfully search for information, without the orientation of a solution concept; one cannot first understand, then solve."

Therefore,

> "the formulation of a wicked problem IS the problem ... since every specification of the problem is a specification of the direction in which a treatment is considered."

Second, the solutions to wicked problems are not \`true' or \`false' but \`good' or \`bad'. Associated with this is the notion that the full consequences of any solution cannot be appraised until the waves of repercussion have completely run out. Certainly they are not capable of estimation in advance of the implementation of a candidate solution. Third, if problems are described as discrepancies between the existing state of affairs and the desired state, the causal explanation of the discrepancy and the removal of that cause may well pose another problem. The original problem may then be regarded as being a symptom of this latter, higher level problem. Thus \`crime in the streets' can be thought of as being a symptom of general moral decay, or permissiveness, or poverty, etc..

"There is nothing like a natural level of a wicked problem [though] the higher the level of a problem's formulation, the broader and more general it becomes and the more difficult it becomes to do something about it."

Finally, the zone of discretion of corporate and governmental policy makers alike, is much more constrained than traditional economics would have it. Choice is increasingly subject to constraints and limitations imposed by external and internal socio-economic, political and regulatory forces. [31] Moreover, planners are liable for the consequences of their actions. [32] These effects can matter a great deal to those people who are touched by their actions. This point is brought home when one considers that we are living in an age where policy issues often have a complex, dangerous or expensive technical aspect to them, which can result in the most disastrous of consequences. The next section, therefore, is concerned with the way in which theories seek to attend to the difficulties of policy making hitherto neglected by the `classical' approach.

2.4 Partial Theories.

Because of the great range and complexity of policy problems and the different situations in which they arise, many theories of policy making are partial in nature. This may be reflected in the various aspects of the subject that researchers focus on, or the limited applicability of their prescriptions to certain types of problems, in certain decision situations. Thus far this chapter has considered the rational-comprehensive approach as representing perhaps, an ideal, though unpractisable method for dealing with complex policy issues. However, it does retain some usefulness for lower order, more routine problem solving and hence has some partial applicability.

Nevertheless, the intention was that the model could improve actual practice by being a generally applicable set of rules, capable of being followed in most circumstances. Further, not only is this the best method for policy and strategy makers to follow, in order that their previously defined objectives be maximised, it is also said to be the actual method by which successful policy making proceeds. Yet it is not at all clear how the model is supposed to serve simultaneously as an accurate description of how decisions are made and a prescription of how they might be made differently by way of improvement. This criticism applies to much of the research in public policy and strategic management which often claims to supersede the comprehensive approach as a normative model.

Thus many writers presume that there is some correlation between `is' and `ought' and that explanatory social research can have prescriptive policy implications. There is nothing inherently wrong with this, except that authors adopting this position often do not explain their stance, or what it takes to act in accordance with the rules of their theories. [33] This point is further exemplified below with reference to the political science and strategic management literatures.

The work of Simon and Lindblom has already been mentioned in connection with the shortcomings of the comprehensive approach to policy making. Their criticisms were firmly based on the prescriptive inadequacies of formal planning and linked to their own conceptions of what real-life policy making involves. From these descriptions of the decision and policy making process, emerge their own suggestions for improving the quality of the process. Thus while Simon had in his earlier work demonstrated the extent to which `administrative man' fell short of the ideal of rational decision making behaviour, by 1960 he was outlining why and how administrative man could become more rational. [34]

This rests on a view of decision making which involves the activities of intelligence and design as well as the moment of choice, and which distinguishes between `programmed' and `non-programmed' decisions. The activities of intelligence involve finding occasions for making a decision, whilst those of design are reflected in the search for possible courses of action. As for the distinction between programmed and non-programmed decisions, the former are programmed to the extent that they are repetitive or routine and that definite procedures have been worked out for dealing with them. Non-programmed decisions, however, are novel or `unstructured' and may not be easily defined or complex. For such decisions there will be no specific procedure available for handling them, so decision makers will have to rely on whatever general capacity there is for intelligent, adaptive, problem-oriented action.

Traditionally, methods for handling programmed decisions have included habit, standardised operating procedures and organisational structures stressing specialisation and clear rules and roles for action in particular circumstances. Traditional methods for dealing with non-programmed decisions, have included the exercise of intuition, experience and creativity. Both are capable of improvement. For Simon, the key at the time was to improve the making of programmed decisions. This was to be achieved using the new tools of operational research, systems analysis, and mathematical techniques such as linear programming and probability modelling. Advances in computer technology were to assist in the automation of the most routine types of programmed decision making and eventually many non-programmed decisions could be handled in a similar way. Thus if more and more non-programmed decisions could be programmed, the top layer of the organisation would be able to deal in greater depth with its remaining unpredictable and intractable problems. Noticeably, Simon is not able to provide any further insight into the making of these latter sorts of decisions.

The most notable manifestation of the programmatic approach has been the `planning-programming-budgeting-system'(PPBS). [35] This was first used in the United States Department Of Defense and, since 1965, ostensibly applied by all domestic U.S. federal agencies as the chief formal approach to policy analysis. In the PPBS schema, one generally tries to identify the objectives of the agency,to relate costs and budgetary decisions to these objectives, and thereby assess the cost effectiveness of present and proposed programmes. By these means, the budget is intended to develop beyond both simple fiduciary and management control to the realm of strategic planning. Thus the annual routine of preparing a budget is converted into a "conscious appraisal and formulation of future goals and policies". [36]

Unfortunately, the practitioners of the programmatic approach have had to confront the limitations involved in attempting strict application of the techniques of PPBS, especially with regard to `big' problems. Indeed, Heclo quotes Robert Mayo, one-time Director of the Bureau of the Budget as follows:

> "we are not at the stage - if we ever will be of having a program category structure that will simplify in a substantial sense the problem of choosing among programs designed to serve different objectives". [37]

Moreover, "agreement on objectives has proven highly problematic even within a single policy area, such as education or law enforcement". [38]

Aaron Wildavsky has presented the most important contributions to the field of budgeting, in his various critiques of the programming approach and in doing so given empirical support to Lindblom's incremental thesis. [39] Unlike the economists and traditional students of public administration, Wildavsky is concerned with budgets as `political things'. [40] For Wildavsky, the budget lies at the heart of the political process and he hits out at what he sees as the overwhelming complexity of budgetary programs. Moreover, he considers the staggering burden of calculation these programs present and the imposing problem of making comparisons among different programs that have different values for different people. Further, he states that as an aid to the calculation of budgets, some budget officials use the incremental method. Thus

> "the largest determining factor of the size and content of this year's budget is last year's budget ... Budgeting is incremental, not comprehensive [and] special attention is given to a narrow range of increases and decreases". [41]

In Wildavsky's view it is the fragmentation of power which is characteristic of the political system of the United States which `makes budgeting possible'. Thus to alter fundamentally the existing budgetary process "one must alter in some respect the political system of which the budget is but an expression", rather than to try to reform the budgetary process in isolation. The latter is only likely to heighten conflict and increase the burdens of calculation, of which the level of conflict can be seen in terms of a question of values. Wildavsky argues that since the mitigation of conflict is a widely shared value in society, it ought to be realised that program budgeting is likely to affect that value. Therefore, future reform should imply a more thoroughgoing incremental approach rather than a comprehensive one. [42]

Wildavsky's position is bolstered by Heclo's remarks that, apart from the calculative problems mentioned above, PPBS has baulked at questions of redistributing costs and benefits "with a tendency to dismiss political issues as troublesome deviances from objective rationality". For Heclo, "analysis has lost touch with political reality" and the realisation of the deviance of actual from official practice in decision making, has led to the re-evaluation of PPBS by many of its major advocates. [43]

Criticism of Wildavsky's work has often centred on the question of `how large is an increment?' This is an issue which may or may not be trivial depending on how one understands the concept of incrementalism and on what aspect of the budgetary process is of concern. According to

Dempster and Wildavsky, the question signifies two types of confusion. [44] First, there is the failure to distinguish between incrementalism as a method of calculation and as a process of budgeting. Second, there is the failure to distinguish policies from bureaux. So, if one's interest is in budgetary problem solving, incrementalism as a method of calculation should be the focus. Alternatively, if the object of study is to find out whether an incremental method is actually being used, then it is the regularity of the increments or subtractions from past practice that is important. In this case, the focus will be on budgetary processes.

In order to clarify their position, Dempster and Wildavsky cite their concern as being with organisations involved in budgeting, not with policies, something which Natchez and Bupp saw as taking public policy out of budgeting. [45] This is a criticism that Dempster and Wildavsky do not deny, pointing only to the limited validity of Natchez and Bupp's findings (from one agency) and the costliness of doing research using policy as the unit of analysis, instead of agencies. Moreover, Dempster and Wildavsky claim that their earlier work was only explanatory in purpose, while their recent work focuses on change in the form of predictive theory. Hence now what matters is the regularity or irregularity of the relationship between the actors in the budgetary process, reflected in the regularity or otherwise of changes in the size of the budget. What is not of importance is the absolute amount of the changes. [46]

For Premfors, these statements are only of a clarifying nature, they do not "even pretend to provide an answer to the normative question concerning the desirability of small or large changes". [47] What Dempster and Wildavsky do say in this respect is that in the face of a perceived need for change, the expected costs of calculation - which were large enough before to preclude non-incremental behaviour - can now be commensurate with expected losses resulting from incremental decisions. In such cases, therefore, once it is realised that the existing state of affairs is undesirable and that the expected gains from change exceed the costs of calculation in expected utility, non-incremental decisions will result. This is not to say that more than a limited number of alternatives need rationally to be considered, nor that some of these need necessarily involve monetary outputs of a given size, large or small. [48]

In terms of the normative debate concerning the desirability and efficacy of incremental versus comprehensive methods of policy and strategy making, the contribution which has dominated has been that of Charles Lindblom. Heclo's view is that: "while `analytical' has typically been treated as synonymous with `rational choice models', the analysis [of Deutsch as well as Lindblom] is not particularly concerned with formal rationality nor with the act of choice; [the] analysis centers on dynamic patterns of interaction and adaptation". [49]

Given the situation of complexity and imperfect information which faces any individual decider, Lindblom argues for the value of a strategy emphasising incremental, sequential and repetitive attacks on a given problem. However, Lindblom expands his analysis beyond the conscious individual decider to encompass realistic relations among deciders and is thus able to consider policy which occurs as the unintended by-product of these relations. In short, Lindblom's concern is to show the valuable collective by-products produced by `partisan mutual adjustments' and to argue that many of the advantages claimed for central control can be just as well, if not better achieved through the dispersed interaction of partisans. Indeed, in tackling complex problems, one need turn away from the practice of incrementalism `only rarely', in order to `do better'. [50] So, Lindblom's thesis is simultaneously descriptive and prescriptive in nature and the strategy of `disjointed incrementalism' may be outlined as follows.

Instead of attempting a comprehensive evaluation of possible policies, decision makers and analysts take as their starting point, not the whole range of hypothetical possibilities, but only the here and now in which we live moving on to consider how alterations may be made at the margin. Incremental problem solving adapts to man's limited intellect, reduces the demand for information and takes into account the considerable costs of analysis. Disjointed incrementalism also adapts to the fact that policy problems are often `highly fluid' and that ends are adjusted to means unlike conventional views assert.

The strategy engages in `reconstructive analysis', continually redefining the policy problem itself. Policy makers and analysts engage in a never-ending series of attacks on slowly changing problems. Fundamental problems are rarely solved, at best they are alleviated. Finally, by adapting to open systems, through its remedial, serial and fragmented character, the strategy challenges a kind of `fallacy of composition' made by the adherents to the synoptic ideal. This fallacy implies that no analysis rises to a greater level of completeness than is possible for a single analyst or group of analysts. Thus Lindblom's thesis is based on the simple idea that `people can co-ordinate with each other without anyone's co-ordinating them', an idea borrowed from economics and transferred to the realm of politics. [51]

Reservations about Lindblom's work have centred on the suggested limited validity of the `muddling through' thesis and its tendency to reinforce conservative pro-inertia and anti-innovatory forces. [52] For Dror, unless three interrelated conditions are concurrently met, the incremental method will not be an adequate one for making policy. These are: 1) the results of present policies must be in the main satisfactory, (to policy makers and society) so that marginal changes are sufficient for achieving an acceptable rate of improvement in policy results; 2) there must a high rate of continuity in the nature of problems; 3) there must be a high degree of continuity in the means available for tackling problems.

Thus if the results of past policies are undesirable, it may be preferable to take the risks involved in radical departures from existing policy. Also, if there are no past policies in relation to a particular issue, or if the problems to be faced have quite novel characteristics, incremental change may, in fact, be impossible. Finally, changes in knowledge or technology may put new means of action at the disposal of the policy makers, which unless ignored, lead to radical new policies. Dror's view is that the three conditions mentioned above are most likely to prevail where there is a high degree of social stability. Even here, however, many issues are tied up with rapid changes in aspirations or the means of action available, so that a different method of policy making, other than `muddling through', is required. [53]

A similar conclusion is reached concerning the validity of the incrementalist approach arising from Dror's examination of the reliance on agreement on policy as the main criterion of the policy's quality. The objection is made on the grounds of the likely danger of substituting agreement for the examination of the consequences of policy. In particular, under conditions of high rate change, ignorance can produce agreement upon a catastrophic policy, there being no background of shared experience to serve as a basis for consensus on policy. Above all,

> "the formula that `agreement' equals `high quality' is the more dangerous because of its appeal to a value highly regarded in democratic ideology".

Hence Dror's concern about the impact of `muddling through' in reinforcing conservatism in policy making. [54]

Dissatisfied with both rational comprehensive and incremental models, Dror offers his own Normative Optimum model. [55] This stresses the possibilities of making procedural policies for making policies more rational. The term he later coined for this was `meta-policy making'. This is based on the following assumptions: 1) optimum policy making involves an effort to increase rationality content, through more explication of goals, extensive search for new alternatives, conscious attempts to elaborate expectations, with an explicit cut off point, and some formulation of decision criteria; 2) extra rational processes play a significant role in optimal policy making on complex issues, owing to limits to rationality and the positive contribution made by intuitive judgement and the creative invention of new alternatives; 3) these extrarational processes can be improved by various means including case discussions and brainstorming, while rational processes can be improved by increasing the knowledge of policy makers and the time they have to operate in, for instance; 4) actual policy making tends to follow precedents.

If this involves using the incremental method, a lag may be created between policy making practice and changes in aspirations or the problems faced by policy. This can and should be improved, says Dror, in ways that echo the work of Simon. However, Dror's prescriptions, especially where the role of intuition and experience are concerned are vague and, according to Smith and May, the model verges on the tautologous. Essentially, it does little to settle the dispute between the rationalists and the incrementalists. [56]

Etzioni, too attacks the incremental approach for being too conservative. For him, it ignores the underprivileged and politically weak collectivities and neglects and can provide no explanation of major, non-incremental, `fundamental' changes in policy direction. In Etzioni's view it is a mistake to relegate non-incremental decisions to the category of exceptions, for it is these which set the context within which incremental decisions will be taken. Thus, in Etzioni's own `mixed scanning' model he distinguishes between a "high order, fundamental policy-making process which sets basic directions" and an incremental process which "prepares for fundamental decisions and revises them after they have been reached". [57] Here, policy makers ought to spend some of their time scanning the environment for issues, near and far, which might require attention as well as attending to everyday operational details.

More specifically,

"the policy maker ought to consider all the main alternatives for such [fundamental] choices, trying to eliminate those options which reveal crippling objections [and] the implementation of a fundamental decision is to be flexible and serial ... scanning should search for problems which its implementation is causing". [58]

Collingridge and Douglas's critique of Etzioni's mixed scanning model points to the way it `collapses' into incrementalism and, similar to synoptic rationality, makes too great a demand of our limited expertise. [59]

Another attempt at formulating a `third' approach to policy making, while criticising incrementalism, is that of Gershuny. [60] Gershuny suggests that the concept of rationality be reformulated so that the requirement for a social welfare function be removed. Instead, the policy makers' own preferences should be substituted, thus paving the way for a mixed scanning strategy such as Etzioni's or Dror's by appealing to the concept of `limited rationality'.

This notion of rationality requires policy makers to choose those policies which best suit their own preferences, except where more than one such optimum exists, in which case choice among elements of this optimal set should be made on the basis of the preferences of groups whose values differ from those of the policy makers. This is not to specify the technique by which policy is actually made, but is a criterion by which particular policy making strategies may be judged, it is claimed. Such a criterion requires comprehensive consideration of alternatives as a basis for selection of rules of closure, on one hand, and detailed consideration of an appropriately limited subset of the available options, on the other. Only mixed scanning can serve as the strategy for the ideal. Gershuny is quick to point out that mixed scanning is only a logical resolution of the problem of rationality. It still leaves the sociological problem that organisations do not behave in the demanded by the mixed scanning model. In particular, the need for malleability in the organisation of decision making bodies is frustrated by `goal displacement', which signifies increasing resistance to change.

Others, (such as Goodin and Waldner, Schulman and Mushkat, for example), have pointed to the likely difficulties of `threshold' (and `sleeper') effects. [61]

Thus small changes in inputs may produce incremental changes in outputs until a threshold is crossed, whereupon the change in outputs is markedly non-incremental. Hence, to ensure the success of policies subject to such effects, a great deal of commitment or some overall theoretical vision on the part of the policy makers may be required.

Schulman cites the example of the NASA space exploration programme as being one which is characteristic of this type of `indivisible' policy making, and which could not have been made incrementally. However, as yet there does not appear to be a rival model of non-incremental policy making, capable of making these kind of decisions any more successfully than under the incrementalist approach. The point is further underlined when one considers, for example, the various expensive and fatal technical errors which have seriously blotted NASA's copybook, including the Apollo and Space Shuttle accidents.

Additional evidence of the pitfalls of pursuing non-incremental strategies is provided by the experience of David Stockman. Stockman was Director of the Office of Management and Budget during the first half of the 1980s, in the Reagan Administration. His `Grand Doctrine' formed the cornerstone of `Reaganomics', a brand of supply-side economics having the aim of turning back the `tide' of `Big Government'. [62] Anti-Statist economic policy was to be implemented by way of huge reductions in taxation and government expenditure simultaneously. In doing so, an inherited budget deficit of $100 million in 1981, was intended to be transformed into a balanced budget only three years later, with budget surpluses to follow. What actually occurred was the accumulation of a trillion-dollar national debt over a period of five years, which still bears important consequences for the well-being of the world economy. The moral of the story lies in the performance of previous incremental national economic policy, characterised by relatively small adjustments in taxation and by political bargaining with interest groups over the various areas of budgetary allocation (defence, social welfare, and so on). Whilst far from perfect in terms of the efficient use of public resources, the operation of such policies had at least the virtue of being adjusted to the political realities of state budgeting and the limited comprehension of politicians and economists alike of the complexities of national economic management.

In 1979, Lindblom clarified his position. [63] Now, he sought to distinguish between `incremental politics' and `incremental analysis'. In its core meaning, incremental politics is a political pattern where change occurs in small steps, regardless of the method of analysis. (The size of the steps can be arranged on a continuum from small to large). Incremental analysis can have three meanings. Simple incremental analysis refers to analysis which is limited to policies which differ only incrementally from the status quo. Disjointed incrementalism is the more complex method described above and, finally, strategic analysis denotes any calculated or thoughtfully chosen set of stratagems to simplify complex problems, that is, to short-cut conventional `scientific' analysis.

In defence of incremental analysis, Lindblom acknowledges the objection that better forms of analysis can possibly be found, but states that the synoptic method is not that better form of analysis, nor even a useful norm or ideal. In defence of incremental politics, `to which incremental analysis is nicely suited', Lindblom maintains that it is not in principle slow moving, or a tactic of conservatism. Moreover, a series of small changes can accomplish more than infrequent major changes.

This is something Etzioni has recently disputed, and as long ago as 1964, Boulding had noted that disjointed incrementalism could lead "step by little step to colossal disaster as well as to substantial achievement". [64]

However, Lindblom's later writings do recognise more explicitly the limits to incremental politics and partisan mutual adjustment as he attempts to relate his thesis to issues of political-economic organisation. In particular, it is big business and its privileged position in market economies which prevent the really important issues from being seriously considered.

In the field of technology policy, support for the prescriptions of incrementalism has come from the empirical work of Morone and Woodhouse [65] and Lovins and Lovins. [66] Morone and Woodhouse have focussed on the task of averting environmental catastrophe, considering the existing strategies which have been employed to minimise such risks in five key areas within the United States: toxic chemicals, nuclear power, recombinant DNA research, threats to the ozone layer, and finally, the greenhouse effect. To varying degrees, these cases revealed five strategies for coping with the potential for catastrophe. [67]

The first of these strategies involved protection against the potential hazard, on the basis that since errors are inevitable then the main priority is "to protect against the worst consequences that might result from errors". Various tactics for achieving this strategy included, on one hand, the prohibition of the use of the risky technology, and on the other, `catastrophe mitigation', where the accident occurs and steps are taken to reduce its effects. Between these two often impractical and incomplete extremes, a combination of three intermediate tactics became necessary. Thus limits on use, the prevention of the most serious effects of any errors made or the containment of the effects of what might otherwise be a catastrophic incident have had to be employed.

Since the likely consequences and severity of a hazard are difficult to ascertain in advance, it is difficult for decision makers to know just how stringently protective measures should be applied. Morone and Woodhouse thus cite a second strategy which was being followed in the aversion of catastrophe as being to proceed cautiously. Hence, in the case of nuclear power,

> "it would have been possible to be less cautious and require that [reactor] containment designs withstand only the most likely accidents. Instead a more conservative approach was taken: assume the worst and design to withstand it". [68]

The remaining three strategies involve the testing of the potential risks of the hazard, learning from experience and priority setting. Essentially, the strategy of priority setting provided a framework for testing and monitoring experience. In the five cases considered by Morone and Woodhouse,

> "the possible risks were so numerous and varied that it was impossible to evaluate all of them at once. Regulators had to set priorities for which risks to study, and at any given time, they focused attention on only small subsets of the possible hazards". [69]

In terms of the relevance of the literature on decision making to practice as witnessed in their case studies, Morone and Woodhouse have this to say:

> "The type of decision making apparent in our cases does not entirely fit either the analytic or the strategic [i.e. incremental] approach but is clearly much closer to the latter. The decision makers in these cases exhibited a more deliberate and evolved form of the strategic model than the literature predicted. While these decision makers did employ certain elements of the analytic approach, it was typically in support of strategy rather than in its stead". [70]

Building on these observations, they advance their `strategic approach to improved risk management', comprising the following four steps. [71] The first measure within Morone and Woodhouse's prescription is to attack `egregious risks', meaning those risks which are clearly worse than others, even after making some allowance for uncertainty. Secondly, policy makers should seek and employ policy alternatives that "transcend or circumvent risks", by employing creative compromise, making technical corrections and paying attention to opportunities for risk reduction. A third step in improving the efficiency and effectiveness of the catastrophe-aversion system is the development of prioritised research strategies so as reduce key uncertainties. Fourthly, policy makers ought to be

> "actively prepared to learn from error, rather than naively expecting to fully analyse risks in advance or passively waiting for feedback to emerge". [72]

Morone and Woodhouse later produced a study more specifically to do with the demise of nuclear power in the United States. [73] This concentrated on the question of how earlier successes in the management of policy in this area had turned sour. Essentially, they give two reasons for this. One of these relates to changes in safety strategy which occurred in the mid-1960s, primarily involving a shift from the consideration of containment tactics to a strategy based on attempts to `engineer safety' into nuclear reactors. Focusing on prevention in this way came at the expense of future research into smaller reactors which at the time had the potential to be `inherently safe'. The situation was exacerbated by the setting in of `technological and intellectual inertia' during the 1960s, whereby alternative reactor types to the light water variety were no longer seriously considered. [74]

Based on a wide range of case studies designed to expose the United States' vulnerability to disruptions in various areas of its energy supply, Lovins and Lovins state their proposals for the development of a `resilient' energy supply system. [75] Inherently, such a system should consist of: a). numerous, relatively small modules with a low individual cost of failure; and b). short, robust links for the delivery of energy to its users. [76] They contrast their prescription (which involve a move towards more decentralised, renewable energy supplies) with their view of the complex and centralised existing U.S. energy supplies system. The current approach is something which they picture as representing a vain attempt "to build high technical reliability into modules so large that their cost of failure is unacceptable". [77]

Their own philosophy, however, "accepts the inevitability of failure and seeks to limit the damage that failure can do". [78] Finally, the cost of failure or disruption in current U.S. energy systems is related to such attributes as the inflexibility of energy delivery systems in terms of their lack of ability to deal with fluctuations in demand by adapting volume carried (or throughput) or the speedy construction of new facilities. Other similarly important attributes exacerbating the cost of energy supply failure include the high capital intensity, long lead times and specialised labour and control requirements demanded by the technology of major energy facilities. [79]

Collingridge has arrived at similar conclusions to both Morone and Woodhouse and Lovins and Lovins, although he has much more explicitly set out to test the incremental prescription. As such, his work will be considered in greater detail in the following chapter.

Further support for incrementalism, this time in the more specifically management sphere, has come from Quinn, although this has not been without some modification to the incremental thesis. [80] In a way similar to the above, Quinn bases his prescriptions on his observations of real-life strategic change and how this is managed in large organisations. What Quinn advocates is a process of `logical incrementalism', based on his findings that successful strategists purposely guided important actions incrementally toward strategies embodying many of the structural principles of elegant formal strategies.

In the companies concerned, the approach was not `anti-planning'. Indeed, formal planning was usually an essential building block in the step by step process executives used to develop overall strategies. However, for reasons such as the need to keep future options open, or to secure individual and organisational commitment to new strategies, the decision makers relied on more evolutionary practices than the rational model would usually imply. In this way, successful managers operating logically and proactively were able to sow the seeds of identity, commitment and understanding into the very processes which created their strategies.

Careful incrementalism, therefore, allows strategists to improve the quality of information used in decisions and deal with the practical politics of change, while building the organisation's momentum toward the new strategy and the psychological motivation to carry it through. In short, logical incrementalism is for Quinn, "a purposeful, effective, proactive management technique that is capable of improving and and integrating both the analytical and behavioural aspects of strategy formulation". [81]

The main difference between Lindblom's position and that of Quinn rests with the wider generation of alternative courses of action, in the latter's brand of incrementalism. Hence, in Quinn's strategy, some alternatives can vary greatly from present policies. Here, as issues and possible strategies become clearer, `persuasive data' about the options is collected. Only when the decision makers are confident that support exists for a particular option, is one selected and announced. The process can so skilfully be managed that even radical changes never emerge `full grown' and appear more as tactical adjustments. In this kind of situation, advocates are cautious not to alienate allies, to carefully co-opt or neutralise strong opponents and to seek out `zones of indifference', where changes can be implemented without activating the opposition. At the heart of it all, is a process of learning and readjustment which enables the organisation to keep itself in line with changes in its environment. [82]

In considering the incrementalist model, Johnson has noted some of the difficulties associated with the development of normative theories. [83] For example, while he does not deny that an incremental pattern of strategy is discernible in many organisations, there are many other explanations as to how such patterns of development came about. Unfortunately, the whole idea of `logical incrementalism' can be seen as a "rationalistic interpretation of processes that can be accounted for in quite different ways". In particular, Quinn's belief in the prescriptive value of logical incrementalism, "means that it is not always easy to disentangle what he has discovered empirically from what he would like to see". [84]

With this in mind, Johnson warns that care is needed in building too much upon what managers espouse. Thus because they espouse the idea of logical incrementalism does not mean they behave in such ways, nor that normative models should be built upon such espousal. Explanations of management and such lessons that can be drawn, should instead be based on the empirical investigation of practice in the political, cultural and cognitive arena that organisations are. Like Smith and May, Johnson appears to be casting doubt on the utility of expending any more intellectual energy on the development of a priori `models' of decision making. What, following Chaffee, has been labelled the `interpretative mode', comprises research reporting and assessing the role of cognition and culture in strategy formulation. [85] Hence, Johnson argues that strategy is the product of the "political, cognitive and cultural fabric of the organisation".[86]

In his longitudinal study of three domestic retail clothing firms, Johnson found that the espousals of logical incrementalism on the part of the managers interviewed, served only to disguise the system of management revealed on closer inspection. Thus in meeting complex situations, organisational action could be better explained in terms of the cognitive maps of managers and how these maps related to their perceptions of the environment and their strategic responses. Playing a central role in the interpretation of environmental stimuli and configuration of relevant strategic responses, was the organisational `paradigm', or

> "the set of beliefs and assumptions held relatively common through the organisation, taken for granted and discernible in the stories and explanations of the managers". [87]

The relevance of this can be demonstrated by Johnson's findings that the managers in his study believed they were managing logically incrementally, but were not aware that this did not necessarily mean they were keeping pace with environmental change. Gradually, `strategic drift' set in eventually requiring `global' change, in order to avert impending disaster. The normative implications of this involve the need to maintain a `constructive tension' between that which must be changed and that which must be preserved and the need to build ideological heterogeneity into management systems. [88] Suggestions for achieving the latter include the adoption of organic management styles with a reduction of hierarchical lines of communication or reporting and the active involvement of outsiders with less adherence to organisational culture or paradigm. [89]

With respect to the last point, Grinyer and Spender note the existence of industry-wide patterns of managerial belief or `recipes' to which individual companies can compare their own. [90] In the face of failure, obsolete recipes may be replaced, through the innovation of new recipes drawn directly from other recipes with which the senior management is familiar. Alternatively, a currently successful recipe may be brought in by a new chief executive with a track record in the industry, though there is no guarantee that this will itself be viable in the face of new environmental conditions.

Grinyer and Spender are careful to note that recipes have "a generality that ensures that [they] can seldom be a prescription for action" and that the

> "strategic decision process must remain at the level of the firm, reflecting its policy objectives, limited resources and historical position". [91]

It is just that the outcome is a plan whose fundamental rationality is shared within the industry, beyond the specific company.

It is to be hoped that by now some of the issues and problems of prescriptive theorising in the areas of public policy and strategic management have been reasonably outlined, particularly at the level where complexity in decision making is at its most severe. Although this has been by no means an exhaustive survey of the literature, it should be clear that there are a variety of perspectives which can legitimately claim some accuracy in representing at least some part of the process of policy and strategy making. This, of course is nothing new, but lends support to the message of those such as Allison [92] and Morgan [93] who argue that researchers and managers can profitably conceive of organisations in different ways by using different `conceptual lens' or `metaphors', respectively.

In doing so, the albeit limited importance of rational approaches is not further diminished, but as Johnson has said it is placed in context arguably making this view all the more useful. One might add that the other main prescriptive approach to policy making, that is the incremental model, similarly would benefit from the conduct of empirical analyses recognising the peculiarities of context and time. The way forward would seem to be to follow the path of Popperian ideas of the advancement of scientific knowledge. [94] Bold statements should continue to be made concerning the nature of decision making processes in public policy and/or strategic management, and the way in which decisions in these areas should be made. These `conjectures' can then be the subject of refinement or even rejection following testing by observation, a procedure which forms the backbone of this thesis' methodological approach. Indeed, the following chapter seeks to explain how such an approach is to be used in attempting to evaluate the prescriptive merits of incremental politics. In particular, this involves the consideration of the rules for success laid down by incremental politics for the management of technology, providing a basis for the later discussion of whether North Sea oil technology contravenes these rules in the interest of relevant agents.

NOTES.

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CHAPTER THREE

METHODOLOGY

3.1 Introduction.

Thus far the major objectives and scope of the thesis have been identified and the case argued, mainly on theoretical grounds for the adoption in practice of incremental approaches to policy making. Henceforth, the task to be performed will be concerned with examining the prescriptive claims, advanced earlier in Chapter 2, that incrementalism represents a better tool for dealing with complexity and uncertainty in policy making than its rivals. Essentially, this is to be achieved by way of an empirical test which attempts to falsify the apparent success of a non-incremental policy. As indicated previously, in the first chapter of the thesis, the case of North Sea oil field investment provides the focus for the empirical work which follows in subsequent chapters. Here, the intention is to establish and lay the methodological foundations upon which the remainder of the thesis is to rely.

The chapter is structured in the following way. Firstly, it is appreciated that different approaches to science and social science are underpinned by various assumptions concerning epistemology, ontology, methodology and human nature. [1] Whilst the intention is not to enter into prolonged discussion about competing philosophies of science and social science, it is necessary to locate falsification as a tool for testing rival theories within the terms of this debate. Secondly, it is recognised that to state that the main object of study is to attempt to falsify non-incremental politics may be to beg questions of a definitional nature. Hence, the concept requires clarification.

Similarly, it is necessary to be clear about the meaning of what it is to act 'non-incrementally'. Some of this ground may already have been covered in the previous chapter, though on this occasion the concept of non-incrementality is to be explored in the course of explaining the nature of the test to be performed. Another essential element in the effort to falsify the success of non-incremental politics is the concept of technological inflexibility. This is applied to an analysis of North Sea oil technology and together with an evaluation of the performance of North Sea oil technology may constitute the grounds on which the validity of the incremental thesis may be reconsidered. Finally, more specific methodological issues are addressed. These include the nature and source of the data, the method of analysing that data, plus guidelines for interpreting the results of the analysis within the general framework of the thesis as a whole.

3.2 The Nature Of Social Scientific Inquiry.

An interesting aspect of the potential contribution which social science can make to policy practitioners concerns the way in which the quality of its products might be improved. Essentially, the position adopted here is underpinned by a Popperian view of the philosophy of science, which is deemed to be applicable to social science in general and, closer to home, to political science and to the methodology which this thesis employs. [2]

For Popper, whether in qualitative or quantitative terms, the most important source of knowledge apart from inborn knowledge, is tradition in the form of learning, taking criticism or respecting 'truth'. Nevertheless, there are no ultimate sources of knowledge and each source or suggestion is open to critical examination. Popper declares that a typical procedure for doing so is to examine or test an assertion and whether theory is consistent with observations made. [3] Indeed, Popper's suggested methodology for the testing and evaluation of rival scientific theories lends support to the idea that scientific theories may be tested by being subjected to falsification and rejection.

For those who seek truth, therefore,

> "scientific conjectures must be submitted to assessment by a methodology which ensures that all can receive criticism and that any may finally be rejected".[4]

Popper's 'supreme rules of methodology' fulfil this requirement by stating that all other rules of methodology are to be designed so as to ensure that no scientific claim is immune from criticism and rejection. Moreover, this condition provides Popper with his criterion of demarcation, which states that a claim is scientific only if it is possible to falsify it empirically. [5]

In tracing the sources from which knowledge is derived and providing a criterion of demarcation between 'scientific' and 'pseudo-scientific' statements, Popper's theory develops the theme that it is possible to learn from one's mistakes. [6] It is a theory which assigns to rational arguments the role of criticising the often mistaken attempts at problem-solving. Also, it is a theory of experience which assigns to observations the equally important role of tests which may help in the discovery of mistakes. At root, it is a theory asserting that knowledge and especially scientific knowledge, progresses by unjustified and unjustifiable anticipations, guesses or conjectures. [7]

Thus, "the scientific process is a process of conjectures and refutations". A hypothesis is put forward and the predictions deduced from this hypothesis are tested against the facts, with the aim of refuting the theory. A theory is never verified; at best it is well corroborated, the reverse being its falsification. Moreover,

> "scientific honesty no longer means verification but continuous criticism. Progress is made ... only if we recognise our errors and use them critically instead of persevering in them dogmatically." [8]

The procedural parallels between falsification and disjointed incrementalism should be apparent from this and it should be of little surprise, therefore, to learn that Popperians see the actual practice of science as the reflection of Popperian methodology in action. [9] If this were not so, then any of the success of science in real world decision making may have to depend on coincidence or accident for its explanation. In this way, the normative aspect of incrementalist theory becomes primary, since its success in describing actual decision practices depends on an initial clarification of what practices ought to be followed. [10]

3.3 Testing Incremental Politics.

The principal contributions to the advancement of the incrementalists' cause have, in the main, failed to test the theory's normative claims rigorously. Until quite recently, empirical research has been lacking, both in the sense that it was simply not being carried out and also in that when it was being conducted it was flawed methodologically or its prescriptions were vague or impracticable. For instance, the work of Lindblom [11] is seen by many as seminal and has sought to champion the prescriptive message of the incremental approach. Yet, in developing his ideas, Lindblom relies on his acute powers of observation and reasoning, there is no systematic empirical research to support or deny his claims.

As for Quinn [12] the evidence that he gathers in support of what he calls 'logical incrementalism' is of an admittedly positivist nature, in methodological terms. Interviews with 'top management' in nine 'multiple billion dollar' companies, appear to confirm the application of incremental techniques in situations calling for 'significant changes in strategy'. [13] Unfortunately, the validity of Quinn's contribution suffers, for a number of reasons. First, there is the matter of the introduction of bias into the data because of the restricted number of companies and individuals chosen to study and question. Secondly, there is the likelihood of post-hoc rationalisations of strategy by the latter. However, a still greater sin is that, quite simply, Quinn's study tells little of any real interest. True, it may be quite nice to know that certain actors have enjoyed success using the incremental approach. Yet, it would seem that a far more valuable contribution may be had if one considers the limitations of the theory in terms of the potential for success that there might be when trying or having to follow another rival prescription.

Fortunately, the balance has been somewhat redressed by the work of Morone and Woodhouse [14], the research of Lovins and Lovins [15] and in still more rigorous fashion by Collingridge. [16] Morone and Woodhouse's research into the political and economic failure of nuclear energy in the U.S. serves as test of the prescriptive claims of incremental politics, even though this was not what the aim of their studies was. For a while, inflexible technology appeared to be operating in a satisfactory way, until the problems of too rapid scale-up and the costs of safety measures invited economic, if not physical catastrophe. Although also using a case study approach, the work of Lovins and Lovins employ a less sound methodology in offering support to the incremental prescription. This is so because they are appealing to the potential danger of large-scale and complex technologies, effects which have yet to be realised. Since the failure of such technologies belong to the future, one either must consider them to be a success, so falsifying the thesis that the use of non-incremental technology will frustrate success in policy, or decide that perhaps their development has been more incremental than previously acknowledged. The former is totally at odds with what Lovins and Lovins are suggesting, whilst the latter would represent another successful case of incremental politics, adding little to knowledge.

By modifying Popper's methodology towards his own 'critical decision theory', Collingridge develops and conducts a test for 'partisan mutual adjustment'. This is the version of incrementalism which stresses the importance to policy making of the dispersal of information gathering activity and of promoting consensus between actors (or partisans) in the policy process. In the Collingridge framework, partisans may be governmental or corporate in character; they may also represent special interest groups or regulatory agencies.

Essentially, the methodology employed within this thesis, follows that which underpins Collingridge's test.

For Collingridge, there are basically two ways of dealing with the discovery of a set of choices which cannot be made in the way prescribed by a general theory about how decisions ought to be made: [17]

a). If the decisions causing the problem seem to be perfectly ordinary ones, then the theory will be judged to be inadequate, for it fails to lay down rules for the making of these straightforward choices; or

b). Keep the theory and show that there is something abnormal about the class of decisions to which it fails to apply.

Collingridge takes the latter option in retaining partisan mutual adjustment, by showing that decisions about nuclear power are so aberrant as to make them inherently difficult to manage. In this way the outcome is success for partisan mutual adjustment rather than its abandonment. [18]

Substituting incremental politics for partisan mutual adjustment, the formalisation of Collingridge's test may be set out in the following manner:

1. Incremental Politics - If an agent wishes to further his or her own interest, then all decisions should be made by the rules $R_1 \ldots R_N$.

2. Decisions to invest in items with features F cannot be made by the rules $R_1 \ldots R_N$.

3. A technology T has features F.

1.2.3. entails 4.

4. If decisions to invest in a technology T further an agent's own interests, then

Not (incremental politics).

If from statement 3 it is found that technology T has features F, then by 2, decisions about investing in it cannot be made by $R_1 \ldots R_N$. If such investment decisions further one's own interests, then this cannot be because they are made by the rules $R_1 \ldots R_N$, in contradiction to incremental politics by 1. If technology T is regarded as any other technology, then it will certainly be possible for decisions about investing in it

to serve the chooser's interests, in which case incremental politics will have to be given up.
Putting this formally:

5. Deciding to invest in technology T furthers an agent's own interests

4.5 - Not (incremental politics).

Thus 1.2.3.5 amount to the success of non-incremental politics, in contravention of the prescription of incremental politics. However, if any such success can be falsified, then the validity of the incremental model may be salvaged. This would result if it could be argued that investment in technology T has involved such incalculable risks or expense that it has not served in anyone's interests i.e. if the contrary of 5 can be shown, as follows:

6. Deciding to invest in technology T does not further an agent's own interests.

If 6 is accepted, then 1.2.3. pose no problem for incremental politics. Collingridge then strengthens the test further by arguing for 6 indirectly through the general assertion

7. Deciding to invest in items with features F does not

further an agent's own interests, so that

3.7 - 6.

(N.B. F = inflexibility, the meaning of which is considered in detail below).

To reiterate briefly, the test involves holding up incremental politics as the model which best suits policy makers if they are to achieve their own interests. Then in an essentially Popperian manner, the theory will be subjected to criticism, through the attempted falsification of the success of a non-incremental policy. In other words, if a non-incremental strategy is found by experience to be better than incremental politics in serving the policy makers' interests, then the validity of the latter approach will be weakened. Notably, there are few empirically based studies supporting strategies other than incrementalism which would lead to an abandonment of the approach. However, should the success of a non-incremental method be falsified, then continued support for incremental politics would be warranted.

With respect to the North Sea oil case, there are a number of important questions which have to be dealt with in relation to the above. These will be addressed during the course of the thesis. The first of these concerns whether the North Sea case involves technology which may be said to possess features F, in other words, is the technology inflexible? This is a matter dealt with in Chapter 4 on the nature of North Sea technology. Another important issue is the identification of the 'agents' in the case. After all, it is the degree to which their policy objectives are successfully attained which is at the heart of the thesis. (See Chapters 5-7). Finally, and connected to the previous point, what are the criteria for success which need to be taken into account in the evaluation of policy? Moreover, are there any particular cases where such criteria have been met with respect to each agent? (Again, see the thesis' latter chapters).

In performing this test, the definition of incremental politics will also need to be clear. As used here, it denotes incrementalism as a political pattern, where political change is and ought to be in small steps, in order to be successful. Thus policies are adopted only where they differ marginally from the status quo, in preference to large-scale, non-incremental leaps in the dark, the cost of which may be much more difficult to remedy. Such change does not necessarily have to be associated with an incremental analysis of various policy options or with decentralised, pluralistic policy making processes as some versions of incrementalism might insist upon.

Here, it is simply the size of the change that matters and for that reason the focus will be on the prospects and problems involved in the adoption of non-incremental options which cannot be made according to the rules of incremental politics. Thus the topic of concern is not with the way in which alternative policies are or ought to be analysed, prior to the making of a decision. Rather, the attention centres on the issue of whether or not non-incremental changes can lend themselves to successful implementation. Such cases which are found to do so add to the weakening of the validity of the incremental approach.

An essential aspect of the test involves the notion that incremental politics is not a model capable of making decisions to invest in policies involving inflexible technologies. A consideration of the nature of the features which promote such inflexibility may be helpful in understanding why this should be the case. Again, much is owed to the work of Collingridge who has suggested four physical properties that together may establish a technology as inflexible. These features are long lead time, large unit size, capital intensity and dependence on specialised infrastructure. [19]

Lead time (or construction time) refers to the length of time in which problems with the technology may be detected and to the rate at which any required learning may take place. In the case of nuclear power plant, British experience with Magnox reactors involved lead times of seven to eight years. Only after this period could capital costs be known and a figure for the load factor during the first year of operation be calculated. Learning was quite slow and painful, therefore. [20] This was not helped by the large unit size of the Magnox stations, with only nine stations each built with two reactors, coming on stream between 1962 and 1971. So, there were just nine occasions where testing of forecasts of capital costs and load factors could take place. Moreover, the fact that the first two stations exceeded capital cost expectations by 25% could not be taken as any sort of guide as to the cost performance of subsequent stations. [21]

Capital intensity refers to the degree to which capital costs are 'sunk' prior to the technology becoming operational; inflexible technologies such as nuclear plant or high-rise buildings are capital intensive in the sense that little money can be saved by abandoning them. Figures for high rise blocks suggest that two-thirds of their lifetime costs are sunk with the remaining one-third representing costs such as maintenance, servicing and so on. Demolition therefore saves only a third of the cost of a building. [22] Capital intensity, therefore may be represented as follows:

$$C = \frac{CX}{TC} \%$$

Where:

C = the capital intensity of a technology

CX = the capital costs incurred over the lifetime of a technological project

TC = the total lifetime costs of the project, comprising the total capital costs plus total operating costs.

The infrastructure of a technology is the technology needed for its operation but which serves only this purpose. [23] In the Magnox case, for example, the infrastructure consisted of mining the uranium ore, producing uranium metal, fuel fabrication and reprocessing, and waste handling and disposal, among other things. [24] In the high-rise building case, infrastructure involved the construction of special plant and factories and transporters for pre-fabricated units; cement does not count as infrastructure since, although it is essential to high-rise building, there are plenty of other uses for the material. [25]

3.4 Investigating Success In North Sea Oil Policy.

At first glance, North Sea oil appears to be an example of great success in the employment of inflexible technology. As such it is a case capable of providing a stiff test for the thesis that such technologies are bound to face severe problems. Whether or not this proves to be the case on closer inspection, the consideration of a case of this kind will do much to counter the view that existing cases tend to provide incrementalism with protection from any criticism. Hence to examine a much more threatening case where it appears that a highly inflexible technological project has been very successful, contradicts the view that only troublesome inflexible technologies recieve any attention. This would also be to comply with Popper's rule that any attempt to support a scientific claim by evidence must risk criticism or falsification.

However, there are certain very important issues to be addressed relating to the appraisal of the performance of policy as part of the test described above. Whereas the inflexibility of a technology may be defined with reference to the physical properties already mentioned, the concept of a successful policy i.e. one which furthers the interests of an agent is a little more tricky. Since the case of North Sea oil appears to be one where the inflexibility of the technology is fairly clear-cut (see Chapter 4 for a discusssion of the nature of the technology employed), questions concerning the evaluation of performance and whether outcomes have satisfied the interests of the agents involved are primary.

The issue of what constitutes success in oil policy has been addressed by Robinson in terms of developing a greater understanding of the nature of governmental interests in the conduct of North Sea oil affairs. [26] This matter is discussed in more detail in the chapter on government policy in this thesis. For now, however, the position adopted with regard to the evaluation of performance and the interests of the relevant agents (i.e. governments, companies and society in general), is as follows. Generally, the focus is on North Sea oil technology, viewing its performance in project appraisal terms. Therefore, it is assumed that all relevant actors share a common interest in wishing to reduce the costs of field development, especially if one allows for the relative timing of financial inflows and outflows.

An assessment of the performance of the technology may be made, therefore, by using discounted cash flow analysis to arrive at estimated economic returns generated by the technology, before this value is split between the companies and the Treasury. In doing so, the failings of discounted cash flow for project appraisal are recognised, so too are the limitations of focusing only on narrow economic returns. Nevertheless, the use of discounted cash flow is less of an issue in studies involving hindsight and thus with more data on performance than would otherwise be the case. Similarly, if investments in North Sea oil are not good projects in narrow economic terms, then they are not likely to be any better when externalities such as pollution costs are taken into account.

Concentrating on the performance of the technology of North Sea oil has its advantages. Firstly, this type of approach avoids the pitfalls of attempting to delve behind the technology to consider the nature of the policy making process from which its adoption had stemmed. It is, however, recognised that technology involves a complex web of interactions between hardware, institutions, individuals and society as a whole. Yet it always includes 'machinery' and the inflexibilities caused by the physical components of technology are much more straightforward and easy to comprehend than those arising from institutional and social aspects, such as organisational inertia, cultural lag or the unwillingness of interested parties to admit to error. [27]

The economic performance of North Sea oil will be examined largely from public and semi-public sources, supplemented where necessary by unstructured interviews. Two particularly valuable and reliable sources are the Department of Energy's 'Brown Book' and County NatWest Woodmac's North Sea service, both annual publications. [28] The various volumes of these periodicals contain information obtained from a wide range of corporate and governmental sources, with the Woodmac studies providing individual field production, cost and revenue profiles given in money-of-the-day terms.

Lifetime field performance is assessed by considering historic and future estimated cash flows for various fields in real (1989) terms, on a pre-tax basis (i.e. gross revenues minus capital and operating costs is equal to cash flow). The annual cash flows are then discounted at a rate of 15% to give present values for each of the fields (the subject of choice of discount rate is taken up again in Chapter 6 of the thesis). In addition to this historically based appraisal of performance, other scenarios are developed based this time on: a). a rate of growth in nominal oil prices of 2% per annum above prevailing rates of inflation from 1972 onwards (converted to 1989 sterling terms); and b). a constant real (1989) price of £10 per barrel over the lifetime of each field's activity.

Details of oil prices are based on Woodmac data of the price of Ekofisk crude up to 1976; subsequently, the 'marker' price as given by BNOC for first Forties and then Brent blend is used. From mid-1985 onwards, the spot price for Brent crude at Rotterdam is applied to revenue calculations. In the analysis of field performance based on historical data, there may be some years of production still remaining. In such cases, a modest real rise in oil prices of 1% per annum from 1990 is assumed. Prevailing average rates of exchange for each year of oil activity are used to convert dollar values into sterling pounds. Future average rates of exchange for sterling against the dollar are assumed to be £1 = $1.70, in 1990; $1.68 in 1991; $1.66 in 1992; $1.64 in 1993; $1.62 in 1994; $1.60 for each from 1995 onward. The rate of inflation used for each year of production relates to the index of general retail prices. The rate for 1990 is assumed to average 6.5% declining to 5% per annum from 1991 and thereafter.

Fields capable of generating positive discounted values under both hypothetical yet plausible price scenarios as well as under historical conditions may be considered as being successful, although performance appraisal will be less determinate if values range from positive to negative with only small shifts in price. Additionally, the internal rate of return of the projects together with the length of time to taken to reach project payback (the 'payback period') may be taken into account in evaluating project performance.

In terms of the sample of fields to be considered, the study focuses on the earlier developments in North Sea history. Offshore oil fields which commenced development prior to the OPEC and oil equipment price explosion of 1973-74 present the best examples of non-incrementality, being at the forefront of technical innovation in what was considered a 'pioneer' oil province. As such, huge investments had to be made without the benefit of hindsight or learning, in 'ignorance' as it were. [29] Fields which fall into this category all received Annex B development consent in 1973 or before. These fields are: Argyll; Auk; Beryl A; Brent; Forties; and Piper. Another band of fields received development consent during the following year and thus are also deserving of attention. These are: Cormorant South; Dunlin; Heather; Montrose; Ninian; Statfjord U.K.; and Thistle. In addition to these thirteen fields more recent developments are considered, by way of some comparison. Certain of these fields are accorded the same treatment as the afore-mentioned namely: Alwyn North; Buchan; Clyde; Duncan; Magnus; and Maureen. Care needs to be exercised in interpreting performance indicators with fields only recently in production and with more to look forward to than to remember.

The size of the sample is approximately two-thirds of total proven plus probably recoverable oil and gas reserves in present discoveries and over half of the estimated maximum for possibly recoverable reserves from present discoveries. [30] Finally, the sample mixes a range of field sizes, geographical locations and conditions, field ownership characteristics and types and time-spans of technical development. The question of technical development, in relation to the concept of non-incrementality, forms the subject matter of the next chapter.

NOTES.

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Power: French `Success' and the Breeder, Energy Policy, vol. 12, no. 2, June 1984, pp. 189-200; as well as Technology in the Policy Process, op. cit, 1983. More recent studies are by D. Collingridge and P. James: Technology, Organizations and Incrementalism - Large Irrigation Schemes in Developing Countries, a working paper carried out jointly by Aston and Warwick Universities as part of the Diseconomies of Scale in Production Systems Project, March 1989; and Technology, Organizations and Incrementalism - High Rise System Building in the U.K.. Technology, Analysis and Strategic Management, vol. 1, no. 1, 1989, pp. 79-97.

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29. See D. Collingridge, The Social Control Of Technology, Frances Pinter, London, 1980.

30. The estimates and the definitions of 'proven', 'probable', 'possible' recoverable reserves are to be found in the latest (i.e. 1990 editions) of the Brown Book and the North Sea Service.

CHAPTER FOUR

THE NON-INCREMENTALITY OF NORTH SEA OIL TECHNOLOGY

4.1 Introduction.

Following on from the previous chapter, the task here is to facilitate the test of incremental politics, by introducing a case study where `non-incremental' technical change has taken place. Essentially, this entails a description of the nature of North Sea oil technology as this has been developed in the British sector of the North Sea. As the methodology chapter sought to explain, the non-incrementality of such technology may be associated with the degree to which it is inflexible. This inflexibility, in turn, has been shown to obtain where the technology in question possesses at least the following four characteristics : [1]

i). large unit size
ii). long lead time
iii). high capital intensity
iv). dependence on specialised infrastructure.

In applying these factors of inflexibility to the case of North Sea oil, it may be demonstrated that the introduction of technology bearing such characteristics cannot be achieved in a fashion according with the principles of incremental politics.

There are various ways in which the term `non-incremental' change may be understood. Firstly, it may be explained in terms of being the reverse of `incremental' change. For Lindblom, the chief architect of the `incremental' approach, `incremental politics' is a political pattern whereby political change is made in small steps. [2] Such change may or may not be associated with various forms of incremental analysis which limit the consideration of alternative policies to only a few options which differ slightly from the status quo. Whatever the form of the analysis, incremental politics is deemed by Lindblom to be the best method of confronting complex policy situations.

One might also consider Simon's distinction between `programmed' and `non-programmed' decisions, where the latter reflects the extent to which decisions are novel and there exists no definitive procedure for their handling. [3] Similar to this is Mintzberg's notion of `structured' versus `unstructured' decisions. The latter is used to refer to decision processes which have not been encountered in the quite the same form and for which no predetermined and explicit set of ordered responses exists in the organisation. [4]

In addition to the above, Schulman has employed the term `indivisible' (and Lustick the term 'decomposable') to refer to some decisions which cannot be taken incrementally. This type of decision involves a large degree of commitment to policies which may be particularly risky or must consume vast amounts of resources in order to stand any chance of success. One such example, is the NASA space exploration project. [5] This idea links comfortably with the concept of `irreversibility' put forward by Douglas and Wildavsky in their discussion of the problems of adopting risky or dangerous technologies. [6] Policies become irreversible where the costs of abandoning a policy or changing its direction are prohibitive. Such costs may relate to political or corporate demise and/or the undoing of certain `inflexible' technologies.

The next section relates the ideas conveyed by the above discussion to the case of North Sea oil. Initially, the focus is on the lack of precedence there was for guiding decision makers attempting to encounter the unique environmental problems posed by the North Sea. This is then linked to an explanation of the nature of the technology required to explore, develop and produce from fields in such a province. Finally, the technology of North Sea oil is reconsidered in terms of the factors of inflexibility discussed above.

In terms of offshore development outside of tropical or semi-tropical areas, the North Sea has been something of a pioneer province. [7] The only other similar offshore area of any significance is the continental shelf off Eastern Canada, where the activity has been on a much smaller scale. The technical problems of the work have arisen from the combined effects of deeper waters, which have required larger structures and, more crucially, the extremely adverse environmental conditions, which make necessary the development of extremely robust equipment.

Yet the main source of available experience at the beginning of North Sea exploration and development, centred on thirty years of oil and gas development in the Gulf of Mexico. The difference in environmental conditions between the two provinces may be illustrated by the fact that, in the Gulf of Mexico, wave heights are less than one metre for over half the year. In the North Sea, by contrast, the existence of a calm sea is rare and maximum wave heights range between eighteen and thirty-five metres, drilling only being feasible for approximately one-hundred and seventy-five days per year.

Such circumstances make for very risky investments. However, as Noreng has explained, the North Sea has attracted much attention and capital because it has been seen as a test area, where new methods can be developed for future use elsewhere. In such an area, high costs and long lead times may have to be borne initially, until the new technology is mastered, at which point they begin to decline. [8] Indeed, early investment in the North Sea was seen at the time as the most expensive and risky offshore venture in the history of the oil industry thus far. [9] These features may be observed at various stages of field development, in particular in those oil fields which were among the first to developed in the North Sea. Having little relevant experience to draw on, these fields represent the biggest `leaps in the dark' in the history of North Sea activity, the epitome of non-incremental technical change.

4.2 Exploration Technology.

The exploration stage comprises the conduct of seismic and geochemical surveys, followed by the drilling of first exploration wells and then appraisal wells, in the areas deemed to be of good commercial potential. In 1972/73, the first major fields to be discovered were about to move out of the exploration and into the development stage. This preliminary activity typically took anything from two to six years to complete before even construction work could begin, requiring an estimated capital investment of between $125-750 million per project (1989 money).[10]

Although constantly evolving, one shortcoming of early seismic data was lack of penetration, especially through the Zechstein salt layer. Interpretations of the underlying Permian sandstone reservoir rock were limited to gross structural descriptions.[11] As surveys tended only to establish that certain geological conditions were present, costly exploratory drilling was made all the more necessary.

The type of rig used for drilling varies according to water depth and environmental conditions. On land, for instance, rigs still tend to consist of either a fixed derrick dismantled upon well completion and then transported to a new site, or more commonly, a specially designed lorry carrying a collapsible derrick. In shallower offshore areas, barges or `jack-ups' can be used. Where provinces are kinder, such as in the Gulf of Mexico, barges are used extensively. However, the depths to which they may be employed are limited because of: the anchor and chain system used to maintain position; their shape and poor motion characteristics; and weather conditions. Jack-ups are an alternative in slightly deeper waters than this and have four or more legs which may be lowered to the sea-bed, the platform section being `jacked-up' above the waves, although this is not so feasible, or economical, during long-period swells.

Both drill ships and semi-submersibles were developed to operate in deeper waters, though the latter cannot operate in the fierce conditions of the North Sea. Drill ships consist essentially of a ship's hull with the derrick located in the centre of the ship or over one of the sides of the hull. They are kept in position by a number of anchors hung over the bow or the stern and elaborate systems of propellors controlled by a computer - the `dynamic-positioning' system. The latter compensates for the lateral or forward movement of the ship. Vertical movement is controlled by a system of hydraulically operated compensators.

Semi-submersibles float on the surface, with a large substructure reducing the impact of the waves and have helped companies to pursue an active North Sea evaluation on a year-round basis. Moreover these rigs were built to withstand waves of 20-25 metres in height, while operating in water depths of 65-130 metres. [12] The semi-submersibles in operation during the first phase of North Sea development were platforms supported by three or more tubular legs made of steel, at the bottom of which were hollow pontoons filled with water and sunk to a depth of 15-18 metres below the waves. The platform remained a similar distance above the waves, kept in place by anchors winched to each leg, with vertical movement controlled, as above, by compensators.

The ability of rigs to drill effectively depends on how well they attend to the following needs, which have made necessary the development of a number of infrastructural innovations. Some of these include: the need to maintain position over the drilling location; to provide a competent connection between the subsea stack and the drilling floor; to operate a blow-out preventer stack on the sea floor; to compensate for the up and down movement of the rig to maintain constant weight on the bit; and to attend to other problems of safety, environmental regulation and so on.

To combat these difficulties a number of systems have been developed. Among these are the subsea blow-out preventer stack, which is lowered down to the sea floor along guidelines and attached to a guide base and casing previously placed on the bottom; flexible control lines which allow the pressure control activities of the blow-out preventer stack to be operated from the surface; and the flexjoint, a pressurised ball joint allowing about ten degrees of angular deviation between the blow-out preventer stack and the riser. The marine riser itself is a large diameter pipe serving as a conduit for the mud returns and as a guide for the drill string. In addition to the above, riser tensioners may prevent risers from sagging or bending and slip joints form a telescopic link between the upper end of a riser and the drilling vessel, allowing the vessel some vertical movement.

Nevertheless, despite these infrastructural innovations, `downtime' presented a persistent problem. For Phillips, in the Norwegian sector, rig downtime actually attributable to the weather varied between 20% and 30% during the winter, with the annual average being 14% over a four year period from 1968-1972. However, these figures do not include time loss where storm damage repair work was being carried out. The companies and their drilling contractors have had to learn by experience when to suspend operations during bad weather and misjudgments in securing for storms have occurred, resulting in losses. [13] Finally, fatigue was quickly recognised as being a critical factor in floating rig design, yet for years its effect remained unclear. [14]

Drilling has presented other difficulties for the companies and for contractors, too. In the northern sections, thick gumbo shale, up to 2,000 metres deep, slowed drilling and hampered efficiency, penetration rates being cut back by using less weight on the bit. In southern sections, Zechstein salt from 300-1300 metres thick presented similar problems, with the thicknesses varying greatly over short distances. Well drilling was also to be frustrated by the heavy demand and worldwide shortage there was in the mid-1970s of the specialised steel casing required to line wells in order to prevent them from collapse. Such steel was also needed, in offshore areas, in the construction of the `riser', the section of casing running from the derrick floor to the seabed. Indeed, shortages were so acute that companies, at one point, were forced to rip out used casing from completed wells in an effort to secure this specialised steel. Trimble has noted that one company in mid-1974 was so desperate for casing that it paid nearly five times the normal price in order to secure suppliers, describing the shortages as the most `notorious' of oil equipment at the time. [15]

Other limiting factors concerned the shortage and cost of large floating rigs, supply vessel difficulties and a lack of competent personnel. In mid-1972, when to satisfy leasing commitments on Fourth Round concessions granted in 1971 required the drilling of some three hundred exploratory wells, only eleven floating rigs were in operation. This scarcity was reflected in a dramatic increase in charter rates, only a few companies actually owning their own rigs. The cost of the new rigs under construction at the time was estimated at approximately $125 million each, on average. [16] Drilling costs were roughly $250,000 a day (1989 money) and up to one-hundred and twenty-five days could be needed to drill a well 3,500 metres deep. [17]

Supply operations were subject to 25% downtime due to the weather. In the Forties field area, a statistical study showed that out of 360, twelve-hour periods during the winter, 273 were likely to bad for supply operations. This necessitated new supply vessel designs aimed at decreasing unloading time and safety and continuing research on the weather and its effect on equipment and operations. [18]

As for personnel, operators and contractors alike found qualified engineers, toolpushers, drillers, divers and roughnecks all in short supply. Moreover, after 1972 this problem worsened, especially with the arrival of the new semi-submersible rigs. Of course, this situation of general scarcity was to be a source of cost escalation and capital intensity which had not been foreseen.

4.3 Development and Production Technology.

Once again, there are several areas where licensees and field operators seem to have underestimated the size of the technical problems confronting them. An indication of the nature of these difficulties may be gleaned from Shell U.K.'s identification of three factors said to have seriously constrained their approach to field development. These were:

i). the technological barriers which had to be overcome;

ii). the need to get into production as soon as possible after the decision to commit big money; and

iii). the lack of detailed information available at the time that major development decisions were being made. [19]

There were a number of technical `firsts' which had to be achieved before oil could flow in large quantities. Below, these innovations are discussed under three headings which involve:

a). development drilling;

b). platform design and production technology; and

c). transportation facilities;

a). Development Drilling.

The function of development drilling is to cover as much of the field as possible with effective wells, the actual number of which will depend on the size of the field, the permeability and porosity of the reservoir rock and the viscosity of the field. On land this is a comparatively simple and cheap operation. The operator only needs to sink vertical wells over the spot where the reservoir is to be tapped. Wells are then completed with a unit comprising several valves called a `Christmas Tree' and the oil piped to a central unit on the field. From here it is piped to its primary destination, usually a tanker port.

Offshore, however, the technology available in the mid-1970s was such that to drill several producing wells in different places was very expensive. Therefore, it was necessary to bend all but one well away from the vertical in order that the largest possible area could effectively be drained from any particular platform. (Such wells are known as deviation wells). Deviation drilling is a complex and costly exercise, achieved by placing a wedge-shaped piece of equipment, the `whipstock', at the bottom of the well being drilled. The bit and drill-pipe are then re-inserted but, because of the whipstock, are forced to deviate from their original path. Casing is then inserted as for onshore drilling and Christmas Trees placed on the lower decks of the platform.

b). Platform Design and Production Technology.

Platform design techniques have been the subject of constant revision in the battle to surmount the difficulties arising from the environment of the northern North Sea, in particular. Here, it seems as if companies seriously underestimated the severity of the conditions and the time it would take to build and install the facilities required. [20] These platforms have had to incorporate new features relevant to supply and platform space and sit in record water depths. Weighing in at over thirty thousand tons without equipment, they were at the time of their construction the largest ever built.

Generally, the debate over production technology has centred around whether steel or concrete, jacket or gravity structure platforms ought to be preferred in the development of North Sea fields. The jacket structure has been used, for example, on B.P.'s Forties platforms and has required the development of special growing docks for their construction and new construction techniques for their installation. [22] These structures are made from specialised steel though the weight of these (over twenty thousand tons) meant that their strain could not be taken by barges. The structures therefore had to be constructed on specially designed `flotation collars'.

Flotation collars comprise two large tubular sections joined together by cross-members. The sections are subdivided into compartments which can be flooded with water through valves leading to the outside. During installation these watertight compartments are gradually flooded, enabling the collar to tilt from a horizontal to a vertical position. The whole unit is then let down onto the seabed, piles driven into the soil and rock and the collar detached from the structure. The piling is made necessary according to seabed conditions and can add another seven or eight thousand tons to the weight of the structure.

In order to afford some protection against corrosion, structures are coated above sea level with a special epoxy paint providing an impervious layer for the steel with the minimum number of coats. In addition, cathodic anodes are placed strategically all over the sumbmerged part of the structure, creating an electrolytic reaction which helps to neutralise otherwise corrosive electrons.

The gravity structure makes its own demands on infrastruture and capital although it also holds some advantages over the jacket variety. For Auk and Brent fields, for example, for both of which Shell is a joint licensee and the field operator, problems have included the design and installation of platforms in up to 150 metres of water. Achieving this feat has necessitated the evaluation of completely new materials and design concepts, including concrete structures secured in place by gravity. Moreover, there was the design and construction of prefabricated packaged units on the necessary scale for drilling and production facilities, for power generation, for pollution control, and for living and recreational facilities which would have to last for decades, with the minimum of maintenance. [21]

The main advantages of the gravity structure have been their shorter installation time, the absence of the need for piling and the fact that the steel required for their construction has been similar to that used in the reinforcement of concrete office blocks and not as highly specialised as the steel needed for the jacket structure. Gravity structures may also be made from concrete. The advantages of shorter installation time and lack of need for piling derive from the incorporation into the structure of a hollow base, which during towing out to the field can be used as a buoyancy chamber. On installation, this chamber can be filled with water thus letting the structure sink and settle on the seabed under its own weight. The hollow base may also be adapted to be used for storage. The growing attraction of gravity structures during the mid-1970s, lay in the perception that they were cheaper than jacket structures in water depths exceeding 350 feet, where North Sea activity would in future be increasingly directed.

One of the most technically advanced versions of the gravity structure during the 1970s was the `Condeep'. Unfortunately, during the height of development activity during the middle of that decade, Condeep structures were only being constructed in Stavanger, Norway, as deep water sites in the U.K. either did not exist or, if they did, were to be found in areas of outstanding natural beauty (Drumbuie, for instance), where planning permission could not be obtained. Sheltered, gently sloping, deep water sites were particularly important since the Condeep had to be built in stages, starting at the bottom and working upwards. After each stage had been completed, the structure could be winched out a little further into the fjord - this is termed `slip-forming'.

Not surprisingly, in view of the above, platforms were the subject of year-long delays in delivery and/or installation and proved to be a major item in capital expenditure on field development. Typically, they consumed between 50-70% of capital costs for the first generation of North Sea fields, with estimates of the cost of the platforms on Forties, for example, rising from $500 million each in 1972 (1989 money) to over $1,200 million each in 1988 (1989 money). (The figures quoted relate to the first four platforms to be installed on Forties, namely, Alpha, Bravo, Charlie and Delta but not Forties Echo a satellite platform which came on stream in 1987 and which is remotely controlled from Alpha). [23]

A more recent innovation has seen the advent of subsea completion systems, which may be of particular benefit where reserves are limited and/or seas are very deep - in other words where the circumstances are not especially suitable to conventional platform development. While subsea systems may themselves be expensive (since development wells have to be drilled from mobile rigs and sea floor gathering equipment is costly and complex), they may be economic when compared to giant platforms. Interestingly enough, the latter observation was hinted at as long ago as 1973, by John Heaney who was one of the management team responsible for Shell/Esso's joint North Sea concessions. He talked of the likelihood of being able "to inject [water] into wells drilled some distance from the platform and completed on the sea bed" as being a "possible glimpse into the future". [24] Of course, the nature of the platforms being built and installed at that time removed from consideration this potential avenue of contemporary field development.

c). Transportation.

Another aspect of development work requiring technical innovation and the heavy consumption of resources, concerns the transportation of the oil ashore, whether by pipeline or by marine terminal. For example, there was a need to develop techniques for laying large diameter pipelines in deep water, or alternatively to enhance the provision of oil storage capacity offshore with some means of loading directly into tankers.

Oil transportation by pipeline involved higher capital costs than the tanker method but was less susceptible to the adverse weather conditions and thus capable of sustaining lower operating costs. However, a 1965 Oil and Gas Journal article gives pointers to some of the difficulties which needed to be overcome in pipeline engineering and construction. [25]

Thus, in addition to the severe weather conditions, the pipeliner was faced with problems of servicing and supplying the pipeline operation. Even small diameter pipe could be unwieldy and the transfer of joints of pipe from a supply barge to the pipelaying vessel represented a hazardous operation. Consequently, keeping construction crews and equipment services was to prove difficult. Other problems peculiar to the North Sea, include submerged wrecks and mines, fishing trawlers trailing their nets and trawls across the sea floor and marine traffic co-ordination in what is a very busy area. Moreover, in the earlier years, land pipelining techniques were extended to marine pipelining requirements. Hence valves, manifolds, separators and gaskets were applied directly, frequently without modification to the task in hand.

As work progresed farther north, pipelines became more and more difficult to install. In 1972, Shell estimated that a line approximately 100 kilometres long in 150 metres of water would require three summers to install north of the 62nd parallel. Work would only be possible for three months of the year so that barely 30 kilometres a year could be laid. [26] Further, the cost of a pipeline in the northern North Sea has been equated to the cost of a four-lane expressway on land. For example, the pipeline system connecting Brent, Cormorant, Dunlin, Hutton and Thistle fields cost over an estimated £500 million (1989 money). [27] Cost considerations, here, were exacerbated by a doubling of the price of line pipe during 1973/74. [28]

A completely new generation of derrick barges, pipelaying and pipeburying barges had to be designed and constructed to cope with North Sea conditions and this was reflected in the supply and cost of suitable equipment. In 1974, pipelaying barges cost £40 million each (over £170 million in 1989 money). Further, weather conditions made great demands on the type of steel used to construct North Sea pipelines, especially when these have often had to be thirty-two inches or more in diameter. This compares with the twenty inch diameter of the pipeline laid from Algeria across the Meditteranean Sea to Sicily, where the combination loads of bending and the external pressures of the environment are not so great.

Typical of the sort of planning problems that have beset projects in the North Sea, a great deal of uncertainty accompanied decisions concerning whether to transport the oil ashore via a pipeline or by some other method. A case in point involves the Shell/Esso Brent field. Here, it was not certain if transportation should have been effected using an adaptation of the Exposed Location Single Buoy Mooring system, a new type of tanker mooring buoy developed to be used on the Auk field. This innovation was designed to more stable than its predecessors and included a loading hose that could be reeled up and was thus less prone to wave damage than floating hoses had been. It also featured a helipad for maintenance personnel, which made it accessible in sea conditions that would have precluded boat use. The initial intention was to use just such a system on Brent but this was in advance of information concerning the full extent of both the reserves on Brent and on neighbouring fields, which could possibly have made desirable co-operative arrangements for the construction of a pipeline to shore serving the whole area.

4.4. Measuring Non-incrementality.

By any stretch of the imagination and certainly with reference to the factors of inflexibility cited above, North Sea oil technology is of a non-incremental nature. This point has been at the heart of this chapter but may be highlighted in a more rigorous manner. In particular, it may be possible to outline the cost of North Sea infrastructure in comparison with existing technology in less hostile areas of exploration, the capital intensity of North Sea projects and the lead time necessary to reach production start-up.

The cost of specialised infrastructure is indicated by the disparity between hire costs for various types of drilling vessels used in differing offshore environments. For example, in 1974, drilling ships were estimated to cost £6-8,000 per day to hire (£24-32,000 in 1989 money), jack-ups £10-12,000 per day (£40-48,000) and semi-submersibles £15-25,000 per day (£60-100,000). [29] At one point during that year, the charter rate for the semi-submersibles needed to drill the deepest and roughest waters increased to over £40,000 per day. Remembering that well drilling typically took two to three months, this adds up to quite a considerable cost.

Flotation collars were developed specially in order to facilitate the construction of jacket structure platforms. Yet due to the stresses involved each one could only be used twice and cost over £100 million (in 1989 prices). In addition, the cost of the special coating required to protect deeply laid North Sea pipelines in the first wave of field development was over £150,000 per mile (1989 money). Notably, the cost of laying pipe at that time was roughly between £1.5-3 million per mile (1989 terms). Considering that several North Sea pipelines, certainly the major ones, are about a hundred miles in length shows the great expense entailed in the employment of this type of infrastructure.

Tables 4.1 and 4.2, below, provide support for the claims that North Sea oil projects are non-incremental by virtue of their long lead times and their capital intensity, respectively. Lead time is given for various fields and is measured in two ways: the time in months which has elapsed between the date of the discovery of a field and production start-up; and the time in months which has elapsed between the granting of development consent for the field (its `Annex B') and production start-up. The latter period represents the development stage where capital expenditure is greatest. Capital intensity, is given as the ratio of capital expenditure to total expenditure, which is expressed as a percentage. In Table 4.2, the relevant estimates for capital, operating and total expenditure are given as they apply to each barrel of oil produced from the fields in question, future production being estimated.

Considering these two tables (4.1 and 4.2), it is clear that in general, long lead times and high capital intensity are features common to North Sea oil projects. Parallels may be drawn between the non-incrementality of North Sea oil and the cases of nuclear power and high rise buildings quoted in Chapter Three, section 3.3. The combined effects of long lead time, high capital intensity, plus large unit size and dependence on specialised infrastructure are every bit as serious in the North Sea case as they were in the nuclear and high rise examples.

The very first North Sea fields (and some of the largest) had commenced development by the end of 1973 when oil prices were, in real terms, at a comparatively low level (under £2/bbl in 1989 terms). Moreover, Forties field, the single largest on a solely oil reserve basis (Brent is larger if gas reserves are included), had by this time received about half its pre-production expenditure. This figure of £933 million (1989 prices) represents 27% of estimated lifetime capital expenditure and 24% of total field expenditure (both figures discounted at 15%). Now, suppose that oil prices had remained at a steady but much lower level from 1973 onwards rather than the OPEC-induced quadrupling of price that actually occurred. What consequences could there have been for such an investment? The first point to make is that a field of such dimensions as Forties (over two and a half billion barrels of recoverable reserves) would be unlikely to lose money, despite the amount of capital required for its development. This is so even if relatively high rates of discount are used, since the economies of scale that are available to a field as comparatively simply structured as Forties is, permit very low per unit costs. (A fuller discussion of this and other performance-related issues is provided within Chapter 7 of this thesis).

However, the real problem to be addressed is that of maintaining flexibility and encouraging economically efficient methods of development, rather than obtaining benefits without reference to the costs of so doing. If hypothetically low prices during the mid-1970s had the same effect as they actually did a decade later, then it may reasonably be assumed that lower oil prices would have heightened government and industry awareness of the need to develop more cost-effective technology. Presumably, this awareness would have been translated into developments that were smaller, with shorter lead times and, as in the case with fields served by tanker rather than pipelines or semi-submersibles rather than platforms, lower capital intensity and infrastructural requirements.

Yet by the time that such innovations had been realised, it is possible that the capital expenditure accumulated on Forties, for example, would have been of such magnitude as to make the costs of changing course prohibitive. (Once again, this is a phenomenon that may be seen in other cases involving inflexible technology). Hence, the overall effect of adopting such a non-incremental technology with the features described in this chapter, is a reduction in flexibility as expressed in an inability to take advantage of learning or respond to new information. Essentially, this represents the contravention of Collingridge's rules for the successful management of technology, as set out in Chapter 3, above. The degree to which the adoption of inflexible technology in the North Sea has fulfilled the interests of the agents, remains an issue to be dealt with in Chapter 7 of this thesis. In the meantime, the process by which such technology came to be adopted is the subject matter of the following two chapters. These are devoted to government policy and corporate strategy on the UKCS, respectively and highlight the nature of these agents interests in the North Sea.

Table 4.1

Estimates of Lead Time for Various North Sea Oil Fields (months).

Field	A **Date of Discovery**	B **Annex B Received**[1]	C **Production Start up**	**A-C**	**B-C**
Alwyn North	Oct. 1975	Oct. 1982	Nov. 1987	145	61
Argyll	Sept 1971	Feb. 1973	June 1975	45	28
Auk	Feb. 1971	Feb. 1972	Dec. 1975	58	46
Beryl A	Sept 1972	July 1973	June 1976	45	35
Brent	July 1971	Aug. 1972	Nov. 1976	64	51
Buchan	Aug. 1974	Mar. 1978	May 1981	93	38
Clyde	June 1978	Dec. 1982	Mar. 1987	51	105
Cormorant	Sept 1972	May 1974	Dec. 1979	87	67
Duncan	Jan. 1981	Oct. 1983	Nov. 1983	34	01
Dunlin	July 1973	May 1974	Aug 1978	61	51
Forties	Nov 1970	Dec. 1971	Sept.1975	58	45
Heather	Dec. 1973	Aug 1974	Oct. 1978	58	50
Magnus	July 1974	Dec. 1978	Aug. 1983	109	56
Maureen	Feb. 1973	Jan. 1978	Sept.1983	127	68
Montrose	Dec. 1969	Mar. 1974	June 1976	78	27
Ninian	Apr. 1974	June 1974	Dec. 1978	56	55
Piper	Jan. 1973	Apr. 1973	Dec. 1976	47	44
Thistle	July 1973	July 1974	Feb. 1978	55	43
Statfjord UK	Apr. 1974	Apr. 1974	Nov. 1979	67	67

Note: Formal Annex B approvals were not granted prior to the Petroleum and Submarines (Pipelines) Act of 1975. Where fields were developed before the enactment of this legislation, the dates quoted in column B refer to the time when informal Department of Energy consent was given or field development work was initiated. For such fields, the precise timing of informal Annex B consent can be vague and consequently lead times have been estimated.

Sources: Various editions of the Department of Energy's Development of the Oil and Gas Resources of the United Kingdom, H.M.S.O., London; County NatWest Woodmac's North Sea Service

Table 4.2

Capital Intensity In Various North Sea Oil Fields - Real 1989 Prices Discounted at 15% Per Annum.

Field	Capex/bbl £	Opex/bbl £	Total Cost/ bbl £	Capital Intensity %
Alwyn North	4.64	1.09	5.73	81
Argyll	3.06	2.67	5.73	53
Auk	3.41	2.32	5.73	60
Beryl (A+B)	1.42	0.55	1.97	72
Brent	2.09	0.50	2.59	81
Buchan	5.08	2.06	7.14	71
Clyde	3.73	1.39	5.12	73
Cormorant S.	3.29	0.72	4.01	82
Duncan	6.25	4.05	10.30	61
Dunlin	3.10	0.83	3.93	79
Forties	1.27	0.20	1.47	86
Heather	7.40	1.70	9.10	81
Magnus	2.32	0.66	2.98	78
Maureen	5.52	1.30	6.82	81
Montrose	3.44	1.86	5.30	65
Ninian	3.49	0.67	4.16	84
Piper	1.49	0.40	1.89	79
Thistle	4.74	1.10	5.84	81
Statfjord UK	0.21	0.11	0.32	66

Source: Calculations are based on capital and operating cost data contained in the October, 1989 edition of the County NatWest Woodmac's North Sea Service

NOTES.

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CHAPTER FIVE

THE POLICY-MAKING PROCESS AND NORTH SEA OIL: GOVERNMENT POLICY

5.1 Introduction.

The foregoing has drawn attention to the novel and risky nature of North Sea exploration, centring on the various features of the required technology which have frustrated the making of flexible, incremental policies. Bearing in mind these technological characteristics which add to the inflexibility of policy, it is pertinent to ask how an option so clearly difficult to control came to be adopted in the first place. This chapter, therefore, considers the nature of government commitment to and interests in the development of North Sea oil reserves.

Explanations of continued commitment to North Sea oil, once again, owe much to the irreversible nature of its technology, which can only hinder any decision to subsequently change the course of policy, or even to modify the tactics involved in attaining current objectives. Nevertheless, there is a degree to which the machinations of the policy making process, especially in the earlier years of North Sea activity has made subsequent changes of course very difficult to implement. The process has operated in such a way as to reinforce the technical constraints of policy.

In order to gain some understanding of the evolution of the policy process, as it applies to the management of oil resources, it is necessary to pay heed to the variety of contexts within which policy-making takes place. Of relevance here, is the manner in which government activity is influenced, constrained or said to be justified, by reference to certain international, national, political and socio-economic factors.

Historically, the period under focus is that following the Geneva Convention of 1958. This gave countries with coastline the first sovereign rights to explore and produce from the natural resources lying on or beneath their continental shelves. This date marks the commencement of North Sea oil exploration activity, although it should be noted that British experience with oil of the onshore variety dates back to the nineteenth century, albeit on a very small scale. 1958 also saw the first moves towards unity on the part of the oil producing states that were soon to form OPEC.

In order to make the work more manageable, it will be useful to consider the development of government policy towards the North Sea in two phases, falling either side of the mid-1970s. there are several reasons for this. Firstly, it is in the period after 1975 that the first commercially viable fields were able to commence production. Policies that were adopted up to this point may therefore be seen as being aimed at facilitating rapid exploitation of oil reserves. 1974/75 also marks the initial aftermath of the first real assertion of OPEC power, with the quadrupling of oil prices that took place in 1973/74 and the subsequent reappraisal of government policy towards the control of energy use and oil production.

Later policies reflect the growing politicisation of oil, with British Governments more determined to counter the power of the large international oil companies. This relates to the perception that was developing at the time that these companies were earning `super-profits' because of the scarcity of oil and its high price. In addition, there was a growing feeling that the State was not earning a high enough share of oil revenues. Nor was it seen to be exerting sufficient control over the resource, especially when private companies seemed unable to contain the costs of exploration and field development. Unfortunately, during this second phase of policy, attempts to redress the balance were consistently to be frustrated by the inflexibilities that had been built into earlier policy. More recently, the activities of successive Conservative Governments, since 1979, enable a third phase in oil policy to be identified. Differences between this and earlier stages principally revolve around curbs that were placed on the activities of BNOC, the state oil company set up under the previous Labour Administration, although in some other respects policy has not varied all that much from what went before.

5.2 The Quest For Self-sufficiency.

Following on from the Geneva Convention, the Continental Shelf Act of 1964 extended British sovereignty to the continental shelf and, subsequently, laid down terms for companies wishing to exploit oil and gas discoveries in the Petroleum (Production) Regulations. The Minister of Power, as the post was then known, decided to establish a `discretionary' licensing system, as opposed to asking for cash bids from interested companies. [1]

Licences were to be of two types: exploration licences allowing for only preliminary geological survey work; and production licences necessary for any large scale drilling activity. Under such a system, which has remained the principal one for allocating licences since 1964, companies submit their proposed work programmes to what is now the Department of Energy.

The first phase of North Sea development was characterised by a policy encouraging `rapid development', with many of the best prospects being offered early on, often in batches, as part of large licensing `rounds'. [2]

Indeed, in more definitive terms, a continuing aim of all British Governments during the 1960s and 1970s has been stated as being:

> "to achieve U.K. self-sufficiency in oil on a net basis (i.e. allowing for trade in crude oil products) ... in order to realise the benefits of the tax revenues and of improved security of supply and the advantages for the balance of payments". [3]

British government policy has been criticised down the years for being too lenient in its licensing policies, not capturing a great enough share of oil revenues and even for having a casual approach to the partition of the North Sea, in the first place. [4] In the first four rounds of licensing presaging the first upsurge in exploration activity, only fifteen blocks of a total of 2,654 blocks offered, were allocated by competitive bidding, rather than at the discretion of civil servants. These blocks, auctioned in 1971, fetched £37 million, although admittedly this was a time when demand was bound to be high because of the finds being made at the time. As for the other licences, initial payments were between £25-45 per square kilometre and the stipulated maximum annual fee between £290-350. Moreover, licences were for a period of forty-six years, and although one-half of each block would have to be surrendered after a six-year period, this was virtually at the companies discretion i.e. the least promising parts would be given up. [5]

Royalties were fixed at 12.5% of the well head value but there was no provision for the State to either influence or determine the posted price system, in order to receive full value. This was unlike the situation pertaining to North Sea gas where producers were forced to sell to a monopsonistic British Gas Council. As for taxation, corporation tax was payable, though there existed ample opportunity for companies to offset tax losses and allowances against these liabilities. Further, the companies benefited by way of capital grants and other financial assistance, particularly where investment activity in development areas was concerned.

As well as the need to facilitate rapid exploitation, the Ministry of Power has explained this generosity in terms of its duty to protect the companies from harsh taxation abroad. In other words, it did not wish to set a precedent for OPEC countries in their dealings with the multinationals, possibly in case this rebounded on the companies ability to undertake North Sea exploration, or as ever, adversely affected the balance of payments situation. [6]

Without getting too embroiled in the traditional argument concerning the relative merits of discretionary versus auctioning systems of licence allocation, some general points may now be made regarding the inflexibility of early licensing policy. First, although the early licensing rounds, especially the Fourth, certainly achieved the aim of stimulating oil company interest in exploring for oil, this was not obtained cheaply. (In any case, these companies had already appreciated the need for their own secure, independent crude supplies, after a period of rising Arab assertiveness over their principal economic asset).

Thus the non-existence of a nationalised oil company or independent oil sector combined with government ignorance of oil exploration in a way which enabled the control of the most precious assets to pass to the majors. Once the latter had begun to invest in exploration and the true worth of the North Sea became apparent, any subsequent attempts to control the pace of developments, or to enhance the State's position in the relationship would face difficulty. (Witness, in this respect, the ballyhoo surrounding later efforts to introduce State participation, measures to control the rate of depletion and to amend the system of taxation in the government's favour). Moreover, decisions about the size and nature of the Fourth Round had to be taken by civil servants with little or no experience to draw upon, save that within the very companies that stood to gain from the allocation. Certainly, at that time, (1971) there were few dissenting voices to be heard on the subject.

This situation has been exacerbated in two ways, both of which demonstrate belated but increasing government awareness of the problems of managing oil. First, it was not until the Ninth Round (1984/5) that licensees were required to support research and development into new technology by U.K.-owned offshore suppliers. In addition, the original tax regime did not provide for a `ring fence' to prevent companies from offsetting profits from North Sea oil and gas activities against tax losses and allowances accruing elsewhere in their businesses. This only occurred after the Labour Government's Oil Taxation Act (1975), with the introduction of Petroleum Revenue Tax. So, in the early period of exploration, real incentives to increase the rate of technical innovation and so cut costs were notable only by their absence.

Official estimates of the Government's `take', reported by the Committee of Public Accounts in 1972/73, were in the range of 50-60% of any profit from North Sea operations. This was comparable to the returns estimated under the taxation provisions of the U.S.A. and Netherlands. However, Norway's share at this time was nearer to the top of a range extending from 55-80%, Nigeria's between 70-75% and that of Middle Eastern countries probably as high as 95%. [7]

The oft-quoted reason for accepting lower returns than those being obtained by other comparable oil producers was the need to provide an incentive to encourage rapid exploration. In the early days, especially, it was feared that the international oil companies, having access to several sources of low-cost oil, might prefer to defer production of high-cost North Sea oil. [8] After all, British Governments had no direct experience of oil production and little knowledge of the technical and commercial aspects of the oil industry. As a result of this inexperience and the somewhat enigmatic nature of North Sea oil potential in the early years, U.K. governments therefore had to

> "opt for a dualistic relationship with the companies: on one hand, they were allies in order to explore and produce oil, and on the other hand, they were potential antagonists". [9]

Certainly, the objective of achieving rapid exploitation was attained, although by the middle of the 1970s this was to pose something of a dilemma for government policy. This might be described by referring to the twin objectives of needing to earn quick returns in order to assuage Britain's economic problems while maintaining an adequate level of control over long term depletion. (These points particularly apply to fears over the substantial foreign, mainly American interest in the companies exploring the North Sea and the ease with which they might export their profits back home).

Indeed, the claim has been made that but for the immediate requirement for income, the State would ideally have preferred to restrict the rate of production to that needed to offset crude oil imports - a level that would have been lower than that favoured by private interests. Such a policy would be aimed at securing high `social rates of return', with future income being valued more highly than present income. [10]

The macro-economic background to State policy is worthy of a little more consideration. In addition to the need for secure sources of oil supply, rapid exploration policies have been justified, by those making policy, in terms of the nation's weak industrial base, devalued currency and balance of payments situation. The deterioration of the latter was of utmost concern in the 1970s and is indicated by a deficit on current account, which in the 1960s was at most £400 million but, with the oil `crisis', rose to nearly £1 billion (in 1973) and then to over £3 billion (1974).[11] Quick oil revenues have done much to mask Britain's underlying economic ill-health, with the direct contribution to current account of oil and gas activities reaching £10 billion, in 1981. Taking the capital account impact into consideration, the direct effect on the balance of payments, overall, was nearly £12 billion in the same year.[12]

However, the general contribution of oil revenues to the economy has been to obviate temporarily the need for export regeneration and even to frustrate this, by helping to maintain an artificially high exchange rate. Between 1977 and 1980, this rose by 25%, while costs and prices rose by more than in other competing nations. The loss of competitiveness and profitability this caused had a disastrous effect on British industry, economic activity in general and employment, in particular.

Rapid exploitation policies in this light can be seen in terms of the preoccupation of successive Governments with short-term gains and political horizons, together with a persistent need to swell the Treasury's coffers. Hence the notion that society has a duty to future generations to leave oil beneath the sea and that their considerations might be undervalued by conventional economic methods, has not featured to any great degree in the formation of policy. [13] Similarly, and perhaps more directly relevant to this thesis, the idea that in addition to promoting the conservation of resources, depletion rates could be slowed in order to facilitate offshore learning has never really caught on. Whilst this thesis stops short of advocating depletion policy in the quest for `optimal' production rates attempting to maximise the present value of reserves for society, there is a case for adopting policies which improve the quality of information available to decision makers or which ameliorate market imperfections in the allocation of resources.

5.3 The Growing Politicisation Of Oil.

Since 1973, there has been a decline in the relationship between economic growth and energy use. [14] This decline is is often put down to the poor industrial and economic performance of many Western countries since the oil crisis. However, a much more realistic explanation is the greater efficiency of general energy use post-1973, and more specifically, the notion that oil price rises in the 1970s

> "merely intensified and accelerated the structural process of change towards the `low energy' economy". [15]

A partial consequence of this has been the way oil use (in I.E.A. countries) has declined even more than general energy use to 80% of the amount used in 1973. [16]

Given this situation of falling demand and the political problems which frustrated attempts by OPEC to combat global over-supply from both its members and also non-OPEC countries, it seemed almost inevitable that the price of oil - including North Sea crude - would fall. Yet, despite the fluctuations in nominal prices that have occurred since the mid-1970s, (from under $5/bbl in 1973 to over $35 in 1980, then back to about $10 in 1986), in real terms the very least that was being obtained was a price which roughly corresponded to the levels of 1973/4.

So, the past fifteen years or so has generally been a period when very high profits could be earned, certainly pre-tax. This in part has been helped by the entrenchment of the idea that oil scarcity was inevitable, particularly after the 1973/74 crisis seemed to dispel earlier industry optimism. In turn, a willingness was created on the part of consumers, to also accept high prices as being inevitable.

The task of the sections below is to consider various aspects of government policy, in terms of how they have developed alongside the emergence of oil activity as a politically sensitive issue. In particular, decisions aimed at facilitating greater political control over oil affairs or, at least, enhancing learning capability at industry level are the objects of study. The making of such decisions in the North Sea arena is essentially a corrective exercise, an activity hindered by earlier, inadequate or inflexible decisions and their inextricable link with the complexities of North Sea technology.

5.4 Offshore Supplies Industry and Technological Research.

Policy towards offshore industry and technology during the first wave of North Sea investment was characterised by a mixture of complacency, discontinuity and short-sightedness. Committees such as that set up under the Ministry of Technology by Sir Fergus Allen, achieved little by way of the furtherance of research and development. Matters here were not helped by the failure to include industrialists in the policy making process. The development of an overall strategy for British technology in the decade up to 1974 was also to be frustrated by myopia on the part of the subsequent Conservative Government under Edward Heath. In 1973, the

Central Policy Research section of the cabinet office recommended greater emphasis on `customer' control of research and development. Hence this responsibility was placed in the hands of those who were `ill-prepared to receive it and [who] tended to concentrate their demands on short term projects with an obvious pay-off'. [17]

Continual organisational change in this same period did little to promote consistency and coherence in policy and surely hindered the work of the Civil Service administrators. Among the various bodies entrusted with long-term planning in the field of industrial development have been the afore-mentioned Ministry of Technology, the Department of Economic Affairs, the Ministry of Power, the Board of Trade and, later, the Departments of Trade and Industry and of Energy. These bodies have undergone various name changes, mergers and absorptions. Meanwhile, a plethora of governmental agencies, such as the Committee on Marine Technology and the Ship and Marine Technology Requirements Board have also come and gone. Each agency has needed time to settle in and to learn the processes of raising new funds for research. Not surprisingly, one of the results of all this has been the damage inflicted both on fundamental scientific research and on technological research. The consequence of this is, in turn, reflected in the poor performance of the domestic offshore supplies industry, with much more than half of total expenditure by the oil companies in 1974 going to foreign competition. Just as crucially, British firms failed to match the acquisition of expertise that the Norwegian and French companies had gained in areas like pipeline laying and rig driling, in response to the traditional dominance of the U.S. based firms. [18]

5.5 Licensing and Depletion Policies.

As the first wave of North Sea fields were moving towards the attainment of peak production, there was a growing realisation on the part of politicians that energy issues were likely to remain high on the political agenda for some while. All major parties (including the Scottish Nationalists) began to consider how indigenous oil production might in future be controlled. The Labour Government's 1978 Green Paper on energy policy, [19] cautiously recognised that government intervention might possibly be required in order to avoid "too sharp a peak [or] too rapid a rundown" in oil production. [20] The feeling was that to cater for when domestic supplies eventually began to diminish, the present need as far as policy was concerned, was primarily to "preserve the maximum practicable flexibility". [21]

Important considerations at this time warranting such a stance were stated as involving the long term availability of indigenous feedstocks for the petrochemical industry, the well-being of the offshore supplies industry and, crucially, the task of minimising potential supply problems. The latter might occur if there became a need to switch to alternative indigenous supplies or to pay for increasing imports. [22] The Green Paper did not see any contradiction between short-term objectives designed to preserve the momentum of development up to self-sufficiency and the longer-term policy of promoting steady development in order to avoid too sharp a decline in production.

However, the same document had observed that in general terms, many of the investment and other decisions determining energy supply (including oil) up to the mid-1980s, had already been taken. With respect to decisions associated with licensing and depletion policy and the assumptions which underpinned these, therefore, the conduct of oil affairs on the U.K.C.S. can scarcely be said to have afforded the `the maximum practicable flexibility'. This criticism applies both to issues surrounding the management of the resource base and the development of more flexible technology. Prior to more extensive analysis of the policies that have been offered in the area of development and production controls, the theoretical pros and cons of depletion policy are briefly presented.

Typically, the advocates of depletion controls appeal on economic grounds to the `imperfections' and `failures' of natural resource markets, which are said to encourage depletion at non-optimal rates. [23] The proper role for governments and other regulatory authorities is thus to intervene to enforce the `right' depletion rate, usually one less rapid than that which would be realised under an unregulated regime. `Imperfections', here, can be characterised by the presence of monopolistic and oligopolistic competition featuring firms able to manipulate prices or output, or the possibility that market interest rates may be higher than the social time preference rate. (The latter refers to the rate at which society would discount the future, so indicating its preference for the consumption of resources now or for leaving them in the ground for the benefit of future generations). `Market failure' primarily relates to adverse environmental effects involving production, transportation and the consumption of resources which do not fully enter into prices. Consequently, consumers in the market do not receive the correct price signals and may enjoy artificially low prices which stimulate the consumption of and hence the faster depletion of resources.

Opponents of interventionism in depletion policy counter that monopolistic or oligopolistic forces, for example, may work the other way. So, a tendency to deplete `too slowly' will occur, assuming that they raise prices and restrict output in a manner that would occur in a perfectly competitive situation. [24] Also, while high market interest rates (i.e. higher than the social time preference rate) may well encourage excessive depletion because producers generally will want to produce now rather than later, they may give rise to a contrary tendency. Hence high interest rates will depress the general level of investment, thereby reducing economic growth and also depletion rates. Overall, as Robinson observes, it is not at all clear what the net effect of these tendencies is. [25]

Problems associated with the task of forecasting are also likely to damage the real-world hopes of anyone attempting to estimate or achieve a depletion rate which ex post will appear optimal. It is suggested that, at best, informed guesswork at trends in the most crucial variables is all that can be performed when confronted with the sort of uncertainties with which investments in natural resources have to contend. Furthermore, the failures and imperfections relating to the operation of markets and the provision of information are the norm rather than aberrations from the ideals of perfect competition.

Finally, it is claimed that even if substantial improvements in knowledge were obtained, the assumption is often made that altruistic and benevolent governments would take steps to improve markets in pursuit of the maximisation of the social value reserves, using the rent from production for the benefit of society. Politicians and civil servants do not merely reflect or act upon their perception of what the `societal interest' might be. They have motivations of their own and the pursuit of their own self-interest may not lead to the achievement of the social interest, however the latter may be defined. [26] It is recognised, here, that to conceive of politicians, for example, as seeking to act with the winning of votes in mind, either in addition or opposition to the notion of their being social welfare maximisers, requires greater care in evaluating the outcomes of their behaviour than is sometimes exercised.

In his work on U.K. oil participation and taxation policy, Hann has illustrated how inter- and intra-organisational conflict together with self-interest and short-termism have characterised the governmental policy-making process. [27] The main impact of this research has been to reduce the utility of the conception of governmental action which implicitly assumes that `national interest' or the `public good' is the only concern of officials. The picture is much more confused than that which is usually presented.

While the depletion debate has continued to flourish in the literature, the practice of policy has not been so susceptible to argument. There are several reasons why this has been so. One source of difficulty has stemmed from an unhappy coincidence of views concerning the `scarcity' of resources on the U.K.C.S. This faulty alignment of viewpoints has included both the pro- and anti-depletion policy lobbies. This situation has developed to the exclusion of those with a more optimistic view of the extent and potential of North Sea reserves and related alternative approaches to the development of its resources. Thus the consensus was that the North Sea was an oil province of only limited dimensions, with those individuals and organisations having the greatest interest in challenging the conventional technical and geological wisdom being able to exert little influence over the policy process.

In particular, this meant that the exclusion of small and medium `independent' oil companies and the views of certain academics, such as Peter Odell. Odell's view was that ultimately North Sea reserves would prove to be much greater than extrapolations from the geological and technical data of the early 1970s had suggested, the process of exploitation facilitating the discovery of new reserves. Thus the longevity of production allows time for the development of new technology in the areas of geology and oil recovery, so providing for the upward revaluation of reserves. [28]

The major oil companies, on the other hand, are typical proponents of the pessimistic approach to reserve estimation. Here, estimates are based on current geological knowledge, with only fairly conservative assumptions being made about the future. Their belief is that the bulk of U.K.C.S. reserves have already been discovered, no large fields (i.e. over 500 million barrels of recoverable reserves) having been found in the 1980s. [29] In the 1970s, the dispute saw the optimists justified in their assertion that the companies had underestimated the extent of North Sea reserves. Moreover, they had a vested interest in doing so. Pessimistic estimates of reserves have tended to encourage government tax concessions directed at maintaining the rate of exploration and drilling activity. Additionally, the use of scarcity as an excuse for higher than necessary oil prices, together with the desire of governments and companies alike for immediate cash flow has not created conditions conducive to cost efficiency.

The extent to which opportunity has been lost and flexibility in policy has suffered is partly revealed by the upward revaluations that have taken place with regard to some of the North Sea's fields.[30] For example, the estimate for recoverable reserves for the Forties field has been upgraded on a number of occasions. Back in 1975, recoverable reserves were estimated at roughly 1800 million barrels. By April 1987, this figure had increased to 2,490 million barrels, a rise of over 72% For the Beatrice field, the original view of its prospects was that it was barren. Hence, Shell returned to the Department of Energy part of a block that had already been discounted as oil-bearing. A decade later, new seismic data led B.P. to bid £22.5 million to license the same area.

Some other important consequences flow for the evolution of policy in this area from such a reliance upon the scarcity assumption and the centralisation of policy encouraged by the domination of technical expertise by corporate organisations. One concerns and is evident in the temporal pattern of North Sea development. A `normal' pattern of technical innovation is for a few `pioneer', and therefore high-cost, developments to be made which establish the basic viability of the technology. The experience of these developments is then incorporated into a second generation of developments, which will often be initiated by diverse entrants following a variety of technical approaches. As the technology diffuses, successive waves of development occur, each incorporating the experience of their predecessors and, in most cases, improving the performance of the technology.

This pattern was turned upside down in the case of North Sea oil, for a very high proportion of the total resource base was developed with `pioneer' technology. Hence, although the oil companies learnt a great deal from the first generation of fields, for example, in project management skills and designing for deep waters, there was no large second wave in which that experience could be incorporated for more than a decade. By this time some of the original learning was obsolete. This situation may be contrasted with the Norwegian case, where development was phased and, in particular, development of the more exposed northerly oil and gas fields was delayed until the 1980s and 1990s.

One result of this was that the average cost of first generation North Sea fields was possibly higher than might have been than with a more staged development, which would have permitted greater experimentation, allowed greater transfer of learning and reduced pressure on the supply infrastructure.

As well as being associated with the `problem' of scarcity, the arrival of tighter controls on corporate activity in the North Sea coincided with the emergence of the view that these mainly foreign firms were earning `enormous and uncovenanted profits'. As noted by Dam, [31] the size of prospective profits had been a political issue around the time of the 1974 General Elections. Thus it was inevitable that the new Labour Government's White Paper would be a political document emphasising the need to redress the balance between oil company profits and governmental revenues.

Nevertheless, the stated objectives of the White Paper express a commitment "to assert greater public control" over the management of oil resources so as to "safeguard the national interest in an important resource which belongs to the nation". [32] The tools for the job were : a) the creation of a state oil company ; and b) an increase in the regulatory powers available to public authorities in their handling of North Sea activities.

The White paper was concerned with establishing arrangements for new licences but also varying the conditions under which existing licenses operated. In particular, participation was to be negotiated in the case of existing licenses, although for future ones it would be imposed. Due to corporate opposition and the need to adhere to international law and also to be wary of possible retaliation in areas of the world where British oil companies had interests, proposals constituting retrospective changes in licence conditions were not adopted. Hence, the scope of changes in the system governing existing licences ran only to variations in the regulatory and taxation environment within which the licensees operated.

The machinery by which control over output and exploration might be exercised was under the Petroleum and Submarines Pipelines Act of 1975. The 1976 Energy Act could also be invoked. However, the considerable powers enjoyed by the Secretary of State for Energy in regulating production and development in the `national interest' were trimmed by the Varley Assurances. [33] In particular, these set limits on the timing and the extent to which production could be cut. With the Varley Assurances promising no change to current company programmes before 1982, there was little that politicians could do to alter the pattern of production from fields that had already received development consent.

Admittedly, as stated in the above, both Labour and Conservative Governments had favoured policies leading to the attainment of self-sufficiency. Only the Scottish Nationalists, it seemed, wanted a sharp reduction in planned production rates. Nevertheless, the idea did begin to take root towards the end of the 1970s that self-sufficiency did not necessarily imply becoming a substantial net exporter during the 1980s. Thus it would be feasible to produce up to the level of home oil consumption, so conserving resources for the future, although for the reasons given previously, this was an option which could not be pursued in any welfare maximising fashion.

At least until the end of the 1970s, therefore, depletion policy was

> "largely procedural, concerned with checking, if necessary modifying and eventually approving company output programmes for the future. No significant restraints appear to have been placed on current production except to reduce gas flaring." [34]

By the 1980s talk of depletion policy had largely been forgotten as the issue slid away from the political agenda. Moreover, to reduce output in any given year as well as not being a vote-catcher, would be to forego immediate economic benefits thus transferring them to the future to the possible benefit of the government of another party. [35]

In the event, as Robinson suggested nearly a decade ago, the delays pertaining to the development of many North Sea fields operated in such a way as to flatten the peak in oil output expected during the mid-1980s. Thus there has been a longer and lower plateau in the pattern of oil supply than was previously anticipated, despite the inability and unwillingness of governments to apply output controls. Indeed, it seems as if oil production on the U.K.C.S. will be of sufficient quantity to give a net surplus of exports over imports at least until 1993.

As recently as 1987, output controls were rejected by the House of Commons Energy Committee.[36] Its reasons were that the control of production would only result in "increased costs overall and ... less than maximum economic recovery." Also, any such action on the part of government would have an indeterminate influence on oil prices and thus could not be relied upon to help the North Sea oil companies out of their current problems, as had been suggested.

More indirect methods of controlling depletion include delaying field development and altering the frequency and extent of licensing Rounds. Of course, these could not be applied to the first generation of North Sea fields once these had gone into production but, again, during the mid-1970s where talk of energy `crisis' was very high on the political agenda such options gained currency. Similarly, the eventual direction of policy, as in the case of output controls appears to have been guided by considerations which have not always had much to do with the pursuit of economic efficiency.

For example, both Labour and Conservative

Governments since the crucial Fourth Round, have regulated the issue of production licences much more closely. Yet the Fifth Round of 1977 owed its timing (i.e. a five year gap since the previous batch of allocations) as much to the concurrent completion of the participation arrangements that Labour had introduced, as to the problems that the oil industry had had in digesting Fourth Round acreage. Similarly, the size of the Fifth Round was made deliberately much smaller than its predecessor, with 44 blocks on offer as compared to 436, though this may be explained in terms of the `stress and strain' that had been put upon the domestic industrial equipment industry. [37]

One of the principal concerns at this time was to ensure that the offshore supplies industry was able to keep pace with the level of demand generated by the rate of field development. In addition, there was a perceived need to encourage a situation where orders for such equipment were brought to the United Kingdom in order to create jobs. Indeed, a memorandum signed by the Labour Government and the oil companies made it a requirement of policy that the ordering of equipment should be on the basis of genuine `full and fair opportunity' for bidding British firms. The strategic aim of such a move was to raise the British share of this market and to progressively build up domestic industry to enable it to compete on world markets, at a time when exploration generally was moving to more inhospitable areas of the globe.

True, Labour had recognised that smaller and more regular licensing rounds might promote steadier development of domestic manufacturing industry, thus acting as a form of depletion control which did not raise the problems of cut-backs. It was believed that whilst arbitrary cut-backs might affect the confidence of companies working in the North Sea, here was one way to determine how quickly remaining blocks were to be explored and to some extent adjust oil production to the nation's perceived needs. [38] Nevertheless, the main thrust of Labour's policies in this area must be viewed in terms of the State's various macroeconomic considerations and desire to redress the inequalities of its bargaining position vis-a-vis the large multi-national oil companies.

Likewise, Conservative Governments since 1979 have used the licensing regime in such a way as to enable the State to

> "exercise control over the manner in which drilling is carried out, development programmes, the approval of operators, the provision of information about the licensees' activities, and the assignment of interests held under the licence." [39]

These powers, provided for in the terms of existing licences, have the stated intention of being wide-ranging so that the `national interest' can be safeguarded and also flexible, by taking full account of current circumstances so that unnecessary constraints do not hold up "worthwhile activity or transactions." [40] In 1987, the Government's view was that the

> "adaptability of the method of inviting applications and awarding licences and the flexibility with which licence controls can be and are administered, enables the licensing system to remain an appropriate mechanism for regulating the Government's relationship with companies involved in exploration and production work". [41]

Conservative administrations since 1979, have not doubted the validity of the framework of policies that they have pursued. Despite fluctuations in oil prices and the time-lag between the licensing of an area and production from it, it has been thought that the necessary adjustments could be made to each Round to ensure the momentum of licensing opportunities through thick and thin. Such adjustments might involve the size of the round but also the balance of mature and frontier areas offered and the method of assessing applications needed to encourage companies to take up the opportunities on offer. [42]

Broadly speaking, the main emphasis of licensing policy since 1975, appears to have been on smoothing out the peaks and troughs of North Sea activity, the importance of depletion policy as a political issue being replaced by concern that there would be insufficient new fields developed to replete resources in the 1990s, and to maintain a steady supply of orders for the offshore industry.

The first development delays were announced in 1980, by David Howell, then Secretary of State for Energy. His intention was to delay the development of certain fields discovered after 1975 because of the Government's belief that

> "on strategic and security of supply grounds it is in the national interest to prolong high levels of U.K. Continental Shelf production to the end of the century." [43]

However, the first such action taken - to delay production start-up from Clyde by two years - appears not to have been taken after any sort of careful examination of whether the `long term interests of society' were being fulfilled. Indeed, short-term issues seemed to have a greater bearing on the conduct of government policy, here, as they often do. In this case, with a public corporation, BNOC, being the field's operator and the conduct of monetary policy in full swing, delays in the development of Clyde may be viewed in terms of the Treasury and the Cabinet's desire to hold down the PSBR, by controlling the capital spending on the field.[44] The prevalence of short-term horizons may also be witnessed in the case of the Alwyn North field. Here, proposals for the development of the field were received by the Department of Energy in October 1982. Incredibly, approval was granted in fourteen days. The main factor behind such haste was the state of the order-starved offshore industry, which by now had become a major priority. Further, Alwyn North would not reach peak production until after the production `hump' of the mid-1980s and as such was not that important to any lingering questions concerning depletion policy for the 1980s.

Since then, although reserve powers have been retained to meet unexpected contingencies, the Government has seen no role for development delays. Moreover, in 1982, it declared that the economic advantages would have to be clear before any restrictive depletion policy could be justified. Such a stance has been reinforced by assumptions of scarcity, the emergence of sterling as a petrocurrency and, of course, the usual short-run pecuniary considerations of government and Treasury alike.

5.6 Participation.

The most controversial element of U.K. moves to ensure greater political control over oil matters, is undoubtedly the decision of the Labour Government to establish the British National Oil Corporation (B.N.O.C.). This was one of the main purposes of the Petroleum and Submarines Pipelines Act of 1975. B.N.O.C. became the main agent of majority state participation offshore, giving the Government access to production on the continental shelf during periods of international supply disruption. Thus the licensing system was used to give a 51% share to B.N.O.C. of the new licences granted in the Fifth Round of 1977 and representation on all the operating committees which plan the development of North Sea fields. Companies were expected to agree to participation terms for finds made under licences already issued.

Through the use of participation agreements for finds made under existing licensing terms, B.N.O.C. was also provided with the opportunity to purchase up to 51% of all oil produced, net of royalty. This was at a `market price' defined as that which would be agreed between willing buyers and sellers leaving the latter neither better nor worse off. [45] Compared to that of private companies, BNOC's position was also privileged in that it was allowed to obtain licences outside normal licensing rounds and was exempted from Petroleum Revenue Tax. Companies, though, were able to buy back participation oil as a feedstock for their refineries, or the royalty oil that had been taken by the Government as payment in kind. In short, BNOC made for a potentially very powerful force in the North Sea, although the principle was adopted that the companies should be left financially no better or no worse off as a result of participation.

Essentially, the creation of BNOC was intended to:

i). extend public control over oil exploration and production,
ii). control North Sea sales, and
iii). provide the government with alternative information and advice to that of the multinational oil companies.

It was, therefore, a major function of BNOC to facilitate the ability of the State to gain access to and to interpret oil field information. The then Secretary of State for Energy, Tony Benn, saw the need for large-scale participation on the grounds that

> "first-hand experience is vital to gain the necessary expertise and information in all North Sea oil activities." [46]

If the Labour Government was to control, rather than to regulate the oil industry, it clearly would need to be in possession of considerable information and expertise.

Labour's view in 1975, was that state intervention and control over the North Sea was in the public interest by definition, because it was a socialist action. [47] The activities of the multi-nationals were evidently a major and topical political issue, with strong popular support for the government to be seen to be taking some action in the oil sector. One of the problems associated with the setting up of BNOC, however, was what appeared to be a fundamental conflict of roles for the Corporation. BNOC was intended to operate both as a competitive oil company and, at the same time, as a partner of the private companies gathering confidential information and with an intimate relationship with the government. [48]

Such a duplication of roles was to be the source of great uncertainty and no little opposition, both party politically and from the oil industry itself. This is quite ironic since the setting up of BNOC can be seen as an institutional response by government designed to enhance its ability to adapt to the uncertainties and vicissitudes of the world oil market of the 1970s. Nevertheless, the degree to which BNOC could deliver such assistance to government was hampered by its wide frame of reference, since for it to operate for the `good' of the nation would render it incapable of taking decisions purely on commercial and financial criteria.

Moreover, the companies feared loss of profits through retrospective and (possibly, in their eyes) immoral legislation, although eventually participation agreements were negotiated with all North Sea producers. Still, the threat which hung over future investment was real. After all, the Secretary of State for Energy now had been vested with very considerable powers of discretion over depletion and control over fields and BNOC was formed only about twenty years after the companies had begun to experience what, for them, would be the doubtful joys of selling their gas output to a monopsonistic British Gas. This had slowed the exploitation of British gas. [49]

Finally, once BNOC had established itself as a credible oil company, the `rational' ambitions of its top executives led it to seek financial and managerial independence. This it did by borrowing from commercial banks (an $825 million loan in 1977, for example) and by increasing multi-nationalisation. Such moves lessened the opportunity for government control and intervention and added to the potential complexities of any future break-up of BNOC. [50] The need for decision-making freedom on the part of BNOC's executive may be explained in the following way. First, it was quite conceivable that the objectives of politicians and civil servants might clash with the long-term commercial aims of the Corporation. Second, and related to the previous point, if the government had been BNOC's only source of finance and the Corporation needed to request funds for an investment project, the money could be denied because it conflicted with any wider governmental objectives, rather than because of its commercial viability. [51] The implication of the drive towards greater independence, therefore, was that political interference, rather than control or regulation, was likely to continue, or maybe even increase over time, thus adding to the uncertainties of oil management.

This uncertainty and speculation continued into the first term of Mrs. Thatcher's Conservative Government, with the unveiling of plans which would dramatically alter the role of BNOC in the domestic oil sector. The situation was not helped by the fact that a government pledged to reduce state intervention and to dismantle BNOC would have to confront the complexities of its financial and administrative arrangements. Further, there was a realisation on the part of the incoming administration of the value of BNOC revenue. These factors served only to encourage "government procrastination and ambiguity with respect to BNOC." [52] In particular, the Energy Secretary, David Howell faced the political embarrassment of a domestic petrol shortage, in the summer of 1979, having to use BNOC as the instrument by which government would attempt to divert oil supplies while considering how best to dismantle it. Political pressure also came to bear from within the Conservative Party and the Government to use BNOC revenue for political and economic purposes. For instance, such funds could be used for helping to finance government borrowing.

Such a confusion of interests and views, in addition to other sources of opposition in Parliament and BNOC itself, made the complete dismantling of BNOC an unlikely option. Instead, various forms of restructuring and privatising the Corporation were considered. Eventually, in 1982, after Nigel Lawson had replaced David Howell as Energy Secretary, B.N.O.C. was divided into two with Britoil taking over its exploration and production interests before being privatised and later taken over by B.P.

By March 1985, the Government had announced that the remaining part of B.N.O.C. would be abolished as soon as possible, following its failure to effectively regulate the market price for participation oil. Throughout the winter of 1984/85, BNOC was once again to embarrass the

Conservative Government. This time the Administration was seen to be attempting to hold up the price of U.K. oil thus supporting OPEC's weakening price structure, in contradiction to its stance on free market principles. Also, with the spot price of Brent blend consistently below the official price, BNOC was forced to sell its oil at a loss, losing about £86 million during the six months to April 1985. The company's losses combined with the large subsidies it had been granted by Parliament (£65 million in three months from December 1984 - February 1985), plus the embarrassment of Conservative state intervention, made abolition all but inevitable. BNOC was replaced by the Governmental Oil and Pipelines Agency which continued to trade royalty oil in kind but in the spot market, rather than through a system of official pricing. [53]

Once again, the importance of short-term political considerations in influencing policy intentions, this time through the process of privatising BNOC, has been illustrated. The privatisation programme was a central part of Conservative policy and the privatisation of BNOC was a symbolic expression of the government's commitment to free enterprise. Moreover, for his part in the exercise, Nigel Lawson won considerable praise within the Conservative Government and after the General Election of June 1983 was rewarded with the post of

Chancellor of the Exchequer. [54]

As for the role of B.N.O.C. in the North Sea `play', this is something which has often been overstated. Fears that it would have a `carried interest' in the oil companies, i.e. let them pay for developments until the Corporation decided that it would enter the game, proved unfounded. Instead,

> "the dreaded `participation' [turned] out to be merely an option to buy oil for B.N.O.C. and an assurance that most of the refining [be] done in Britain". [55]

5.7 Taxation.

As it had functioned up to the mid-1970s, Corporation Tax was seen as containing too many loopholes and incapable of generating acceptable levels of revenue for the Government, even given a policy aimed at encouraging rapid exploitation. By 1972, the major oil companies were generating annual tax losses of around £470 million in total, to be written off against North Sea profits at the time of between £500-600 million. (This is after depreciation at 1980 values and is based on a price of $3.50 per barrel). [56] Nevertheless, the Labour Government of 1974-79 was still determined that taxation policy as expressed in the 1975 Oil Taxation Act and the Petroleum Revenue Tax, contained within it, should not discourage investment in the North Sea .

Petroleum Revenue Tax was to be levied at a flat rate of 45% on profits. (It later rose to 60% in 1979, 70% in 1980, and 75% in 1983). The calculation of `assessable' profit, on which taxes would be levied, was made after the deduction of royalty, operating costs, accelerated depreciation and various other allowances from gross profits. Further, the assessment of tax liabilities was made on a field by field basis, the `ring fence' operating so as to prevent losses incurred on other fields or activities elsewhere being offset against the liabilities of the field in question. [57]

Of the allowances, the most important have been `capital uplift' and the `oil allowance'. Capital uplift allowances of 75% were originally allowed by Labour, in response to the companies' claims that, because so much of their money was being tied up in projects which could not produce for several years, they should be allowed to charge interest on the money and offset the cost against PRT. In the event, an allowance was decided upon because of government fears that the companies would charge themselves unrealistic rates of interest, which would considerably decrease tax income.

Nevertheless, for every £100 million spent developing a field, the company concerned could offset £175 million. To match this, a field having a cost profile projected over six years, would have to have been accruing interest at an annual rate of 15% or more. Later, in 1981, the Conservative Government reduced the uplift figure to 35% and removed the provision for expenditures on those fields which had reached payback. (The latter should have reached a position where the cumulative profit and depreciation was at least equal to cumulative expenditures and were therefore capable of self-financing). Lack of uplift has affected decisions to invest in secondary developments linked to existing producing fields, which lie in the PRT ring-fence of that field. [58]

The oil allowance was aimed at the smaller fields, initially enabling production free of PRT of up to half a million long tons per six month chargeable period, up to a maximum of ten million long tons over the life of a field. In fact, it was the larger fields that tended to benefit from the allowance, smaller ones having a productive life often less than the ten years and thus unable to claim all of the allowance. The allowance was reduced by half in 1979, to a quarter of million tonnes free of PRT, each chargeable period, [59] but was later restored to its original level for fields granted development consent after 1 April, 1982. [60]

In 1981, Supplementary Petroleum Duty was introduced, being a royalty charged at 20% of gross revenue, after the oil allowance. Although abolished in 1982, it had been a deductible expense from both PRT and Corporation Tax, reducing their size considerably. The replacement for SPD was Advance Petroleum Revenue Tax (APRT), operating along similar lines, though for fields gaining development approval after 1 April, 1982, royalty payments were to be abolished. The new tax served only to affect the timing of PRT payments rather than the total amount owed. APRT was abolished after 31 December, 1986, but nevertheless demonstrated governments' preference for receiving tax monies as soon as possible. [61]

To complicate matters further, the Labour Administration had introduced a system of `safeguards' designed to reduce the impact of PRT on a field as its production declined. This provision limited a field's PRT bill, for a six-month chargeable period, to being no more than 80% of the difference between the adjusted assessable profit calculated for a year and 30% of the cumulative capital expenditure to date. (The adjusted assessable profit is the PRT profit calculated after adding back in the oil allowance and all capital expenditures, upliftable or otherwise. The figure for cumulative capital expenditure was to exclude uplift). In 1981, the Government restricted the safeguard by making it unavailable to fields that had produced for 150% of the payback period and reducing the cut-off limit to 15% of the cumulative capital expenditure. [62]

Through the years Corporation Tax has continued to be charged on all profits from North Sea activity, once any royalty, PRT, operating costs, accelerated depreciation (with no uplift) and other allowable expenditures, such as loan interest have been deducted.[63] The rate has been 52%, reducing to 35% after the 1984 Budget, with a ring fence drawn around the Continental shelf for all calculations, so that losses incurred in onshore or overseas operations cannot be offset against offshore profits. The taxation requirement is that companies paying a dividend to shareholders have to pay in advance three sevenths of the likely tax bill. This is Advance Corporation Tax. [64]

A great incentive to exploration for the companies with taxable profits has been their ability to offset abortive exploration costs against PRT and Corporation Tax Profits. In practice, however, companies have delayed the declaration of abortive wells for tax purposes until they have been certain that no commercial finds would be made in an area. This delay could be for several years. The 1983 Budget allowed the claiming of PRT relief against all exploration and appraisal expenditure, without waiting for the expenditure to be declared abortive. [65]

Having described in outline main elements of taxation policy, there are certain related points which need to be made at this juncture, concerning the evolution of government policy, and its relevance to the nature of the technology employed in the North Sea. In general terms, the system of taxation that has operated on the UKCS since the 1975 Oil Taxation Act, may be characterised by its tendency to promote complexity, uncertainty and `gold-plating' (or the wasteful use of capital expenditure). These accusations are especially relevant if one considers the view that a licensing allocation system based on the auctioning of fields, rather than on administrative discretion, would have enabled licensees to treat payments for block licences as sunk costs, to be ignored in later decision making. [66] In the British case, North Sea development decisions have been sensitive to the method of rent collection and the process through which it has arisen and subsequently been altered. Thus taxation has not operated in a `neutral' way and has distorted the making of investment decisions.

Prior to the Oil Taxation Act, reliance upon Corporation Tax had proved to be an ineffective method of oil sector taxation. Whilst one virtue of employing the same system of taxation for the oil sector as for other industries lay in the relative certainty this afforded to company decision making, there were two principal weaknesses. Basically, Corporation Tax was both incapable of capturing an adequate amount of the economic rent for the government and also served to encourage `gold-plating'. The evolution of taxation policy since the 1970s seems to have had much to do with governmental attempts to derive more of rent from North Sea activity and, at the same time, to apply some leverage over the major oil companies. Securing lower-cost developments of North Sea fields does not appear to have played a central role.

The main motivation behind the Labour Government's White Paper of 1974 and the subsequent Bill on oil taxation, concerned a desire to be seen to be taxing excessive oil company `windfall' profits and to close the loopholes that were being exploited under the previous system. In particular, the various opportunities for diverting capital adversely affected the incidence of Corporation Tax on companies operating in the North Sea. For example, multi-national firms were able to make inter-corporate loans to British based subsidiaries, which qualified for interest relief under the existing provisions. Moreover, they were able to offset tax losses incurred under British Corporation Tax against profits elsewhere in the world, as well as on their other domestic operations. Hence, both rent capture and any incentive to the cost-efficient development of resources suffered. [67] Similarly, by specifying royalty payments on the well head value of production, rather than on the landed value of production, the licensing regime enabled fields on acreage granted in Rounds 1-4 to claim deductions from Corporation Tax and later from PRT, for refining and transportation expenses.

The introduction of the new system of taxation may be viewed as a response to the emergence of oil issues on the political agenda. Political parties during the period of the first `oil crisis' had to be seen to be doing something about excessive oil company power and profits. As one commentator has noted:

> "only in the period of supposed energy crisis did politicians feel that they needed to supply the electorate with interventionist policies". [68]

One partial consequence of this was the haste with which Petroleum Revenue Tax was adopted, with little or no consideration of other plausible alternatives, such as the Resource Rent Tax. [69]

In addition, government officials and politicians had been quickly made aware of the difficulties implied by the suggestion of retrospective taxation and also of the provisions of the new tax regime on the momentum of field development. Constant and somewhat effective lobbying by oil company tax bureaucrats ensured that specialists on either side encouraged the development of ever more complex systems of taxation and a diversion of resources into the negotiation activities associated with subsequent amendments to the system. Whilst the four-tier system of taxation was eventually simplified (down to two tiers of Corporation Tax and PRT for `new' fields), the auctioning system of licensing has rarely found official favour. So, for `old' and `new' fields alike, rent collection has generally proceeded with short-term, upward, adjustments in the rate of PRT, increasing the level of the State's take to the very limits of the industry's taxable capacity. Simultaneously, such measures have generally been accompanied by a willingness on the part of governments to accept oil industry concerns relating to the high cost of development and the need to maintain sufficient current cash flow to fund future investments. Overall, the impact of such bargaining (and also of governments' own wishes to protect the offshore supplies industry) has been reflected by the degree to which the State has borne the brunt of the cost of developing North Sea resources.

For the older large fields, this phenomenon may be demonstrated with reference to the several allowances available to field operators, protecting them from the financial risks of development, though at the expense of the usual factors encouraging corporate efficiency. Thus the provision of `uplift' has sought to improve the discounted cash flow value of field investments, initially by enabling 175% of capital expenditure to be claimed by fields against PRT and so delaying payment of the latter. (Interestingly enough, as originally proposed and prior to company complaints concerning the disincentive effect of the 1974 Oil Taxation Bill, the uplift figure had been lower, so that 150% of capital expenditure would be allowed). Moreover, the early large fields which still contribute the bulk of North Sea output have been the subject of a marginal tax rate as high as 85%. [70]

As Robinson has noted:

> "companies knew that, provided they were in a taxable position, any costs they incurred would at the margin be shared 15 : 85 as between them and the taxman. That inevitably blunted the incentive to develop fields efficiently. There does seem to have been some very wasteful spending in the early years". [71]

Robinson continues by referring to the impact of the 1986 price crash and the `new' field tax regime, with its much lower marginal rate, on the oil companies newly-found ability to reduce developments costs for new fields (by between 30-40%). [72] Finally, the taxation system has operated to insulate companies from the effects of price fluctuations, with again a detrimental impact on technology and costs. Hence, a dollar rise in pre-tax revenues generated by oil price rises had the result of adding only 15 cents to company profits after tax. However, a fall of one dollar in crude oil prices has led to only a 15 cent drop in post-tax profits for the company and an 85 cent fall for the government. [73] Clearly, this is a situation which has not encouraged companies to develop cost-saving technology. Indeed, the reverse would seem to apply.

5.8 Summary.

What this chapter has shown is the generally short-term nature of government policies towards the North Sea, particularly in the early stages of its development. Moreover, the likelihood that politicians and civil servants will attempt to pursue their own interests, rather than those which might in some way be defined as the societal interest, has been explored. Clearly, the prevalence of shorter-term horizons has implications for the evaluation of North Sea policy. Thus it will be necessary to consider the conduct of policy in terms of both the shorter- and longer-term interests which politicians, administrators and society in general may wish to fulfill. Chapter 6 now considers the corporate perspective to North Sea affairs, in terms of the factors influencing oil company interests in the area.

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CHAPTER SIX

THE POLICY MAKING PROCESS AND NORTH SEA OIL: THE CORPORATE PERSPECTIVE

6.1 Introduction.

This chapter continues the work begun in the preceding one by providing some background to the conduct of corporate strategy in the North Sea. Primarily, this is a task which involves a discussion of the main factors likely to have an impact on corporate objectives and investment in the North Sea over time. These may appear in the form of external constraints on the actors or may be reflected in bounds on industry sector or individual company behaviour. The consequences of such contextual consideratons represent another important source of enquiry, particularly as they exemplify the process by which non-incremental policy options come to be chosen, to the exclusion of other potentially more flexible ones.

To begin with, the focus centres on the changing relationship of the multi-national oil companies to the governments of oil-producing countries, particularly those in the Middle East on whom the West came to rely for its oil supplies. Essentially, this discussion links the timing and nature of North Sea development on the

UKCS to the power struggle between these actors, over the management of the global oil system. Another important factor to take into account follows on from this issue. This, as noted in the previous chapter, is the general political climate in Britain and more specifically, developments in the conduct of government policy towards oil matters as the potential value of the North Sea came to be realised. Certain areas of policy, such as those concerning taxation, licensing and depletion rates have already been dealt with in the previous chapter. However, with the corporate perspective in mind, policy issues are reconsidered in terms of their relationship to technological choice in the North Sea.

As far as inter- and intra-organisational relationships within the industry are concerned, their relevance is discernible at various stages throughout the project cycle. This includes the original decision of whether to invest in exploration, the criteria that are chosen to evaluate progress and the degree of commitment with which a policy is pursued, once adopted. Of relevance, here, is the nature of competition in the industry, project definition and management, the perceived likelihood of adequate returns on investment and the availability of sources finance, for example. Some of these factors may impinge upon the the degree to which the centralisation of policy excludes the involvement of smaller firms with perhaps a greater incentive to cut costs through technical innovation. Almost all of these considerations will have an effect on even the largest company's ability to handle the complexities and problems of North Sea oil technology.

6.2 OPEC and the Major Oil Companies.

The first potentially important prospect in the North Sea was discovered just as the seeds were being sown for the formation of the Organisation of Petroleum Exporting Countries. In 1959, a collaboration between Exxon and Shell, the two largest companies, found natural gas at Groningen, off the coast of Holland. However, it was not until 1963, that the North Sea attracted large-scale exploration. The timing is coincidental since, before this time, Middle East oil had seemed limitless and recent discoveries in North Africa appeared to be safe from the threat of any growing nationalism in the area. Now OPEC's formation established a "cartel to confront the cartel", its first resolution making it clear that the multi-national oil companies were the chief enemy. [1] Hence the view that North Sea investment was a reflection of the need for the major international oil companies, in particular, to thwart the threat of increasing OPEC power and control over the supply and price of oil.

Indeed, until the 1960s, the majors had had great freedom to act in the main areas of oil production. [2] Now, all the major oil producing states of the Middle East, North Africa and South America became intent on capturing a larger slice of the oil revenue cake. Moreover, to combat the `neo-colonialism' of the companies, there were moves to establish greater degrees of state participation in, and control over, the companies' operations. Often this took the form of either joint ventures with state-owned entities or general overall control by a government ministry or other official body. In addition, the `independent' oil companies were encouraged to participate in, or even initiate oil development programmes at the cost of the major companies' share of total production. [3] The following paragraphs, therefore, consider in more detail how such changes in the control of oil supply and price are related to North Sea investment.

As well as the emergence of `independent' American oil companies, the traditional dominance of the majors over the producing countries was complicated by the new rivalry of national companies from the consuming countries of Europe and also Japan. Thus the 1950s saw a glut in the supply of oil with the attendant downward pressures this brought on both the world market price and the `posted' price of oil.

At this stage, perhaps, some explanation of the system of pricing in the oil industry is warranted. The pricing system of `posted' prices had been established by the cartel of major oil companies as long ago as 1928. It was a result of a bid by three biggest companies of the time, Exxon, Shell and B.P., to limit destructive price competition, maintain profits and, as Rockefeller claimed, to efficiently manage production and regulate the use of reserves. [4] Basically, the system revolved around the establishment of posted prices for crude oil and its products in the Gulf of Mexico, from where most domestic United States oil production was shipped overseas. The `Gulf Plus System', as it was known, was one where in order to protect American interests, oil from elsewhere in the world was fixed at the price in the Gulf plus the standard freight charges for shipping the oil from the Gulf to its market. [5]

As well as keeping prices higher than they needed to have been in most markets, this system also restricted the development of low-cost sources of oil, wherever it originated. [6] Moreover, posted prices were the basis for the fifty-fifty taxes that the major companies paid to the producing countries, who came to plan whole budgets om the expectation of this income. [7]

The companies were able to operate this system with reasonable success until the advent of North African and especially Libyan oil, the upsurge of nationalism in this area and the Middle East which occurred during the 1950s and the new competition mentioned above - a by-product of these events. But facing cuts in the price of oil globally and the increasing availability of supplies that was a result of the imposition of import quotas by the United States in 1959, presented the majors with something of a dilemma. Thus on one hand, they were forced to reduce prices in the market place, while on the other sticking to the same posted prices, which would in effect mean paying the producers more than their fifty per cent. Clearly, something had to give. In February 1959, the posted price was cut by eighteen cents a barrel, thus reducing tax payments to the four main Middle East producers by about ten per cent. On August 8th, 1960, Exxon announced further cuts in Middle East posted prices of roughly ten cents a barrel. The interdependence of the major companies ensured that the other `sisters' also cut prices, though initially by different amounts and with some reluctance. [8]

This threat to revenues and to the domestic spending programmes of the producers did much to encourage the formation of OPEC, barely a month after the second increase. The new organisation, though not always at one with itself, struggled to conduct the exploitation of their most precious commodity in ways that would meet their own internal needs. The producers' major ambition was to restore and maintain posted prices at pre-1960 levels, and for some, to achieve full control over production. [9] Bound up with this, these aims was the notion that for OPEC to become a cartel capable of controlling prices, there would have to be some agreement among member states to restrict output.

For the companies, the strategic options at the time revolved around views concerning prospective trends in demand, supply and therefore the price of oil (both posted and market). Economic growth based on ever-increasing oil consumption was a fact of life in the 1960s. Indeed, oil replaced coal as the major source of energy in Western Europe, both industrially and domestically. [10] Moreover, the conventional wisdom of the time was that there would be a continued rate of growth in the use of oil. Still further, there was no doubting the future availability of oil. Thus one option was to try to sustain the increase in demand by way of the recovery and exploitation of new reserves. The incentive to do this could be provided if sufficiently high prices were maintained. [11] Again, with the prevalence of low prices, the companies could aim to keep their respective market shares by exploiting the burgeoning European market and adopting aggressive marketing strategies. These paths did not necessarily exclude each other.

What actually occurred was that the market price of oil continued its downward trend during the 1960s and the early 1970s while the posted price was held relatively stable. A temporary hiccup did arise in the market price at the time of the Six-day War, in 1967. Here, the Arabs in OPEC used oil as a political weapon, boycotting supply to Britain and the U.S.A., in particular, who had supported Israel in the conflict. This created a temporary imbalance between supply and demand which could not be fully restored by supply from elsewhere. As for the posted price, this seemed unlikely to rise as long as individual producing countries remained desperate to push up production in order to secure greater revenue. This was exemplified by the willingness of some OPEC members like Iran, Libya and Venezuela to exploit the others' boycott to their own advantage by expanding their exports to Europe.

The inability of OPEC to effectively control supply, the emergence of oil as a politically sensitive resource and the optimism on the part of the industry about future demand and supply (even with currently low prices) are all factors which must have figured in the oil companies commitment to continue North Sea exploration and also in government policies encouraging this. This is so since, although gas had been found in the Southern Basin of the North Sea, until 1969 there was little else to support the belief that the area could live up to the potential Groningen had pointed to. Indeed, it has been suggested that the increase in exploration rate that occurred between 1964 and 1967 and its stability until the end of the decade, was more a reflection of the companies intense need

> "to diversify their interests and production potential outside the OPEC countries rather than because they saw a large potential in the North Sea".[12]

This point is made all the more relevant considering that even the most substantial British sector finds of 1970 and 1971 (Forties and Brent) would only have been marginally profitable at 1970 prices.[13] Nevertheless, the discovery of these major fields established the existence of potentially commercial projects in the North Sea.

The expansion of exploration activity was prompted by this and a second factor linked to the shifting of bargaining power and control away from the companies. This, of course, was the huge increase in price occurring in 1973/74, when the posted price climbed from \$2.8 to \$11.6 a barrel. The rise can be seen in terms of a culmination of events which had begun with the coming to power in 1970, of a left-wing government in Libya, led by Colonel Quadaffi, which immediately cut output and increased price. Other producing countries were quick to follow suit and the early seventies saw a succession of small price increases dictated by OPEC members, prior to the doubling of price which signified OPEC's dominance of the world oil market. [14]

Between the 1973/74 increases and the next oil `shock' of 1979/80, when the OPEC-imposed rise drove prices close to $35 a barrel, the power balance of the producers and the companies was to be further disrupted. One by one, OPEC's members took control of the oil concessions that the companies had secured from them in the past, by nationalising the bulk of their assets. [15] This represents another factor in continuing the companies commitment to the North Sea at this time. So although exploration rates were falling during this period, this could possibly be better explained by the desire to focus energies on rapidly developing existing discoveries, than the reason of dissatisfaction with British government policy that is usually given.

There is one other factor which has not yet been discussed that seems to have encouraged the development of oil in British waters. In addition to the need for independent sources of supply and the higher prices which made U.K. oil more economic to extract, the imperfect nature of the international capital market and its effect on individual OPEC members ought to be taken into account. Hence, those OPEC countries with insufficient oil revenues to finance their plans for development (`high absorbers') have faced borrowing difficulties in attempting to use their reserves as collateral, because of their history of asset appropriation. Again, `low absorbers' are unable to achieve high rates of return on their investments because long term assets face the risk of expropriation and are difficult to acquire, whereas short-term securities earn only low nominal rates. The effect of this within OPEC is to induce the extraction of both high-cost and low-cost oil, whilst globally, low-cost oil from OPEC members is replaced by high-cost OPEC and non-OPEC oil. [16]

6.3 Industry - Government Relationships on the UKCS.

As chapter 5 has shown, the major international oil companies have been able to exert a great deal of pressure and influence over government policy towards domestic oil supply. This is something which actually pre-dates activity on the UKCS. In the post-war period, for instance, the domination of the U.K. petroleum industry by the likes of Shell, B.P. and Esso, succeeded in stifling competition and promoting the belief that only the most powerful companies could best ensure the supply of much-needed oil imports.

Unfortunately, a vicious circle was to develop which was connected to the balance of payments and ought to have provided a lesson for government in their handling of affairs with the oil firms. During the 1950s and 1960s, it had seemed that one remedy to emerging balance of payments difficulties lay in the ability of domestic multi-nationals or home-based subsidiaries of foreign companies to offset some of the cost of importing oil. This would be through profit remittances and orders for domestic industry, as well as increases in U.K. refining capacity.

Yet, as governments accepted that oil would play an increasingly important role in national energy policy, they also accepted the setting of prices by the companies. In this way, Britain was forced to endure higher oil import prices than elsewhere in Western Europe. This fed back into the balance of payments and showed how companies could dictate to and influence governments given the opportunity. In OPEC and in other European countries there was much more encouragement for `independents' with access to lower-cost sources of crude, or national companies were formed, enabling domestic prices some 25% lower than in Britain.

This over-reliance on the major oil companies on the part of British administrations was to endure as licensing and depletion policies came to be formed during the 1960s. Moreover, where the civil servants in these areas turned to such companies for advice in the making of policy, those in other disciplines such as taxation seemed to fear antagonising them too much lest they take their business elsewhere.

Overall, therefore, the largest companies were able to enjoy a great deal of influence over the pace of exploration and depletion, in the decade after the first production licences were granted. Thus up until at least 1974, these companies were able to operate on the UKCS relatively free of political control. Persistent governmental concern with securing the benefits of rapid exploitation meant that the companies were constrained only by the need to pay heed to `good oilfield practice' and the basic ground rules of the Petroleum (Production) Regulations. A particularly important area where companies have been able to use their influence concerns reserve estimation. The previous chapter has already noted the tendency for oil companies in the North Sea to be unnecessarily conservative in their estimates of field potential (see section 5.5).

One reason for this owes something to the nature of oilfield development, which is characterised by geological surprises, providing a welcome boost when reserves are higher than expected but proving disastrous when they are not. Another important reason, as demonstrated by Aaron Wildavsky and Ellen Tannenbaum for the U.S.A., [17] is the tendency for reserve estimates to be influenced by the interests of those compiling them. Pessimistic estimates of reserves at the outset of North Sea activity have helped to encourage government tax concessions and to sustain high oil prices. When considered alongside corporate needs for immediate cash flow, factors such as this have not fostered conditions conducive to cost-effective management of the technology of oil.

Another aspect of the relationship between U.K. governments and the oil industry having a bearing on the evolution of policy in the North Sea, concerns the management of North Sea gas reserves. The southern basin of the British North Sea had been proved to be a significant gas-bearing region during the mid-1960s, beginning with the discovery of the West Sole field by B.P. in October 1965. However, the companies were soon to find themselves up against a monopsonistic British Gas Council, which favoured a strategy of low pricing, clearly not to the companies' liking. This and the perception towards the end of the 1960s that the most important gas reserves had been located, encouraged the oil companies to look for oil further north, in the knowledge that they were likely to have much more influence over the pricing system for that commodity.

6.4 Industry Sector Dynamics.

The dynamics of relationships between the various firms to be found within the oil industry sector are an important factor in the making of corporate strategy and in investment behaviour in the North Sea. In this respect, Davis has advanced an institutional approach, arguing that

> "pure `economic' opportunity cost behaviour is `bounded' by a corporate combination of organisational dynamics, oligopoly behaviour and political activity". [18]

So, if vertical integration and control are critical to the oligopoly behaviour of the industry then `commitment' to high-cost provinces like the North Sea will vary according to corporate needs for secure sources of crude oil, for refining and marketing purposes and secure, preferably nearby product markets. [19] There again, where organisational behaviour is a critical variable, the dynamics of North Sea group behaviour become of significance to the investment decision. [20]

At the turn of the 1970s, the combination of large oil discoveries in the central and northern North Sea, the nature of government policies designed to encourage rapid exploitation, plus the industry's own perception of the risks involved in developing the North Sea's fields, resulted in high industrial concentration. Whilst North sea projects are far from homogeneous there are a number of common features that they share. These make the U.K. oil industry more amenable to certain types of organisation than to others. The features refer to the geographical environment, the severity of which acts as a barrier to entry to companies not already in the offshore oil exploration business. They also relate to economic barriers to entry present in the form of uncertain returns on investment, huge project costs and the long pre-production period involved. Investors in the North Sea, therefore, have had to be able to commit large-scale funds for a number of years without suffering any short-term financial hardship. Finally, the operation of government licensing and taxation policies has served to provide both barriers to and incentives for entry, as shown in the preceding chapter.

In general, larger companies with diversified and integrated operations are better able to deal with and spread the risks of exploration and to cope with the uncertainty and high cost of development. Hence in 1986, just three `majors' (B.P., Exxon and Shell) accounted for 40% of North Sea production, while the six biggest international oil firms held nearly one-third of the licensed area. [21]

The costs and technical difficulties of North Sea exploration and development has ensured that instances of companies being able to afford to own individual blocks outright have been relatively rare. Participation in consortia, therefore, has been a common and necessary method for progress. This carries several advantages for the companies. In particular, risk is shared, the raising of capital made considerably easier and the pooling of knowledge and expertise facilitated. However the development of consensus within consortia may be hindered, especially bearing in mind the different opportunity cost perspectives that firms have. [22]

Interestingly, while some companies have turned to Game Theory to find mathematical answers as to what constitutes an effective group, others turn to successes in past agreements for clues to the future conduct of policy. The latter method may obtain whether or not these successes are, in fact, derived from the actual terms of the agreements concerned. Some of the problems of group cooperation include voting procedure, different reserve and cost estimations, the spread of expertise across group members and the activity of individual members to raise the necessary capital, without becoming too over-exposed in their borrowing. [23]

In practice, conditional voting occurs, the minority party being forced either to support the majority view, sell their shares to others willing to invest in the prospect or opt out. However, the minority are protected by the inclusion of self-risk clauses in agreements allowing group members to act at their own risk in exploring, developing or confirming a project, or conversely not to act. Should the former be attempted and be successful, other members may be able to enjoy the benefits, on payment of a certain penalty. [24] Expertise becomes an issue especially where several of the partners in a group have oil as a secondary activity. However, this can sometimes lead to more effective cooperation than is possible in groups where the petroleum engineers of companies very active on the UKCS, deadlock over development prospects.

Turning to the problems of finance, Odell and Rosing point out an example of the limits borrowing can put on the financing of a project. In this case, a one-platform system was adopted on Piper field, when a two-platform system would have earned much more over the lifetime of the field. Each member was committed to shares of over $650 million. [25] This type of dilemma readily exemplifies the way in which the financial considerations that oil companies have had to take into account have led to conflict over the extent to which UKCS fields ought to be developed.

Hence corporate decisions influenced by the desire to quickly recoup any investment, may well result in the development of fields with fewer platforms and wells than are needed to produce all the technically recoverable reserves from a field, in an economically relevant time period. This is so because the minimum number platform system will have its platform(s) located so that the maximum possible oil can be produced in the shortest possible time, thus enhancing the present-value of cash-flows to the owner(s) of the field. [26] This type of decision results in the field being depressured to greater than desirable levels or the possible loss of reserves due to the irregular advance of the oil-water contact zone cutting off reserves from future recovery efforts. [27] Thus

> "once the initial platform location decision is taken ... every other location for a platform on the field becomes sub-optimal with reference to the original technically recoverable reserves". [28]

Such problems are exacerbated when decisions have to be made for finds extending over several blocks of the North Sea and which may be owned by several groups. Since in British law each field has to be developed as a unit, `unitisation' agreements have to be reached as to the one best way to exploit the field as a whole. The potential for friction should be readily apparent in such circumstances. An example of this is the conflict between Shell/Esso and B.P. over platform location on Forties, owned by B.P. but with seven per cent of its area `tailing out' into Shell/Esso's adjoining block. [29]

6.5 Intraorganisational Dynamics.

The main focus of this section is on the internal, company-specific dynamics which may influence investment decisions and their implementation and review. Clearly, the portfolio of alternative opportunities and risks that are available to a company and also its internal resources, both actual and potential, are of significance. More specifically, there are a variety of investment appraisal criteria tools which are used to evaluate the merits and progress of the respective projects, which have to taken into account. These include: the net present value of the cash flows and the internal rate of return of the project; the project cash flow curve showing the magnitude and timing of the capital expenditure and subsequent revenue stream; and the project payback period, the length of time from the start of the project until the capital expenditure is recovered. [30]

The use of the internal rate of return as an indicator of investment profitability merits some further attention as it provides one of the main criteria for analysing success in policy later in the thesis. Its use is relevant since the calculation of North Sea profitability is not just a matter of comparing the `accounting' capital and operating costs with the revenues that might be expected. [31] This is so because the timing and profile of expenditure are also extremely important. Therefore conventional methods are likely to

> "overstate the true profitability of any activity where capital expenditure is incurred ahead of the receipt of revenue". [32]

This technique, then, is particularly pertinent to the North Sea, where capital expenditure is often very heavy and generally well in advance of production. Hence an application of discounted cash flow methods, such as internal rate of return, can correct for the `time-value' of money, by calculating the present value of a future stream of income. Internal rate of return, then, refers to the rate of interest at which a project makes neither a loss nor a profit and is primarily an indication of the relative timing and magnitude of investments and revenues.

Other indicators may be used alongside `IRR' such as an assessment of technical risk or of the uncertainty involved in a project. [33] If the estimated internal rate of return is greater than the company's cost of capital (equity or loan), then the project will be deemed to be profitable and vice-versa. [34] Moreover, quick exploitation policies will be followed in situations where prices are increasing, stable or declining, provided that the rate of interest is greater. This is so because the company will be able to maximise its income over any time period by exploiting now and reinvesting the profits. Production will be deferred only if the expected rate of price increases is greater than the rate of interest or if the costs involved in obtaining a more rapid rate of production more than offset additional revenues from extra output. [35]

The `rules of thumb' used to assess the opportunity costs of competing investment options or to evaluate the progress of options actually selected vary quite widely across the industry. For example, the rate of return required may vary depending on the company concerned, the size of the field or the rate of production. Hence Compagnie Francaise Petroliere might develop a large field with strong production rates on the basis of a 20% return, smaller finds might only be commercially viable at rates in excess of 40% or 60% and perhaps as much as

100%. Again, Gulf might require 25% for a major find in the North Sea and Shell only 15% - a rate not untypical of British manufacturing, in general. [36]

This of itself is not all that surprising but the differing views of opportunity cost do find an expression in firms' commitment to the North Sea and also the specific commitment that they develop towards certain North Sea fields, especially higher-cost ones. Indeed, taken together with the capital costs necessary to develop a field, field size and the rate of production comprise just one element of the corporate perception of `risk'. This is in addition to the previously mentioned requirements of secure, good quality future supplies and favourable political conditions and policies.

Certain aspects of the internal functioning of firms charged with performing operational duties on behalf UKCS consortia are also relevant to the inter-organisational co-operation necessary to realise oil projects there. Most notable among these is project management, the primary aim of which has been to ensure that timetables for achieving production have been met. From the outset the cause of gradual learning about North Sea technology together with cost control have been sacrificed in favour of maintaining such development timetables.

The inappropriateness of this form of project definition and failures to acknowledge the problems associated with fulfilling declared objectives, prevented the establishment of adequate management structures and systems. It also resulted in operators and contractors adopting inadequate plans and applying ineffective controls. For example, operators would contract out management responsibility for North Sea projects. Unfortunately, it turned out that contractors were often not up to the task and there were also shortages in experienced in-house design and management staff. In this way, responsibility for overseeing construction programmes ended up with those who were available, frequently managers with experience of oil exploration and production rather than the required skill of project management. [37]

Another aspect of project management giving cause for concern relates to the issue of co-ordination. Because of the tendency to define projects in terms of target dates, it was common practice for different organisations to be simultaneously contracted to perform those parts of a project that could be pursued in parallel. So it was possible for three or four companies to be involved in designing different parts of the same platform or as many as twenty contractors to be involved in jacket fabrication. The necessity for close co-ordination of such activties was crucial, therefore.

However, contractors did not establish adequate mechanisms for dealing with the technical difficulties which were bound to arise. In addition, the

> "allocation of management responsibility and authority was ill-defined, resulting in omissions, duplication and misunderstanding [and] a tendency emerged for decisions to be delayed or passed up to the operators". [38]

The cost of development delays and of grappling with the technical complexities of North Sea is reflected in the performance of the various fields in the region. However, in considering an evaluation of the degree to which non-incremental technology has permitted corporate (or other) agents to attain their objectives, some care is warranted. Hence, whilst analyses based on discounted cash flow may be employed to assess field performance in a narrow micro-economic sense, it is recognised that all agents in the North Sea exercise may be seeking to satisfy more political or strategic aims. Chapter 7, therefore, seeks to cater for such issues in addition to focusing on the costs incurred in securing the pecuniary advantages of North Sea oil.

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CHAPTER SEVEN

THE IMPACT OF INFLEXIBILTY ON PERFORMANCE IN NORTH SEA OIL FIELDS

7.1 Introduction.

The final two chapters of this thesis are directed at two fundamental tasks. This chapter reconsiders the physical and social inflexibilities discussed above in the context of an evaluation of the conduct of North Sea oil policy. In Chapter 8, the conclusions drawn from this assessment are extended to the making of technology policy in general, with lessons for the improvement of policy making being the object of study.

In short, the aim of this chapter is to demonstrate that the non-incremental policy of rapid exploitation has provided `success' only in partial and illusory ways, through the achievement of self-sufficiency in oil, for example. Moreover, in the course of fulfilling this and other near-sighted objectives quite inflexible technologies have been adopted, which have been very resistant to control.

The consequences of this may be highlighted by considering ways in which the outcome of policy has diverged from what may legitimately be portrayed as the agents' longer-term interests. Delays in the manufacture and installation of capital equipment, leading to late production starts provide one such example. Universal and unimaginable increases in development costs are another. All agents, whether they are considered in terms of governments, corporate bodies or 'society' will ultimately find that some aspect of their 'interest' is damaged by such increases or delays. Of course, any long-term harm that is done has to be considered alongside the achievement of short-term objectives which the agents may have wished to pursue. Finally, by constructing scenarios incorporating different price trends, it is possible to see the apparent success of rapid exploitation in its true light, striking a further blow to any claims to success.

7.2 Success And Failure In Rapid Exploitation Policy.

Questions surrounding the pace of oil depletion and the nature of licensing and taxation policies relevant to this, have never been far from the centre of attention in this thesis. Rapid exploitation is a policy which may be seen as attending to the converging short-term interests of the State and the major oil companies. So, as shown earlier, the foremost concern of the policy makers has been, on one hand, to achieve self-sufficiency as rapidly as possible, whilst on the other, ensuring the earning of quick revenues to enable the companies to repay borrowings and to minimise investment uncertainties.

The need for self-sufficiency is usually explained by reference to the continued underlying weakness of the domestic economy and to a dependence on foreign oil imports at a time when energy demand was burgeoning. The effects of these conditions manifested themselves in government concern about Britain's persistent balance of payments difficulties and also the security of oil supply once OPEC had begun to flex its political muscles. For the companies, the late-1960s was a time when greater Arab assertiveness toward their oil resources was to be reflected in corporate fears for their own profitability and long-term survival.

Whatever the actual complexity of these agents' interests, it may be reasonably assumed that the profit motive represents a large part of corporate aspirations in the North Sea. Similarly, governmental hopes can safely be said to include a desire to earn sterling revenues where possible, or at least to avoid greater than necessary foreign currency payments. The objective in this case is to facilitate governmental policy making over a range of areas, by reducing the Public Sector Borrowing Requirement. Accordingly, it is within the interests of the participants to adopt policies which permit and enhance positive cash-flows. Unfortunately, this has not occurred in the way that the decision makers would have wished.

This is particularly true of cost overruns, especially the way in which the escalation in costs occurred during the period 1973-75, when the development of the first commercial oil fields was in full swing. Although it is very difficult to arrive at reliable figures for overall cost escalation at that time, some indication of its magnitude may be given by considering changes in estimates over time as well as absolute increases in equipment cost. Thus the annual rate of cost escalation during the period Autumn 1973 - Spring 1975 has been put at 80%. This may be broken down into two components, unexpected increases in input costs and increases in work content, measured at 20-30% and 80-100%, respectively. [1]

Figure 1 provides support for the severity of equipment cost increases, with rises in input cost largely the product of bottlenecks in supply induced by the simultaneous licensing, and hence development, of many promising areas. For example, in 1972, when to satisfy lease commitments on Fourth Round concessions alone entailed the drilling of some three hundred exploratory wells, only eleven were in operation. Such

Source: N. Trimble, The Costs of North Sea Oil Developments, Past Trends and Future Prospects, North Sea Occasional Paper No. 10, University Of Aberdeen, Department of Political Economy, 1976, p. 5.

scarcity was to be reflected in charter rates. Contemporary estimates of exploratory drilling costs (i.e. rig plus services), therefore, were of the order of $250,000 per day (1989 prices). [2] By 1976 this figure had fallen to between $41-63,000 per day (1989 terms). [3] By comparison, the southern area of the North Sea saw drilling costs of around $125,000 per day (1989 prices), in 1972, jack-up rigs being more feasible here. [4] Similarly, the price of line pipe doubled during 1973 and 1974. [5] As for as increases in work content are concerned, the numerous changes which occurred in platform design and construction was a major contributor to both the delays in the commencement of production and the higher costs of development that this encouraged. This again is something which stems from the ignorance against which early licensing and development decisions were taken.

Looking at particular fields on the U.K.C.S., the tables below provide an interesting tale of the impact of policy. Some of the consequences of the explosion of exploration and development activity, in the early-1970s, have already been noted. However, they make even more interesting reading when individual field projects are considered. For example, even allowing for general price inflation peaking at a rate of roughly 25% per annum during 1975 and an increase of 61.4% in the cost index for capital equipment, between 1973 and 1975, [6] the disparities shown in Table 7.1 between successive development cost estimates are remarkable. As Table 7.1 demonstrates, a doubling of cost estimates between 1973 and 1976 was the least that companies could expect to suffer. Just to make matters worse, this was also a period of rising interest rates, with the one-year loan rate on the London inter-bank market rising from 9.5% in January 1973 to 15% at the beginning of 1975. [7]

Some of the basic reasons for this failure to contain costs have already been covered above (see Chapters 4-6). To briefly recap, these include a tendency to establish project definitions which underestimated the specific technical difficulties of exploring for oil and preparing for its production. By focusing on time rather cost criteria, attempting to simply transfer existing techniques where these were inappropriate and failing to co-ordinate the work of sub-contractors satisfactorily, operators were bound to experience serious increases in project costs. The nature of governmental arrangements, during this initial period of North Sea development, did little to improve matters, certainly not where licensing, taxation, the development of offshore industry, or the encouragement of independent companies were concerned.

Table 7.1

Changing Estimates of Development Costs for Various North Sea Oil Fields. (£ million 1989 money).

Field	**May 1973**	**Feb 1976**	**1981**	**Current**	**% increase 1973-1989**
Argyll	73	138	144	309	323
Auk	73	169	152	474	549
Beryl A	685[1]	-	719	3023	341
Brent	2448	3640	5590[2]	8994[2]	267
Cormorant South	392	621	799	1259	219
Dunlin	783	1240	878	1381	76
Forties	1763	2573	1757	5229	197
Montrose	294	433	240	510	73
Piper	636	960	1085	2293[3]	261
Thistle	783	1255	1278	2191	180

Sources: For the 1973 and 1976 estimates, N. Trimble: the Costs Of North Sea Oil Developments: Past Trends and Future Prospects, North Sea Occasional Paper No. 10, University of Aberdeen, Department of Political Economy, May 1976. 1981 figures are from M. Lovegrove: Lovegrove's Guide to Britain's Oil and Gas, M. L. Petroleum Services Ltd., London 1981, Table 29, p. 116. The "current" estimates are based on data from County Natwest Woodmac's North Sea Service (October 1989).

Notes: 1. This is Lovegrove's figure for the field's "original" estimated development costs, Beryl Field was not included in Trimble's study

2. These include costs incurred on the Brent gas project

3. Based on capital costs before redevelopment began after the Piper Alpha Disaster. Woodmac have put redevelopment expenditure at approximately £400 million (1989 money).

Further, the under-critical acceptance of industry oil reserve estimates only served to encourage the adoption of short-term rather than long-term criteria of evaluation and to reinforce the pre-occupation with rapid development and near-future profits.

It is somewhat ironic that the products of combined governmental and corporate activity directed towards these short-term goals have been delays in equipment installation and, therefore, production starts and also reductions in potential overall cash-flow because of unanticipated rises in capital costs. The extent of development `slippage' is given in Table 7.2, below. Although no-one could possibly have forecast the extent of the price rises of 1973-74, when the first development consents were obtained two years earlier, there is little doubt that substantial extra gains could have been made if production had begun on time. Yet any advantages gained as a result of high oil prices have to be considered as fortunate and coincidental, rather than as adding in some favourable way to any assessment of oil policy. The role of high prices in bolstering North Sea field performance is considered in the next section.

Table 7.2

Development Slippage In Various North Sea Oil Fields.

Field	Original Date	Actual Date	Months Lost
Argyll	6/74	6/75	12
Auk	5/74	2/76	21
Beryl A	11/75	6/76	7
Brent	2/76	11/76	9
Cormorant S.	11/76	12/79	37
Dunlin	11/76	8/79	33
Forties	11/74	9/75	10
Montrose	6/76	6/76	Nil
Piper	5/75	12/76	19
Thistle	2/77	2/78	12

Source: M. Lovegrove, op. cit, Table 29, p. 116.

7.3 The Role Of Prices In The Performance Of North Sea Fields.

In the first instance, this section assesses the role of prices in influencing the conduct and success of North Sea investment. In particular, the consequences of the price `shocks' of 1973/74 and 1979/80 are compared to the reverses in price which occurred in the mid-1980s. This takes into account variations in field size and ownership.

At this juncture, it is worth recalling how terms such as `success' and `interest' are to be viewed. With respect to the concept of `inflexibility' which has been at the heart of this paper, the following criterion should provide some guidance. Successful policy making ought to act in the long-term interests of the agents involved, including society. In this case, it means that activities on the UKCS be performed with the aim of improving the micro-economic performance of North Sea fields so that all parties may benefit. Concern, therefore, is not with governmental tax revenues, as is so often the case, nor with micro-economic post-tax cash flows to the companies. To focus on these issues would be to miss the point somewhat by discussing the relative distribution of oil benefits between these parties. What is important is the overall contribution of North Sea activity to the U.K. economy. Hence the primary focus is on the cash flows generated by selected fields before taxes but after both operating and capital costs have been met. It should be apparent that for policy to successfully work in the decision makers interests, its aim must be to earn high pre-tax discounted cash flows while keeping costs low.

Steep rises in the price of crude oil did much to improve North Sea field economics during the first part of the 1970s and again at the end of that decade. Consortia which sought and won development consent for their fields before mid-1973, submitted their proposals against a background of average nominal $ prices of less than $2, in 1970, and just over $4, three years later. [8] In 1989 prices, this range is equivalent to roughly $12.15-19.65 per barrel. With the Arab-Israeli war average nominal prices, in 1974, leapt to over $11/bbl (more than $50/bbl in 1989 terms), then averaging around $14/bbl until the second oil `crisis' occurred, in the aftermath of the Iranian Revolution of 1979. Later the average nominal dollar price rose to a peak, in 1981, of over $37/bbl ($60 in 1989 terms). The average real dollar price peaked in 1980 at over $66/bbl.

Fortunately, for the companies operating in the British North Sea, the decline in the dollar price since

1981 has been matched by a parallel decline in the value of the pound against the dollar. This has insulated the sterling price of crude oil during the first half of the 1980s, so that the peak in nominal prices happened in 1984 (at £23/bbl). The real sterling price remained steadier throughout this period than its dollar counterpart. In 1986, prices plummeted, at one stage to below $9/bbl. Moreover, the dollar began to weaken against sterling, further depressing the sterling oil price to an average of over £10 (£11.70 in 1989 prices). Until the current Gulf Crisis prices had returned to something like their 1973 levels in real terms, notwithstanding a variation of $45/bbl over the period in between. The impact of these fluctuations in price has been to wreck any attempts to forecast price movements as an aid to investment decision making and also to affect the performance of fields where such development decision making has already been acted upon.

As far as the first wave of North Sea projects is concerned, one of the most notable components of the conventional wisdom of the 1970s, was the way in which the level of oil prices was more or less viewed as a constant amongst other variables in decision making. [9] One example of this was Exxon's 1971 forecast that over the next decade Arabian crude prices would not exceed $3/bbl. [10] The rate of growth suggested by such a trend in nominal prices is roughly 4% per annum. If one considers this alongside rates of inflation more typical of the early 1970s than the oil-induced hyperinflation of the mid-1970s, this rate of growth vanishes to a decline in real price of equal proportions. Similarly, Geoffrey Chandler, a spokesman with Shell and then President of the Institute of Petroleum expressed his slightly less pessimistic view of the future of oil prices. [11] For Chandler, a rise in price to over $7/bbl was required by 1980 to provide sufficient incentive for enhanced recovery and exploration in both old and new areas. This 1980 figure implies a real rate of growth in price of about 2%, if pre-oil crisis rates of inflation (averaging 8% per annum) are taken into account.

Adopting the latter view of price expectation, the scenarios developed below include one where oil prices grow at 2% over annual inflation. Calculations for this scenario are based on the historic price of Ekofisk crude in 1972, when several UKCS fields had received development consent, or were about to do so. Inflationary effects are allowed for by converting all revenues and costs to 1989 terms and future inflation is assumed to be 5% per annum from 1990 onwards. Sterling is the currency used in the calculations, historic rates being used in converting from U.S.$. Future rates of exchange are assumed to fall within the range from $1.70 in 1990, slipping back towards $1.60 by 1995, remaining constant thereafter.

For each field, the yearly cash flows generated are discounted in order to arrive at their present values and so account for the timing and magnitude of expenditure and income. Given that North Sea oil is a national rather than private resource, it is reasonable that a discount rate be chosen which reflects this. In considering their worldwide alternative investments, companies pursuing commercial interests may well insist on rates of return of, say 25-40% for riskier than normal projects. However, governments are rarely presented with such opportunities to earn high rates of return on their investments. They also have to consider the economic, political and social consequences of their decision-making much more carefully.[12] Bearing these factors in mind, a rate of 15% per annum is used for discounting purposes, although the employment of such a discount rate, serves to enhance the performance of North Sea fields in project appraisal terms.

Tables 7.3 and 7.4 reveal the contrast to be found in field performance if one compares scenarios incorporating moderate price growth with one based on actual prices. (In the latter, the same assumptions are made concerning inflation, exchange rate etc.). The main focus is on the first six named fields in each table. These constitute the North Sea's `first generation' and as such bore the brunt of its technical challenges.

It is remarkable how the economics of the early fields have been transformed by the sudden leaps in price of the 1970s. Thus once where many projects would have been loss making or vulnerable with moderate price growth, they now become generally very profitable. Indeed, with the sort of price trends more reminiscent of the early-1970s, only two of the first generation fields under review, Forties and Piper, would have been economically attractive (and these are in the kinder waters of the central North Sea). The same situation presents itself when, instead of a scenario based on growth over time, the price in real terms is held constant, say at £10/bbl. This is akin to holding constant the late-1973 price as expressed in 1989 terms and is also much closer to the long run supply price of oil. [13]

One likely effect of the timing of the 1973/74 price increases, with regard to the field developments taking place at that time, was to heighten the desire of governments and companies to make rapid progress towards production. However the wish to take advantage of the higher prices available was to be frustrated by the above-mentioned effects of development delays arising out of equipment shortages and associated cost increases.

Table 7.3

Net Present Value Of Selected North Sea Oil Fields (In 1989 Prices In £ Million Discounted At 15% p.a.), Under Various Scenarios.

(All figures are on a pre-tax basis).

Field	**Historical oil prices**	**2% p.a. rise in oil prices[1]**	**£10/bbl constant real prices**
Argyll	295	-121	-45
Auk	444	-132	-39
Beryl A	1797	-120	-102
Brent	2860	-1536	-2203
Forties	13853	3857	4289
Piper	6468	1683	1995
Alwyn North	-974	-754	-960
Buchan	273	-177	-242
Clyde	5	148	-16
Cormorant	179	-871	-1192
Duncan	24	-73	-98
Dunlin	2099	61	82
Heather	-16	-541	-570
Magnus	1610	774	176
Maureen	444	-60	-375
Montrose	253	-223	-198
Ninian	4989	-648	-981
Statfjord UK	1104	427	117
Thistle	1718	-666	-659

Note: 1. In this scenario, nominal oil prices grow at 2% above the annual rate of inflation, dollar prices being converted to sterling at historical and estimated future rates of exchange. These amounts are then translated into 1989 prices. (The same applies to the 2% growth scenario in table 7.4, below).

Source: Calculations are based on data from County NatWest Woodmac's North Sea service.

Table 7.4

Internal Rate Of Return (%) For Selected North Sea Fields Under Various Scenarios.

(All figures are on a pre-tax basis).

Field	**Historical oil prices**	**2% p.a. rises in oil prices**	**£10/bbl constant real price**
Argyll	54	-7	6
Auk	57	-3	5
Beryl A	44	13	13
Brent	24	11	7
Forties	58	32	39
Piper	72	38	51
Alwyn North	-19	-2	-44
Buchan	36	5	-2
Clyde	15	17	14
Cormorant	17	12	4
Duncan	35	-288	-66
Dunlin	53	17	18
Heather	15	-22	-54
Magnus	38	26	17
Maureen	30	14	4
Montrose	34	0	-14
Ninian	45	12	10
Statfjord UK	42	25	19
Thistle	38	7	4

Source: Calculations are made from data contained in County NatWest Woodmac's North Sea surveys and on the basis of the net present value figures presented in table 7.3, above.

Generally, the larger fields were insulated from the worst effects of this. By developing other constant price scenarios, it is possible to reconstruct the sensitivity of fields to changes in price, in order to gauge their ability to absorb increases in cost. The relative size of the operating firms involved is also important here, as this affects the degree to which it becomes imperative to cut cost, especially by way of technical innovation.

Forties field, for example, would continue to be profitable under almost any reasonable price scenario, with the same assumptions as above. Only at a constant real price lower than £4.50/bbl ($7 in 1989) does its net present value fall below zero. Under these circumstances, attending to cost might not assume the importance that it might do with a high unit cost, low output field. Such a project is the Argyll field and here the picture is vastly different. Whereas Forties is a field of giant proportions (2500 million barrels of recoverable oil, by company estimates and peak production of 523,000 barrels/day), Argyll is very small (70 million barrels recoverable and peak production of 23,000 barrels/day). In fact, it was not until the 1980s that other fields of comparable size to Argyll were developed. Moreover, Argyll's operator and chief shareholder is Hamilton - an independent company unable to absorb or finance the high costs of development in the way that B.P. can, even allowing for a benign tax regime.

Calculating the net present values for Argyll, as above, gives a break-even real constant price of roughly £11.50/bbl ($18 in 1989). This is a vulnerable position which would have been all the more precarious without the innovations that were in fact made. These have included the development of the semi-submersible platform and it is unlikely that bigger companies would have considered such a small project until more conventional alternatives had been exhausted. In the event, Argyll has enjoyed an extraordinarily high rate of return.

Since the 1986 collapse in oil prices, there has been a far greater concern with cost containment than hitherto. This applies to the bigger companies as well as to the smaller ones. There are several plausible explanations for this. The maturity of North Sea development has meant that new projects are smaller in size than the giant fields of the 1970s. Greater attention to innovating cost saving technology has therefore been warranted. In fact, most of the recent developments have been incremental add-ons to existing fields, with only five completely new fields being approved between 1980 and 1986. In addition to this, the more stringent attitude of governments towards the North

Sea has led to more punitive rates of taxation and a willingness to control production levels. This served to increase corporate anxiety during the years after 1981 when prices began to fall.

The period 1980-83 saw only two completely new projects on the UKCS, Clyde and Alwyn, which are now approaching their peak production rates. Ownership of Alwyn is shared by Total Oil Marine and Elf, state controlled French companies, while the principal participant and operator in Clyde has been, first BNOC then Britoil, after the privatisation of the former. The timing of the development expenditure made by these companies has been affected by governmental considerations. One of these was a concern to flatten out the production peak of the mid-1980s and also to defer some production from the 1980s so as to prolong high levels of production until the end of the century. [14] As well as this such factors as the position of the offshore supplies industry and, in the case of BNOC, the level of the PSBR have had to be taken into account before development consent could be granted.

These fields have been included in the discounted cash flow analysis performed above. (See Tables 7.3 and 7.4). Alwyn has a negative rate of return at a constant real price of £10/bbl and a very high break-even price of over £18/bbl ($30). Since more than 60% of its pre-production costs were incurred when prices were falling towards a real price of £11/bbl, it is not surprising that ways of cutting cost were found. Indeed, Total Oil Marine managed to achieve a £337 million saving on the original budget making total development costs £1.5 billion (m.o.d.). Technical factors contributing to this were:

a) the minimising of offshore `hook-up' by testing and commissioning each platform module onshore prior to sail-away;
b) freezing the basic design at a given point and thereby reducing the number of subsequent improvements required; and
c) keeping same the management team throughout the project to ensure that the original project philosophy and aims were maintained. [15]

Clyde for its part, has seen massive savings of £1 billion on its original budget, though much is due to expectations of far greater capital cost inflation being allowed for than was eventually the case.

7.4 Interpreting The Results.

The central message of this chapter has not been to deny some of the remarkable achievements of North Sea development. Although self-sufficiency has been something of a empty objective in itself, the rapidity with which Britain emerged as a net exporter of oil was a triumph, one which owed much to the convergence of government and corporate interests. Thus within the context of these decision makers' own short term objectives, policy in the North Sea may be presented as being successful. This may be noted with particular reference to the strategic need for independent sources of oil which occurred towards the end of the 1960s and offshore employment figures.[16] Similarly, governments and oil firms alike were able to earn relatively early and substantial revenues from North Sea oil operations, though these were subject to the cost escalation and delays in development discussed above and assisted by higher than anticipated oil prices. On the basis of these achievements, therefore, inflexible technology may be adjudged to have performed satisfactorily.

However, despite these short-term successes, the adoption of inflexible oil technologies, as they have been discussed within this thesis, has worked against both the above agents' and society's long-term interests. The selection of non-incremental oil technologies in the North Sea was the outcome of the organisational arrangements that were made. The nature of these arrangements reinforced the inability of decision makers to control or change technology, a handicap which the latter's physical features had by themselves encouraged. In particular, the pace of development inspired by the Fourth Round of licensing and a generous system of capital allowances led to bottlenecks in the supply and installation of equipment, as the domestic offshore industry struggled to cope with the bunching of orders which took place.

The consequences of this were reflected in delays in the development of the earliest and largest fields on the UKCS and attendant cost overruns. High prices during the second half of the 1970s have tended to mask the extent to which costs were not controlled. Further, lack of experience and expertise in oil matters on the part of civil servants responsible for licensing, resulted in decisions such as the Fourth Round allocation, being taken on the advice of experts from the very companies who stood to gain from it.

The impact of this was to concentrate many of the most important oil fields in the hands of the major companies. This lack of diversity was exacerbated by the absence of state companies at the beginning of North Sea activity which, in turn, made future policy more difficult. In this manner, therefore, the ability of decision makers to discover and to implement potentially more flexible technology was constrained. In terms of the need to secure greater public control of oil resources, politicians would now have to take back from the multinationals what they previously paid for.

Revision of the tax system was similarly frustrated. In this area, the regime developed in the mid-1970s was largely ignorant of how the system imposed related rates of taxation to developmental and technical decisions. Indeed, tinkering with the tax system was often seen as the only way of securing the incentives needed to encourage rapid exploration, but not generally as a matter involving the efficient development of resources. The regime was also geared to meet the needs of the Inland Revenue for ease of collection and resistance to evasion.

With high oil prices, tax came to be viewed in terms of a means of obtaining greater shares of oil revenue for the state, while reducing the extent to which `windfall' profits were being made by the companies. Unfortunately, continual rises in the rate of PRT (75% by 1983) backfired as prices fell in the 1980s. This occurred because the high prices of the late-1970s and early-1980s were more predictable than those of 1973/74 and were incorporated into companies' development plans. Attempts by the government, therefore, to tax what were seen as `excess' profits, in fact acted as a deterrent to incentives and to new development plans. [17]

This is not to say that governments should not try to obtain a greater share of oil profits. Rather, the concern is with successive governments' ad hoc treatment of the tax regime which has seemingly had more to do with short term political expediency than with a longer term view which might encourage tax stability and efficient expenditure. This must surely be to the detriment of long term planning. Constant changes in taxation may also be a function of civil servants' needs to promote their own prestige and status. [18]

So, the political arrangements within the oil sector have not contributed much in the way of facilitating control over technology in the North Sea's first generation fields. However, one should not gain the false impression that much could have been done in this respect once most of the provinces' early fields had been developed. Perhaps now that generally smaller areas are being developed, there may be greater opportunities to modify technology after it has been selected. In such cases, the cost of learning may not be so prohibitive, unlike previous developments where the features of the technology employed have precluded the correction of erroneous technical choice. Hence the time, cost and sheer complexity of the technology selected in this initial phase of North Sea policy, left the subsequent performance of the fields involved to the mercy of oil price changes in the mid-1970s and thereafter. Taken as a whole, these cases do not provide a happy instance of long-term planning and technical development.

NOTES.

1. Department of Energy, Paper No. 7, North Sea Costs Escalation Study, H.M.S.O., London, 1976.

2. R.W. Scott, The North Sea: Offshore's Greatest Venture, World Oil, August 15, 1972, pp. 33-40 and pp. 136-139.

3. N. Trimble, The Costs of North Sea Oil Developments, Past Trends and Future Prospects, North Sea Occasional Paper no. 10, University of Aberdeen, Department of Political Economy May 1976, p. 5.

4. Scott, op cit, pp. 34-35.

5. Trimble, op cit, Figure 1, p. 5.

6. Ibid., p. 3.

7. Ibid., p. 3.

8. Oil price data from County NatWest Woodmac's North Sea Service.

9. R.G. Reid, A View Of European Oil and Gas Issues, in J. Rees, P. Odell (eds.), The International Oil Industry, Macmillan, London, 1987, p. 78.

10. Ibid., p. 77.

11. In P. Odell and K. Rosing, The Future Of Oil, Kogan Page, London, 1980, p. 97.

12. P. Odell and K. Rosing, Optimal Development of the North Sea's Oil Fields - the Reply (to the critique of Wall et al), Energy Policy, Vol. 5, No. 4, December 1977,

p. 305.

13. Compare with P. Odell, World and Oil Power (8th Edition), Penguin, Middlesex, 1986, p. 287, Figure 7.

14. David Howell, Hansard, July 23, 1980.

15. Anonymous, First Oil For Alwyn North, Petroleum Times, December 1987, p. 10.

16. The 'Brown Book' (various years) puts average employment on North Sea installations at over 20,000 people for the period covering the last fifteen years.

17. C. Rowland and D. Hann, The Economics Of North Sea Oil Taxation, Macmillan, Basingstoke, 1987, p. 70.

18. D. Hann, Political and Bureaucratic Pressure On U.K. Oil Taxation Policy, Scottish Journal Of Political Economy, vol. 23, no. 3, January 1985, pp. 278-295.

CHAPTER EIGHT

CONCLUSIONS

8.1 Introduction.

The final chapter of this thesis draws together the various strands of the foregoing work within the contexts of technology policy research, in particular, and more generally, the political science and strategic management literatures. As has been the case throughout the volume, the focus is on the development of better prescriptive models of policy making. Again, the achievement of the latter is viewed as being increasingly relevant to the making of technology policy where the outcome of such policy is prone to potentially very high risks.

This chapter has two principal objectives. Briefly, these are: a) to further disseminate any lessons that have been learned from the North Sea oil case for the improvement of policy making in practice; and b) to point the way forward for future study. The sections below thus consider the contribution that the present work makes to the practice of technology policy making; and possible directions for future research, discussing the prospects for being able to apply the methodology used here to research where technology may not provide a clear-cut object for study. Finally, a summary of the main points made within the thesis provides the substance for its closing section.

8.2 Prescriptive Theories of Policy Making: a Reappraisal

At the beginning of this thesis, Chapters One and Two set out the case for testing the incremental approach to policy making, relating this to the demands of technology policy. To reiterate, the issue to be addressed was the need to evaluate and to suggest methods of policy making which could facilitate the control of technology in the interests of all who might be affected by its adoption.

More specifically, the primary focus of the thesis has been on the degree to which non-incremental technological decisions have enabled such control, irrespective of the method of analysis that had led to the choice. Of the several models espoused in the literatures pertinent to this issue, those having a mainly descriptive (though still prescriptive) element to them and those reflecting traditional or "rational" approaches to policy making, were deemed to be less valid prescriptions for guiding practice than incremental politics. This latter approach stresses the importance of making policy changes which do not vary greatly from the status quo i.e. gradual, small-scale and low cost adjustments to policy are favoured.

The grounds for making the above claim stem from a variety of sources. For descriptive research seeking to present models of "good practice", the prescriptions generated have very often been poorly developed. Thus, it is often difficult to ascertain what it takes to act in accordance with the prescriptions made, in any practical way. In addition, the contextual nature of the cases studied makes for difficulties in generalising.

As far as rational methods of policy making are concerned, their inapplicability to the issue of policy making under conditions of uncertainty and ignorance, is well known, notwithstanding future evidence to the contrary. Thus only incrementalism (and more specifically "incremental politics") seemed to offer a valid prescription for dealing with complex problem solving in the technology policy arena and even then the volume of empirical support for its prescriptions was, until comparatively recently, very thin. What follows below is a consideration of the several general and specific implications of the thesis for the prescriptive validity of incremental politics.

The first issue to consider relates to the Collingridge test which was set out in Chapter 3, section 3.3. and which provided the methodological basis for the thesis. To reiterate, this test was adapted in such a manner as to lay down certain criteria for the successful adoption of technology. In particular, these rules stated that only the adoption of flexible, incremental technologies could enable decision makers to satisfy their interests. More especially, their ability to retain control over technology was seen as being enhanced where relatively low cost or small scale technology was developed. The contravention of these rules, therefore, was deemed to be a poor step resulting in the introduction of inflexible technology. Such technologies were considered to be neither susceptible to subsequent control nor capable of performing in the interests of concerned agents.

Secondly, there is the matter of attempting to understand the nature of the interests of the agents involved. The existence of different aspirations or perspectives on the part of the various actors in the policy process, will be reflected in different ideas concerning the acceptability of inflexible technologies. The prescriptive validity of incremental politics therefore diminishes with the discovery of cases where the adoption of non-incremental or inflexible technology fulfils the agents' interests. A similar argument may be applied to policy not having a major technological component, although this issue is considered further in the sections below.

Turning to the case of North Sea oil, it has been shown that the technology employed to facilitate rapid exploitation policy possesses features which jointly establish that technology as `inflexible' or `non-incremental' (see chapter 4). As such, it was impossible for that technology to be implemented according to the rules of incremental politics. Thus the unit size, capital cost, complexity and lead time of developments point to the large-scale impacts of technological choice in the early stages of North Sea activity.

Clearly, the technology employed in North Sea developments breaches the rules referred to above for making successful choices concerning the adoption of new technology. Hence the inflexible nature of North Sea technology provided a valid basis for testing incremental politics. An essential aspect of the thesis has therefore been an evaluation of the degree to which such inflexibility permitted success in the North Sea. In order to facilitate this task, some conception of the various agents' interests was necessary, since success must be related to the attainment of explicit or implicit objectives on the part of relevant agents. Once again, a success for inflexible technology would have been to damage the prescriptive power of incremental politics, unless such success could be falsified in some way.

The agents in the North Sea oil story have been identified as: governments and civil servants; oil companies; and society in general. Certainly, the presence of relatively short-term horizons and objectives has been recognised, especially as they have applied to governments, administrators and corporate organisations. Here, success may be considered in relation to the generation of a momentum towards rapid exploitation of U.K. oil resources (despite the seriousness of initial delays in development). Hence the peak figure of North Sea production was just below 130 million tonnes a year between 1984-1986, not far short of that which was anticipated in the mid-1970s.[1] This output enabled Britain to become a net exporter of fuel and had beneficial impacts on offshore employment and Treasury revenues, though not on the sterling exchange rate. Previously domestic production of oil and gas had been negligible. Similarly, companies have been able to earn quick and substantial cash flows allowing them to begin to repay borrowings and to contemplate further investments in the North Sea.

A longer term perspective, however, considered the extent to which resources have been exploited in a manner that has permitted decision makers to retain control over the technology. In this thesis, the task of estimating optimal rates of depletion has been avoided. In this way, the role of government has not been seen as to maximise the net present value of reserves from particular fields, as is often the case. As Chapter 5 acknowledged, governments would usually be unwilling or unable to pursue such long term welfare maximising strategies anyway. So the long term view of the societal interest has been put in terms of whether governments have pursued generally good or satisfactory policies on society's behalf. In this sense, the interest of society as a whole may be construed as the promotion of the relatively effective use of resources on the North Sea, without any expectation of optimality of production or maximisation of revenue. Once again, the achievement of control over technology is a primary aim.

As Chapter 7 showed, the decision to employ inflexible technology in the first generation North Sea fields, has been fraught with difficulties. In particular, the delays in development and the cost increases which were suffered, reveal their severity most when performance is considered in the absence of the fortuitously high oil prices of the mid-1970s. Hence, whilst the development of inflexible technology has served to generate certain short-term benefits, the cost of these benefits has been relatively high. Moreover, the earning of high historical discounted cash flows must be seen as a quite fortunate accident of timing. Thus the `success' of inflexible technology in the North Sea has generally been due to factors outside of the decision makers' control. In this way, the success of North Sea technology has been falsified and no comfort for non-incremental prescriptions for policy may be claimed.

One of the implications of the above refers to the dilemma of technical control, discussed in the Introduction to this thesis (see section 1.1). The falsification of the success of inflexible technology implies that any benefits deriving from the employment of such technology should be given up on the grounds of its uncontrollable nature and cost. There is a way out, however, since there are often more flexible technical alternatives which might be employed in situations where non-incremental technology has been selected. This may be seen in the North Sea case too. For example, in certain of the smaller fields operated by less affluent independent companies, there was a greater tendency to adopt more cost effective solutions to the development problem. The development of Argyll and North Alwyn fields provide cases where ingenious uses for existing technology were found in a bid to cut the cost of development, or the technology was managed in such a way as to allow subsequent alterations in design or operation. In other words, a more incremental approach could be found. Such an approach is less demanding on prior planning since ongoing changes to the technology may be made. Of course, this sort of strategy is more likely to permit decision makers to take advantage of new technologies and knowledge as they become available than would any non-incremental method.

The main thrust of the thesis has concerned the ability of non-incremental technologies to operate successfully. However, in the light of the falsification of the success of North Sea technology, it is appropriate to consider how a more incremental strategy could have been more widely encouraged. Since incremental methods were not tried on the larger fields, there is no guarantee that such methods would indeed have been more successful than the non-incremental methods which were adopted. However, one may reasonably suggest that incremental approaches to field development would have given the decision makers greater control over the technology and reduced the cost of any errors made. Hence it is likely that the performance of any investments made would have been less dependent on factors outside of the decision makers' control. Again, whilst the inflexible nature of technology has been considered as a serious barrier to control for decision makers once choice is made, the process by which certain technologies are selected or encouraged now becomes relevant. The sections below therefore consider the relationship of both technological and process aspects to policy inflexibility, indicating possible avenues for future research.

8.3 Technology As An Indicator of Policy Inflexibility

Throughout this thesis it has been suggested that inflexibilities in technology may be more clearly understood by reference to the physical characteristics of technology than to the social and political indicators of the phenomenon. Inflexibility is a concept which applies to the resistance some policies display to attempts by policy makers to effect changes of direction or to respond to new environmental conditions. Within the thesis, this concept has been related to other similar constructs such as irreversibility, indivisibility and now non-incrementality.[2] In demonstrating the non-incrementality of North Sea oil projects (i.e. the degree to which any new technology varied from the previously extant state), four factors of inflexibility were presented: large unit size; long lead time; high capital intensity; and dependence on highly specialised infrastructure. However, it was also recognised that the nature of the policy process was also a powerful force in influencing the degree to which policies could possess flexibility. Such an acknowledgement raises some very important questions for the conduct of policy in practice and also for the study of technology policy.

Considering the North Sea oil case study, it should not be too difficult to appreciate the influence of closed forms of policy making in exacerbating the difficulties of developing fields in the area. In particular the consequences of the domination of oil policy early on by the large multinational oil companies; the size of the Fourth Round of licensing on the U.K.C.S.; relatively lenient taxation and participation measures; and the absence of auctioning in the process of block allocation, have all been well noted. Clearly, therefore, the degree to which policy may be said to be centralised (i.e. where the number of actors able to gain access to important information for or to exert influence over the making of policy is small) can be a considerable factor in shaping the nature of policy. Indeed, it has already been shown to be a crucial variable in encouraging the adoption of inflexible technology, in the cases of nuclear power and NASA space exploration, for example. [3]

Bearing this in mind, it is understandable that there are those who show concern for what is considered to be the neglect of political relationships in favour of technologically "deterministic" models of policy. [4] Hence it might be argued that the present thesis is addressing the problem in the wrong way by focusing on the hardware of technology, rather than on the inter-relationships between the actors in a policy situation. The adoption of this point of view would, however, present an unfair accusation against the work contained within. At the risk of being overly repetitive, it is necessary to briefly reiterate the principal objectives and hoped for contribution of the thesis, in order to further clarify this point.

The essential motivation behind the conduct of the research has been a desire to improve the making of technology policy, recognising the possible spin offs for other areas of public policy and strategic management. Achieving this type of improvement implies a concern with developing better prescriptive theories of policy, a matter which is facilitated by the rigorous testing and evaluation of rival theories. In this thesis, the literature review in Chapter Two demonstrated that in order to advance the field of study, some further testing of widely touted incremental views of policy was required. More specifically, incremental politics was to be subjected to testing via the consideration of the success of a rival theory, i.e. non-incremental politics.

An essential task, therefore, that has had to be performed here concerned the specification of incremental politics and non-incremental politics. Both may be understood by reference to the several criteria of flexibility which have been explained at various points of the thesis. Although these criteria reflect certain characteristics of the technology related to its physical properties (unit size, capital intensity and so on), the thesis does not espouse a view that is necessarily one of technological determinism. For too long the impact of technical complexity, scale and cost has been either underestimated or ignored in the making of technology policy. In this way, the thesis has a message that may be considered in terms of the need to redress the balance by demonstrating the potentially adverse consequences of non-incremental technology policy.

So, within the context of this thesis, the physical properties of a technology may usefully serve as a guide as to its potential flexibility. Even in the absence of a focus on procedural questions, it should be evident from the foregoing that the adoption of non-incremental technical policy options is likely to be problematic. In addition, concentrating on hardware can provide certain objective criteria upon which rival theories may be constructed and subsequently evaluated. It is still difficult to achieve this by examining the inter-relationships and objectives of various actors and institutions within the conduct of policy making. The following section appraises the limitations of a prescriptive theory that cannot adequately account for the machinations of the policy process and indicates a future path for technology policy research and also for study in other areas of policy making.

8.4 Towards a Better Prescriptive Theory of Policy Making

How helpful is it to tell policy makers that they ought to be making incremental decisions or avoiding the adoption of inflexible technology? True, the general message of the thesis asserts the dangers that may be associated with non-incremental change, particularly in the sphere of technology policy. Yet, as well as the various operational difficulties that might attend moves to follow the apparently simple prescription to avoid the implementation of large scale changes in policy, other potential limitations may be pointed to. Such limitations do not affect the validity of this thesis, since non-incremental politics as a rule for policy making has been falsified rather than corroborated. What they do relate to are the various avenues for future research which may enhance the study and practice of policy making.

Fundamentally, the proper route for study may be presented in terms of extending the framework adopted here with regard to the concept of flexibility, to processes of policy formulation in technology policy and also to other areas of policy making. As this thesis has progressed, some of this work has already commenced. In particular, the merits of an incremental approach has been tested, with the potential for flexibility in the policy making process being indicated by the degree of centralisation/decentralisation present therein. Thus in addition to the previously mentioned factors of unit size, lead time, capital intensity and dependence on specialised infrastructure, the extent to which only a small number of actors can exert influence over policy making, becomes of relevance. The point is further amplified by reference to the exclusion of certain actors from the process of policy making who could and should otherwise have had their say in such activity. This is an issue addressed by the chapters on government policy and corporate strategy in this thesis, with regard to the role of independent oil companies and advisers in North Sea oil policy.

In a world where big business and politics are becoming ever more intertwined on a national basis and where the same phenomenon may now be witnessed as technology and trade progress on an inter-continental basis, a new challenge arises. The thrust of this study has been primarily of a defensive nature; it has served as a warning against the dangers of "doing things big". In a similar way, incorporating the degree of centralisation as another factor of inflexibility to be considered in testing incrementalism, points to the possible dangers of having too few influential actors involved in the making of policy. This is a problem identified in the North Sea and other cases in technology policy but which might also apply to policy situations where technology is not as prominent. (The Common Agricultural Policy provides such an example of the problems that may be experienced in implementing policies arrived at through closed forms of policy formulation).[5] The new task, however, may well involve some reorientation of the incremental approach. Thus, as well as applying existing methods to testing its prescriptions outside the sphere of technology policy, it will be necessary to consider how these prescriptions themselves may be improved. It is one thing to say to policy makers "don't do x" and "don't do y", but it is another to specify just how one should move in small steps and in a manner that ensures that affected parties have access to information and influence over the adoption and implementation of policy, without causing paralysis in policy making.

The suggestion is, therefore, to continue the testing of the prescriptive claims of incrementalism with reference to empirical research with a less technological bias, while constantly developing the prescription in readiness for future testing. In performing the former, it may be possible to employ existing methods to identify the extent to which a policy can be said to possess flexibility. Thus, in terms of the example of the Common Agricultural Policy, there is a prima facie case for applying the four factors of inflexibility discussed in this thesis, in addition to the degree to which policy is centralised, as mentioned above.

Briefly, unit size could be expressed by the variation in scope between already existing national policies and the new community wide policy; lead time could be represented by the number of years taken to make policy functional, which in this case could mean the time taken to attain self-sufficiency in certain agricultural products; capital intensity could refer to the initial subsidies which had to be given to farmers and nations within the Community in order to facilitate the acceptance of policy; and dependence on specialised infrastructure could be applied to the various mechanisms (primarily financial) which have had to be developed in order to make the policy function. The centralisation factor could refer to the domination of policy by unelected Community bureaucrats and the farmers' lobby; to the exclusion of consumer interests; or to those representing developing countries whose agricultural and trade relationship with the European Community may be a very important factor in their economic well-being. The degree to which a policy is invested with some sort of symbolism may provide the researcher with another dimension for ascertaining the extent to which a policy is flexible or acceptable, these being crucial factors in the evaluation of `success'.

The success of such a policy can again be evaluated in terms of its economic performance. Even where a policy is stated as being more politically motivated, say to foster a spirit of European unity in the initial stages of post-war co-operation as was the case with the Common Agricultural Policy, the assumption remains that this is not something worth obtaining at any cost. Hence the economic calculus remains the prime basis of evaluation, although important qualifications may need to be made in order to adequately cater for the political aspirations of policy.

The other main issue which policy making theory needs to address is the better elucidation of prescriptive theories. In the same way that testing has shed light on the problems of adopting non-incremental technology, so can it perform the same function in respect of non-incremental policy making of a non-technological nature. However, a valuable contribution may be obtained by focusing on the antecedent determinants of policy (and technology) content. This involves tackling the theoretical issue of developing and testing prescriptions, not only geared to policy outcomes but to processes too.

The assumption is made that in most policy situations decision makers have a degree of choice concerning policy outputs (incremental or non incremental politics), methods of analysis (incremental or non incremental analysis) and processes (centralised or decentralised). Thus the task for future research projects entails the discernment of which combinations of these elements of policy making work better in which sorts of policy context and at what levels of policy making (strategic or operational). This is the sort of work which lends itself to the kind of partial theorising and study which has been conducted here. The primary focus of such work should be to define appropriate institutional and decision making mechanisms capable of arriving at, implementing and revising preferably flexible policy choices.

8.5 Summary

The purpose of this thesis has been to test empirically the prescriptive claims of proponents of the incremental approach to policy making, relating these above all to technology policy. This testing of incrementalism was something which had only rarely been attempted previously.

On this occasion, the testing of incremental politics entailed making the distinction between "incremental" and "non-incremental" politics, two rival and opposite approaches to making (technology) policy. North Sea oil policy appeared to offer a clear example of non-incremental technical change which, on prima facie evidence, had operated very successfully for the agents. As such, the apparently good performance of inflexible technology seemed to break the rules which had been established for decision makers to successfully manage technology in pursuit of their interests. However, having described the centralised and inflexible nature of North Sea development, economic analyses of field performance demonstrated mainly failure or, at best, partial or fortuitous success. Thus no prizes may be claimed by advocates of such approaches to policy making and non-incremental politics may be said to have been falsified. Although this thesis has been primarily concerned with the relationship between the size of policy interventions and success in policy making, the importance of the process by which policy is formulated is not to be underestimated. Therefore, whilst size of change has been at the heart of this piece of research, demonstrating the problems which may be encountered in trying to control inflexible technology once introduced, future work will need to address the issues of process flexibility and the antecedents of technological choice more directly.

NOTES

1. C. Robinson, Successes and Failures In British Government North Sea Policy, p. 4, Paper presented to "25 Years of the North Sea", a conference held at the University of Surrey, 22-23 March, 1990.
2. Earlier references to indivisibility (Schulman) and to irreversibility (Douglas and Wildavsky) appear in Chapter 4 of this thesis (see notes 5 and 6).
3. Again, the reader may refer to previous references to these cases - to Chapter 1 (note 1) for the work of Collingridge, Morone and Woodhouse, and Lovins and Lovins on nuclear power; and to Chapter 2 (note 61) for the work of Schulman on NASA.
4. See R. Johnston, The Social Character of Technology (Reply to Collingridge), Social Studies of Science, vol. 15, no. 2, 1985, pp. 381-383.
5. See, for example, A. Swinbank, The Common Agricultural Policy and the Politics of European Decision Making, Journal of Common Market Studies, vol. 27, no. 4 June 1989, pp. 303-322.

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APPENDICES

Appendix 1:

Index of General Retail Prices 1970-2015 (1989=100).

1970	610.3
1971	573.1
1972	523.3
1973	489.6
1974	452.0
1975	389.7
1976	313.8
1977	271.0
1978	233.6
1979	214.3
1980	189.1
1981	159.7
1982	142.8
1983	131.6
1984	125.7
1985	120.0
1986	112.9
1987	109.3
1988	105.0
1989	100.0
1990	93.5
1991	88.8
1992	84.4
1993	80.2
1994	76.2
1995	72.3
1996	68.7
1997	65.3
1998	62.0
1999	58.9
2000	56.0
2001	53.2
2002	50.5
2003	48.0
2004	45.6
2005	43.3
2006	41.2
2007	39.1
2008	37.1
2009	35.3
2010	33.5

2011	31.8
2012	30.3
2013	28.7
2014	27.3
2015	25.9

Note: The above calculations are based on historical annual rates of retail price inflation as quoted in various editions of Economic Trends, H.M.S.O., London. For future years (i.e. after 1989), the inflation rate has been estimated; at 6.5% for 1990; and 5% per annum for each subsequent year.

Appendix 2.

Sterling/U.S. Dollar Exchange Rates 1970-2015.

1970	2.40
1971	2.44
1972	2.50
1973	2.45
1974	2.34
1975	2.22
1976	1.81
1977	1.75
1978	1.92
1979	2.12
1980	2.33
1981	2.03
1982	1.75
1983	1.52
1984	1.37
1985	1.30
1986	1.47
1987	1.64
1988	1.78
1989	1.64
1990	1.70
1991	1.68
1992	1.66
1993	1.64
1994	1.62
1995	1.60
1996	1.60
1997	1.60
1998	1.60
1999	1.60
2000	1.60
2001	1.60
2002	1.60
2003	1.60
2004	1.60
2005	1.60
2006	1.60
2007	1.60
2008	1.60
2009	1.60
2010	1.60

2011	1.60
2012	1.60
2013	1.60
2014	1.60
2015	1.60

Note: Historical rates of exchange are based on the average of daily telegraphic transfer rates in London, as quoted in various editions of Economic Trends. From 1990 onwards these rates have been estimated.

Appendix 3.

Real (1989) Oil Prices Under Various Price Scenarios-1975-2015

HISTORICAL SCENARIO.

1975	21.54
1976	22.21
1977	24.45
1978	16.28
1979	22.72
1980	28.36
1981	29.29
1982	27.16
1983	26.26
1984	28.15
1985	25.77
1986	11.70
1987	12.55
1988	8.81
1989	11.11
1990	10.45
1991	10.65
1992	10.86
1993	11.07
1994	11.28
1995	11.49
1996	11.57
1997	11.66
1998	11.73
1999	11.82
2000	11.91
2001	11.99
2002	12.07
2003	12.16
2004	12.24

2005	12.32
2006	12.43
2007	12.50
2008	12.57
2009	12.68
2010	12.76
2011	12.84
2012	12.97
2013	13.02
2014	13.13
2015	13.20

Note: (Actual and estimated future nominal oil prices converted to 1989 sterling terms.) Prices are per barrel of crude oil from Forties and (from 1985, when the North Sea 'marker' changed) Brent field.

2% GROWTH PER ANNUM IN OIL PRICES FROM 1972 ONWARDS (ALLOWING FOR INFLATION AND EXCHANGE RATE CHANGES), CONVERTED TO 1989 PRICES.

1972	5.88
1973	6.19
1974	7.07
1975	8.11
1976	9.43
1977	9.94
1978	8.67
1979	8.31
1980	8.03
1981	8.87
1982	10.17
1983	11.51
1984	13.02
1985	14.18
1986	12.43
1987	11.44
1988	10.84
1989	11.98
1990	11.35

1991	11.67
1992	12.01
1993	12.36
1994	12.72
1995	13.08
1996	13.30
1997	13.52
1998	13.74
1999	13.96
2000	14.21
2001	14.44
2002	14.67
2003	14.92
2004	15.16
2005	15.41
2006	15.68
2007	15.93
2008	16.17
2009	16.46
2010	16.72
2011	16.98
2012	17.31
2013	17.55
2014	17.86
2015	18.13