FORESTRY and CONSERVATION:
TOWARDS A
SOCIOLOGY of EXPERTISE.

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This thesis is submitted in partial fulfilment of the requirements for the degree of Master of Arts at the Australian National University.
I certify that this thesis is
my own composition and that
all sources have been acknowledged.

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This thesis attempts to develop a sociological approach to the examination of expertise. The case of the forestry discipline is studied in the light of the approach outlined. The framework used builds on the work of T.S. Kuhn, but adopts modifications to his thesis. It is argued that none of the conventional distinctions between science and technology hold, so Kuhn's theory reformulated in the manner suggested should apply to all experts. Kuhn's theory tends to exclude considerations of resources, power and status and a dialectical relationship is posited between organized knowledge and these 'external' variables. In the forestry discipline, 'traditional' and 'conservation' paradigms are identified from literature sources and through a study of forestry students. A number of external factors potentially influential to forestry are discussed. In the light of this study, some directions for a critical sociology of expertise are outlined.
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CHAPTER 1  

INTRODUCTION

1. The Context

Nothing characterizes contemporary life so fundamentally as does the pervasion of technological phenomena and scientific knowledge. As Ellul states, "No social, human, or spiritual fact is so important as the fact of technique in the modern world" (1964: 3). He continues, "And yet no subject is so little understood" (1964: 3).

The nature of science and technology and their control for human and humane purposes is a pressing issue not only for scientists, but for governments and society at large. The problems of science and technology are no longer (if they ever were) properly the concern of an isolated autonomous elite. In Sklair's words, "We cannot ignore science and technology for they will not leave us alone" (1973: 8).

The pressures for control of scientific and technological development are increasingly being institutionalized. For example, the Australian Government recently announced that it intended to form the Australian Science and Technology Council in its White Paper "Science and Technology in the Service of Society" (White Paper 1975).

The sociology of science has an important contribution to make in this field. It is only with a reliable sociological account of science and technology that sensible and effective policies will be developed in the planning and control of scientific and technological change for human welfare.

The most common form of the sociology of science, the functionalist model, is quite inadequate for this task. As discussed in this thesis and elsewhere (e.g. Sklair 1973) it does not consider scientific knowledge itself, but only the normative structure of science. Furthermore, in accepting the scientists' definition of
of their own situation, a fundamental cleavage is posited between science and administration, whereas such a cleavage is only an historically specific form of science. Johnson makes a similar comment in relation to professions, "In accepting the professions' own definitions of themselves, sociologists have tended to accept that a peculiar institutionalized form of control is the essential condition of such occupations rather than being a peculiar historical product..." (1972: 38 emphasis in original).

A new perspective is emerging in the sociology of science, a perspective which promises to replace the hitherto dominant functionalist approach. The new position has not been clearly defined but most appropriately comes under the heading 'sociology of knowledge' which is the term for a group of related sociological approaches sharing a basic epistemological positon. This position is that knowledge is related to the existential conditions surrounding its emergence. Scientific knowledge is seen as a specific form of knowledge arising in specific social and historical circumstances. While sharing philosophical foundations, the sociology of knowledge embraces variety in its polemic intent (eg. Marxism, phenomonology).

Until Kuhn's work, much of the sociology of knowledge approach to science has been concerned to analyse science as a social product at a macroscopic level, without consideration of the interpersonal scientific structure. Kuhn, describing the social nature of scientific knowledge, and the social characteristics of the scientific community, provides a fundamental part of the new sociology of science.

In accepting scientists definitions of themselves, sociologists have also accepted a distinction between science and technology, one which it is later argued is groundless. The rejection of this artificial boundary opens new opportunities for synthesis in the
sociology of expertise. The other launching point for this thesis concerns the impact of the 'environmental crisis'. The environmental movement is closely related to the questioning of modern science. As Smolcicz states, "Under the threat of pollution, the population explosion and the partial disruption of the balance of nature, the most basic assumptions of science are under challenge..." (1974: 1)

The challenges to science and technology have varied between disciplines but a family resemblance linking the critiques has been particularly strong. The types of environmental criticism are now relatively familiar and predictable to those who have followed the literature, although the particular practices and issues are of course not predictable.

One of the major points of interest in this thesis is the response of the various disciplines to the challenges with which they are faced. The thesis takes the case of the forestry discipline and examines the response to criticisms of its practices.

2. The Argument

The basic theoretical framework adopted in this thesis is an extension of the work of T.S. Kuhn, particularly "The Structure of Scientific Revolutions" (1970a).

Kuhn limits his theory, partly by implication, to the study of natural science, excluding social sciences and technology. It is argued in Chapter II that no grounds could be found on which to differentiate science and technology. Therefore if Kuhn's thesis applies to science it should also apply to technology. If this argument is not accepted by the reader, it is still possible and plausible to use Kuhn's approach, applied by analogy outside the sphere he intended (cf. Johnston 1972).

In Chapter II various possible means of discrimination between
science and technology are examined:

(a) in terms of the goals: namely science for its own sake versus technology for some other purpose.

(b) in terms of the limits: natural versus artificial phenomena and knowledge versus concrete artefacts.

(c) as a product or a process, where science or technology may be the process of acquisition of knowledge or the product of that process: knowledge versus its application; long term science versus short term technology: abstract and general science versus concrete and specific technology.

(d) as belonging to certain institutions: scientists in universities versus technologists in industry.

(e) means of communication: public versus private communication.

The next chapter (III) summarizes Kuhn's theory of the structure of science, then examines some of the criticisms of his work. The criticism particularly by philosophers of an irrationalist explanation of scientific development, and the distinction between normal and revolutionary science are examined. Brief consideration is given to the possible sociological alternatives to Kuhn's theory of scientific change. The so-called functionalist sociology of science is criticized and discarded, though the normative theory appropriately reformulated may be worthy of salvage. It is argued that the major weakness of Kuhn's theory is its relative neglect of wider social ('external') forces on a discipline's progress.

Chapter IV synthesizes the preceding lines of argument into a framework for the study of expertise. It is claimed that the model proposed should apply to experts qua experts in all spheres, not only those engaged in research. Variables like class, status, institutional location and supply of resources enter into the heart of organized knowledge influencing not only the expert's ethos, but the actual substance of knowledge. Furthermore, possession of expert
knowledge enables access to material resources, power and status.

Kuhn's thesis is expounded in a form suitable for application to organized knowledge. The formulation is intended to be general, but was proposed with the forestry case particularly in mind. The criteria by which experts make decisions are added to the paradigm (see Table 1). Two analytically separable change regimes, constant decision criteria and constant technological set are suggested.

The model is applied in Chapter V to the forestry discipline including the debate at all paradigm levels between the 'traditional' paradigm and the 'conservation' paradigm. At the metaparadigm level, the two embrace entirely different concepts of nature, which flow onto a related set of beliefs. Discussion is provided of norms, roles and decision criteria applicable within each paradigm. The conservation paradigm places high emphasis on conservation of all the resources the forest may provide. Multiple use management with sufficiently large weight being given to intangible forest benefits and costs, is seen as essential.

Various factors 'external' to the forestry discipline which appear to be potentially influential to forestry are discussed. The current 'crisis' in forestry is linked to the general environmental movement. The transfer of control over the dominant forestry educational institution from the Public Service to Australian National University (ANU) is discussed. The membership of various powerful committees is discussed in relation to the power structure of the discipline. The extent and possible consequences of the high degree of sponsorship of forestry students is considered.

Chapter VI reports the results of a case study of final year forestry students. The most important feature of the study concerns the measurement of paradigm conflict, which is related to a number of other variables.
In spite of the limitations of this thesis, a number of interesting conclusions are drawn regarding the sociology of expertise, and the Forestry discipline.
CHAPTER II. DIFFICULTIES IN DISTINGUISHING SCIENCE AND TECHNOLOGY

A considerable number of writers have attempted to distinguish between science and technology. In this chapter the most important of these attempts are evaluated.

The issue, differentiation of science and technology, is of great importance to the sociology of science.

"...a problem which has bedevilled much work in this field - is to specify the continuities and discontinuities between science and technology" (Sklair 1973:65-66).

"The troublesome distinctions between basic research, applied research, and invention need far more investigation" (Kuhn 1970d:355).

This chapter discusses the limitations of the various approaches to the differentiation of science and technology, in order to assess their value for a critical sociology of expertise. These approaches are grouped, and considered in the five sections which follow.

1. Goals of Science and Technology

Sklair delineates "three general types...of...charter-claims" (1973:66), the charter being the purpose of science, namely:

a) "knowledge for its own sake"; b) "science for human welfare";
c) "a job that people do, for salaries or profits".

He suggests that "The charter-claims of technology overlap the last two of science...The idea of knowledge for its own sake...(roughly corresponds to) solving a problem because it is a problem" (1973:67).

He therefore finds little to distinguish science and technology in terms of the charter-claims, or goals of science and technology.

Kidd identifies "investigator-centred definitions" of "basic research" which specify "...the motive of the investigator...not...the research finding itself" (1965:147). He lists six definitions which fall into this category (1965:147-149). One example from his paper should elucidate the point.

"Basic research is that type of research directed towards an increase of knowledge in science. It is research where the primary aim of the investigator is a fuller knowledge or understanding of the subject under study, rather than a practical application thereof." (National Science Foundation, 1958 in Kidd 1965:147)

The 'motive' criterion which Kidd identifies is similar to Sklair's just mentioned. Kidd, like Sklair but for different reasons, finds it unsatis-
factory. He argues that "...persons aiming to solve a very practical problem have produced findings of general significance," (1965:150). As he goes on to point out, specifying the motive of an agent in no way specifies the substance of his work. (Kidd also lists "substance-centred definitions" (1965:149-50) which he argues constitute the other type of defining criteria between 'basic and applied research'. The substance-centred definitions fall under a later heading and are discussed in Section 3.)

Ravetz attacks this problem from a rather different angle. He introduces the concept of 'industrialized science' which "can be distinguished from... 'academic science'...in terms of the capital-intensity of the tools of scientific work" (1973:5). He traces science as the pursuit of truth in an historical context as: a motive encouraging selfless dedication by scientists; as an ideological weapon against the competing dogma; as a justification of the scientists' work to themselves; as an argument for public support of science (1973:20). Ravetz, whether or not he would concede the point, has given only ideological foundations to science as the pursuit of truth.

To the 'science as the pursuit of truth' Ravetz contrasts "The Technocratic Conception of Science" (1973:20-23) in which science is a commodity, and scientists are thought of as manpower units.

"(The)...social atmosphere (of a science) becomes increasingly 'industrial'...Without some such organization it would be impossible for the scientific community of the present, and of the future, to operate." (1973:22)

In this context the distinction between science pursued for its own sake, and applied science for other goals becomes irrelevant.

"(It)...is impossible to make a neat line of division between the two sectors, allowing one to serve Truth and the other Caesar...no piece of scientific knowledge can be guaranteed 'pure', or free of application ...(and) much of 'pure' or 'basic' research involves capital outlay on an industrial...scale..." (1973:23).

Still another approach to this definition difficulty is an empirical one. Do scientists, however operationally defined, share the primary goal of the extension of knowledge for its own sake? As amateur and gentlemen scientists
are no longer significant (Rose & Rose 1971; Ravetz 1973) academic scientists, given their institutional setting, might be those most expected to endorse the goal of science for its own sake. This goal implies the Mertonian norms: Universalism, Communism, Disinterestedness, and Organized Scepticism (Merton 1972:68-78) along with the many similar codifications which have followed Merton's work (eg. Cotgrove and Box 1970).

It is inappropriate to delve at this stage into the empirical difficulties of the functionalist sociology of science. In any case Sklair (1973:esp. 150-180) provides a useful review. He argues that the Mertonian norms may be the norms of academic science but it is "unrealistic to assume that the values and norms of academic science were necessarily the values and norms of science as such" (1973:150, emphasis in original). Yet it is these norms which embody the spirit of science for its own sake. Krohn argues in a similar manner:

"...the very categories with which we think about science are partly an historical and ideological residue. The division of science into 'basic' and 'applied' constitutes a defence of an historically specific system, namely academic science. That system no longer stands for all science" (1971:18).

Science for its own sake could serve as a tautological definition, but this approach faces the severe empirical difficulty that it may define out of science, many or perhaps even most, scientists. A definition of this type is better pursued as a theory of science.

To review the argument so far: science and technology (or related terms basic versus applied science etc.) are commonly distinguished in terms of their aim or purpose: science pursued for its own sake, against technology pursued for some more material purpose (economic gain etc.). Several of the weaknesses of this criterion have been discussed.

a) Science like technology may have several charter claims or purposes. Science may be pursued for profit, just as technology may be pursued for its own sake.
b) Specifying the motive of an agent in no way specifies the substantive content of his work (this point is related to a) above).

c) In an era of big science, or industrialized science the capital cost and organizational constraints of science make the pursuit of knowledge for its own sake increasingly irrelevant, though it may have some polemic value.

d) Some evidence indicates that scientists do not seem to conform to this goal of science or the norms implicit in it. The goal of science for its own sake and its related norms, should be seen as a theory subject to empirical tests rather than as a definition.

2. Limits

Another means of differentiation of science and technology is according to the limits imposed on the objects of study. A further source of distinction, which cuts across the first type, relates to social science and social technique. The inclusion or exclusion of a 'social' subdivision in no way affects the argument to follow. For the sake of brevity this subdivision is not explicitly discussed.

Two sources of distinction according to the objects of study may be found. One discriminates technical and natural phenomena, and the other, knowledge from techniques in themselves.

2.1. Natural versus Technical Phenomena

One of the criteria listed by Bukharin concerns the natural-technical distinction.

"(It takes)...as a criterion distinction according to objects - the 'pure' sciences study the natural surroundings given to man the applied sciences the artificial surroundings (machines, transport technique, apparatus, raw materials, etc.)" (1971:24)

Bukharin himself goes on to reject this distinction (1971:25) but his explanation is obscure (perhaps caused by poor translation). It is however readily refuted. More often than not, those otherwise termed scientists (eg. chemists in universities) work with highly artificial configurations of materials (eg. pure solution chemistry, electron microscopy). Those otherwise defined as technologists (eg. engineers in industry) characterist-
ically work with 'natural' materials (eg. mining, mineral processing, road making). Not only do 'scientists' characteristically study highly artificial situations (i.e. man-made) but they often do so using knowledge of machines. This knowledge of machines is an integral part of the requisite knowledge of a scientist. Similarly knowledge of 'natural' phenomena is part of the requisite knowledge of a 'technologist' (eg. the metallurgical engineer's knowledge of the surface properties of ores).

It makes a mockery of this criterion to suppose that most scientists use a mixture of knowledge of natural and technical phenomena, and are therefore acting schizophrenically as scientist one minute and technologist the next. Therefore this criterion is not a useful one.

2.2 Knowledge versus Concrete Artefacts

It is possible to draw a distinction between knowledge about phenomena and techniques in themselves, as for example discussed in Johnston (1972:118). This reserves the term science for knowledge, and technology for the concrete artefacts produced and used via that knowledge. However it fails to distinguish between forms of knowledge in agreement with the proposition argued here.

Moreover techniques in themselves have, by definition, no meaning. It is only in conjunction with knowledge that techniques take on meaning, and it is meaning that differentiates concrete objects as technology. The distinction under discussion is thus misleading as well as failing to separate scientific and technological knowledge. 4

3. Process or Product

Science whether 'pure' or 'applied' may be seen as the process of production of new knowledge, or as the product of the scientific process. The process-product distinction is accepted as a useful one. It does not divide scientific and technological research or knowledge, but it clarifies the series of distinctions discussed in section 3.3.
3.1 Science as a Process

a) Science may be seen as methodology; the application of certain philosophical canons of inquiry to validate or prove findings. For example:

"Science...is commonly used to denote a set of characteristic methods by means of which knowledge is certified" (Merton 1972:66).

"(One meaning of science is) ...the application of certain rules of procedure and enquiry" (Rose & Rose 1971:2).

b) Science may be seen as arising out of interaction of a community of 'scientists'. For example:

"(The goal of science)...is a consensus of rational opinion over the widest possible field" (Ziman 1968:9, emphasis in original).

"It is hard to find another criterion that so clearly proclaims a field as a science... (than the achievement of) a paradigm that proved able to guide the whole group's research" (Kuhn 1970a:22).

3.2 Science as a Product

Science may be seen as the product of the scientific process, however this process may be defined. For example:

"Science...is commonly used to denote...a stock of accumulated knowledge stemming from the application of these (characteristic) methods" (Merton 1972:66).

The variations in the manner of description of science as a product can be partly subsumed under other headings in this chapter.

Precisely the same categories enumerated above for science could be repeated for applied science or some like term. Technology is normally defined as a product rather than a process, though Ellul uses the term technique to imply both a process and a product (1964:page xxv).

3.3 Distinctions Arising.

Several possible means of discrimination arise out of the above discussion, and these are discussed below.

3.3.1 Knowledge versus its Application

A major source of differentiation is that between science as knowledge (either the process of its validation or the product) and technology as its application to specific material circumstances. For example:

"(It is possible) to take as a criterion the difference between causal theoretical series...and teleological, normative series..." (Bukharin 1971:24).
"...it must...be remembered that applied research is in the long run parasitic on the growth of basic scientific knowledge" (Cotgrove & Box 1970:170-71).

"...the native picture of technology as applied science simply will not fit all the facts. Inventions do not hang like fruits on a scientific tree" (Price 1972:172).

This distinction is reinforced by the 'value-free' thesis regarding science. If science is value-free then technology may be differentiated from science in that technology is the application of values to raw materials using value-free scientific laws. This criterion may be applied either to the scientific process (research) or the scientific product.

It is generally conceded that scientists use their values in the selection of their objects of study (eg. Ben-David 1971).

What is more contentious is whether the substance of their findings is value impregnated or not. A considerable debate ranges on this (refer eg. Myrdal 1969; Bukharin 1971:24; Kuhn 1970b; Popper 1970:esp. 56) and only a few themes are repeated here. Historically epistemology has not sustained a single perspective. Epistemology itself may be regarded as problematic. Methodological canons are relatively stable agreed bases for science which are reified, while their historical genesis would reveal them as problematic. Methodological canons are value orientations objectified by scientists. Kuhn's argument that consistency, simplicity, and so on are values (Kuhn 1970a:184-5) is an example of this form of argument.

The argument presented here does not depend solely on this point. If the above demarcation criterion were to stand, then science would have to include all manner of 'facts' (technical, social and natural) and technology would only emerge after values and raw materials had interacted with scientific 'facts'. If science does include all manner of 'facts' then no distinction has been drawn between 'scientific' and 'technological' facts. If science is restricted to 'natural' (versus technical) facts, then the
real distinction lies between 'natural' and 'technical' rather than 'facts' or 'causal' laws and value loaded intervention. This criterion has been discussed in Section 2 of this chapter.

In view of the two arguments presented, the causal-normative differentiation was found to be unsatisfactory.

3.3.2 Long-term versus Short-term Orientation

A possible source of differentiation between the processes of scientific and technological research is the time period applicable to each. For example:

"the 'pure' sciences work with a long period in view, forestalling developments, the applied serve 'the needs of the moment'" (Bukharin 1971:24).

While some examples could be found to substantiate this suggestion, so many counter examples could be cited that it serves as a useless distinguishing criterion (eg. Bukharin 1971:25). It is arguable that the time period applicable to a research program is more dependent on the particular decision criteria in operation (consider for example defence 'science') and these depend more on the institution than any basic differentiation between science and technology.

3.3.3 General versus Specific

The degree of generality or abstractness of the product of research is another possible discriminating factor; science being abstract or general and technology concrete and specific. For example:

It is possible "...to take as a criterion...the degree of generality ('abstractness') of the particular science" (Bukharin 1971:24, brackets in original).

"This criterion (is one of)...generality, breadth, or significance of findings" (Kidd 1965:150). This criterion is not absolute or even readily applied as a relative concept, which might be regarded sufficient grounds to dismiss it. Furthermore "...persons aiming to solve a very practical problem have produced findings of general significance" (Kidd 1965: 150).
Bukharin argues the stronger case that "a very concrete science may also be 'purely theoretical'" (1971:25). Bukharin goes on to argue that:

"The problem of the 'pure' and 'applied' sciences, reflecting and expressing the problem of theory and practice...is itself a problem of history...fixed in terms of profession and class" (1971:26-27).

The separation of theory and practice is a problem created by a specific historical development and is not a universal phenomenon. Moreover since Kuhn (1970a) and Masterman (1970) it is no longer plausible to argue that science is 'pure theory' without concreteness.

3.3.4 Published Work versus Concrete Products

An extraordinary definition is proposed by Price,

"I therefore propose, as a formal definition, to take as science as that which is published in scientific papers" (1972:170).

"We shall define technology as that research where the main product is not paper, but instead a machine, a drug, a product, or a process of some sort" (1972:172).

Aside from Price's crass operationalism (after all it does fit rather too well with his citation studies) these definitions do bear a reasonably close relationship to what is being argued here. What is untenable about Price's distinction is its arbitrary nature. What would Price do about internal memoranda in a private research laboratory, one of the basic communication channels in those institutions? Another source of difficulty is the (public) engineering journals; are these science or technology? Whatever Price's answer to these questions, his criterion is too hoplessly arbitrary for most theoretical perspectives, and too strongly linked to his own.

4. Institutional Location

According to Mulkay, "...most of those engaged in basic research are employed by, or associated with universities" (1972:5). Cotgrove and Box define three scientific roles, academic, organizational and professional (1970:21-22). They distinguish not precisely institutional location, but rather role types.

"(We) attempt to distinguish between types of scientist; between
academics on the one hand dedicated to the advancement of knowledge, and 'organizational' scientists on the other hand, who are more likely to find rewarding the application of science in the development of new products" (1970:vii).

Firstly it should be noted that neither definition cited argues for a logical distinction with scientists only concerned with one class of institutions (eg. universities) and technologists only concerned with another class of institutions. It remains to argue whether there exists a high probability that 'scientists' are more likely to be found in one class of institution and 'technologists' in another class. It becomes clear from posing the question in this form that some other means of deciding what constitutes a scientist is implied.

Cotgrove and Box develop a theory embracing three scientific ideal types each of which has a predicted normative structure (1970:esp. 27). This is not the place to discuss their theory of the social structure of science, but it is of great interest to note that Cotgrove and Box refer to all three role types as scientists. Cotgrove and Box do argue that these role types are more likely to be found in different institutional settings (1970:69-90).

There is no intention here to argue against the Cotgrove and Box theory: it is of considerable importance. Their definition of scientific roles is perhaps justifiable purely at the normative level. The problem here is slightly different: is the substance of science different in the different institutional settings or as performed by the different scientific identities?

This question cannot be entirely resolved, however several points are relevant. Universities contain many 'applied' disciplines (eg. applied science, medicine, engineering). Universities are also often concerned with research on industrial problems. Ridgeway (1968) indicates the immense scope of industrial and special interest funding of university research in America.

It is therefore concluded that no differences of kind need exist between science carried out in different institutions. Differences in normative
structure may exist but these are best considered as fruitful hypotheses, not pre-empted by a definition.

5. Means of Communication

The main source of differentiation involved is the contention that scientists communicate in public while technologists don't communicate or do so as in private. For example:

"...most of those engaged in basic research...use similar institutionalized means of communication, namely the professional journal and the conference" (Mulkay 1972:5).

"...the scientist wants to write but not read, the technologist wants to read not write" (Price 1972:171).

"Those who do not contribute at all through this channel (published articles, books and papers) cannot be considered scientists" (Hagstrom 1965:43).

"The goal of science...is 'public knowledge'" (Cotgrove & Box 1970:15).

This source of differentiation is a relative one, and taken alone seems to introduce many anomalies. Applied, engineering and medical researchers in universities use journal publication, probably in much the same manner as do physicists or chemists. Publication is also permitted by researchers in CSIRO in Australia, though the research on which they work is commonly inspired by industrial problems. These anomalies reveal that publication is more a function of the institution than the nature of the research involved, and the institutional variable has already been discussed.

6. Conclusion

It has been argued that differentiation in terms of the goals of science and technology is misleading. Science may have several goals as may technology. Technology may be pursued for its own sake just as other activities (eg. art) may be pursued for their own sake. Science may also be pursued for other purposes like profit. The motive of a research worker in no way specifies the substance of his findings. In an era of industrialized science, pursuit of knowledge for its own sake is becoming
increasingly irrelevant. Lastly, scientists\textsuperscript{12} may not conform to the
goal of science for its own sake or the norms derived from it.

The notion that science be limited to natural phenomena and technology
(applied science etc.) to artificial phenomena is untenable, as all research
workers whether otherwise termed scientists or technologists generally
work in an artificial context, studying artificial (i.e. man-made) config-
urations of materials.

Those writers who limit science to knowledge about phenomena and technol-
ogy to artefacts are supporting the argument here, that scientific and
technological knowledge cannot be distinguished.

Some writers see science as a set of facts, laws and knowledge, and
technology as its value impregnated application to a specific situation.
As argued in the previous paragraph, if science includes all manner of
facts, laws and knowledge, then no discrimination has been sustained between
scientific and technological knowledge. Furthermore it was argued that
scientists use their values in the selection of their topic of study, and
more importantly, that methodological canons are objectified and treated
as absolute while their historical genesis would reveal them as problematic.
Therefore scientific knowledge, being objectified may appear free of values,
but is actually value loaded like technological knowledge.

The relative time periods over which scientific and technological research
operate could not be used alone as a criterion. The large number of anoma-
lies generated, and suggested institutional dependence of the operating
time span, mean that this is not a useful criterion.

The degree of abstractness or generality is a relative notion which is
difficult to apply. The separation of intellectual labour is an historical
reality only in specific societies. In any case since Kuhn (1970a) and
Masterman (1970) it would be hard to argue that science lacked concreteness.
The distinction between science as a paper and technology as a concrete artefact (Price 1972) has also been dismissed.

Institutional location is claimed only as a relative notion. However it is defective on the grounds that it takes no cognizance of the substance of science in the different institutional settings. It was concluded that no differences of kind need exist between science carried out in different institutions. The differences in normative structure between institutions should be regarded as useful hypotheses not definitions. Differentiation on the basis of tendency to publish was likewise rejected, being also dependent on institutional location.

It is therefore concluded that none of the conventional distinctions between science and technology hold. The only distinctions which do hold divide the subject not into science and applied science or technology, but in other ways. Perhaps the most useful distinction is the process-product one, between research and accepted scientific and technological knowledge. This is a clumsy construction and the term 'organized knowledge' will be used here to replace 'accepted scientific and technological knowledge' (after Sklair 1973). The term research will be used to connote the process of acquisition of organized knowledge. The term researcher will imply a person actively attempting to acquire organized knowledge. There is no readily available word to describe the possessor of organized knowledge who is not engaged in research (i.e. to replace scientist or technologist) aside from the disciplinary label (eg. forester) so the term 'expert' will be used to describe the possessor of organized knowledge whether or not he is engaged in research.

There is no longer any need to use the misleading terms science and technology and related nomenclature. However, free use will be made of the words expert, organized knowledge, research and researcher.

The next chapter briefly considers some of the main alternatives in the study of experts, taken mainly from the fields sociology of 'science' and
'technology'. Not all the possible alternatives are considered. The work of Kuhn and the modifications which his thesis requires, including those which follow from this chapter, are examined in the most detail.
CHAPTER III. KUHN'S DESCRIPTION OF SCIENCE AND ALTERNATIVES

This chapter describes Kuhn's theory of the structure of science, considers the philosophical critiques of Kuhn's work, then considers the sociological alternatives. This leads directly into the next chapter which outlines the model proposed in this thesis.

1. The Structure of Scientific Revolutions

Scientific activity occurs in two relatively distinct modes; normal science or crisis, extraordinary science and scientific revolutions. Normal science is research based on one or more past scientific achievements which act as exemplars. Exemplars are sufficiently unprecedented to attract adherents, yet open ended enough to leave a large number of problems unsolved. Under normal science scientists assume fundamentals and speak only to professional colleagues. Normal science is puzzle solving. Exemplars are the unit of puzzle solution, and rules generally (but not necessarily) govern the nature of acceptable puzzle solutions. Normal science does not aim at novelty; solutions (at least in general terms) are known in advance. Normal science is directed towards specific puzzles as defined by the paradigm, whether these puzzles be specially relevant and useful, or discriminating but without intrinsic interest, or articulation within a paradigm.

Kuhn is not very clear about the meaning of the term paradigm, but his book (1962 see 1970a) and clarification (Postscript 1969 see 1970a) indicate the following. There are at least two types of elements in a paradigm. Firstly there are examples or exemplars which are learned along with the theory they exemplify. Secondly there exist a set of elements including shared beliefs or metaphysical notions, shared values and rules. These two types of elements together constitute a paradigm which guides the research of scientists under normal science. Scientists however may vary in their interpretation of a paradigm.
At all times normal science produces anomalies. These appear as puzzles to be solved by the ingenious juxtaposition of exemplars in accordance with beliefs, values and rules of the scientist, though these may vary slightly. Most anomalies are solved by the tradition bound pursuit of normal science. An anomaly is not quite a scientific fact until absorbed into normal science. Some anomalies continue to resist solution by scientists operating under normal science, and come to attract increasing attention eventually from distinguished scientists. Initial approaches to an anomaly conform to normal science orthodoxy, but with continued resistance, divergence from normal science appears.

Crisis will occur if an anomaly (or set of anomalies) refuses to conform to normal science even after it receives increased attention. Crises vary both in size (the number of scientists affected) and depth (the importance of the crisis-provoking anomalies to the scientists affected). Kuhn does not draw clear distinctions but describes the smallest anomalies and crises as leading to new discoveries; larger anomalies and crises leading to new theories; still larger anomalies and crises (here he is not clear) leading to new paradigms. All shifts are of course paradigm shifts but discoveries are generally smaller paradigm shifts than a new theory. A new theory may affect a whole set of exemplars and extend influence into a group of disciplines.

The state of crisis has the following characteristics. Philosophical analysis not evident in normal science emerges to shake the fundamentals of normal science and may provide the basis for a scientific revolution. The scientist may look outward to other fields for solution to the problems of his own. Debates begin over legitimate methods, problems and standards. Rules become important and are debated. Versions of a paradigm proliferate and its loss of unique status makes the research it guided more like that of competing schools.

Typically only a short time elapses in the period between the onset of crisis
and the emergence of a new paradigm. A new paradigm emerges only (he equivocates here 1970a:74-75 versus 1970a:181) after pronounced failure in normal puzzle solving activity. It is at this stage only, that a scientist develops speculative and unarticulated theories, which he attempts to link with experiments. Novelty (as distinct from anomalies) only emerges for the man knowing with precision what he should expect. The novelty may be theoretical, conceptual or instrumental, or any combination of these.

Several other features of a crisis should be noted. Men may desert the field in crisis. The solution to a crisis is often anticipated but ignored in the absence of crisis. Problems provoking crisis have long been recognised and considered solved or all but solved. External factors may affect the timing of a crisis or the ease of recognition, but a technical breakdown remains at its core. During a crisis new discoveries are typically found. Almost always the men who achieve the fundamental invention of a new paradigm are young or new to the field they revolutionize.

The process of invention is itself inscrutable, but it is followed by a period of paradigm conflict between a new candidate and the previous normal science. A paradigm is declared invalid only after a new paradigm is available to take its place. The old paradigm will be developed in an ad hoc manner to reduce paradigm conflict. Incompatibility, discontinuity and incommensurability are the terms used to describe the relations between paradigms, but this incommensurability is never complete. Normally the new paradigm incorporates much of the vocabulary and apparatus of the old paradigm, though seldom in the same way. Arguments between holders of separate paradigms are circular, each using their paradigm in its own defence. The choice between competing paradigms is made by the relevant community of scientists.
Paradigm debaters are at cross purposes, as no reference can be made to super-paradigmatic standards which do not exist. Because competing paradigms solve and fail to solve different problems, choice revolves around which problems are more important to solve. Testing occurs as part of competition between rival paradigms.

Revolution, the conquest of the new paradigm, will affect the historical perspective of the community. Texts record the 'cumulative' result of past revolutions systematically distorting historical material, and showing a progressive trend towards present theory and practice. After a revolution texts will have to be rewritten, research redirected, and new citation distribution patterns should occur. The scientist responds to a 'new world' after a revolution; for example he may see new things when looking in places he has previously looked. He sees his prior concepts as limited and mistaken. Though some concepts may survive revolution, they normally need articulation with new examples. A concept must be related to the subject matter of the discipline through exemplars to be meaningful.

The transition between incommensurables cannot be made a step at a time. Like a gestalt switch it must occur all at once (not necessarily instantaneously) or not at all. For some scientists conversion may never occur. The new paradigm will be likely to claim it can solve the problems which have led to crisis. It will often claim better quantitative precision. It will try to draw evidence from outside the area of immediate conflict, previously unsuspected phenomena being particularly compelling. Neatness and aesthetic appeal are important factors in paradigm choice. Opponents of a new paradigm can usually point to problems faced by a new paradigm which were not even faced as problems by the old paradigm. Paradigm choice is couched in terms of relative problem solving ability, but the real issue is: which paradigm should guide research on unsolved problems.
Future promise is more important than past achievement.

2. Philosophical Critiques.

Kuhn's work has now been recognised, quoted and debated in a large number of articles and books, in itself making analysis of these criticisms difficult. The debate has been readily joined by philosophers, and the following is an attempt to isolate and consider criticisms and alternatives from a philosophical standpoint.

2.1 Rationality of Science.

Kuhn is accused by Watkins, Popper, and Lakatos, of an irrationalist explanation of scientific endeavour. Popper extends this attack to a charge of relativism (1970:55-56). Lakatos sees the end to good reasons for theory choice. Watkins attempts to reduce Kuhn's argument to absurdity in order to re-introduce "critical discourse" (1970:37).

The core of Popper's argument and a fundamental point of disagreement with Kuhn is his belief "in 'absolute' or 'objective' truth, in Tarski's sense" (1970:56). He dubs Kuhn's thesis as relativistic embodying "The Myth of the Framework" (1970:56) being "the central bulwark of irrationalism" (1970:56) Popper argues that Kuhn's relativism leads him to posit irrecoverable cleavage between frameworks allowing no rational discussion (1970:57).

Popper's characterization of Kuhn's argument does not do it justice. Kuhn is careful to argue for continuity across a revolutionary divide (eg. 1970a:149, 1970c: 266-277). He argues that scientists do uphold some of the traditional concerns of science (accuracy, consistency etc.) (1970a:184-185). These are not commandments (methodological canons) but values subject to interpretation by each scientist in each situation (1970a:185). Communication between competing paradigms is partial, not impossible (1970a:149). Translation is possible too, but never perfect (1970c:267). There are good reasons for theory choice, Kuhn argues, but this choice is not simple, depending on the variable application of
shared values (1970a:185).

Yet Kuhn has no role for extra-paradigmatic truth while Popper has. Popper believes that the sciences approach truth⁶, and this belief is inconsistent with some of his basic arguments. Popper's belief in truth is, it appears, in the realm of the metaphysical⁷ along with Marxism and Freudianism which he has so severely attacked. This argument implies that Popper would refuse to allow evidence contrary to this belief, relegating scientists not conforming to this (metaphysical) ideal to hack scientists being "taught badly" (1970:52), and this it seems, is precisely what he does (see 1970).

Lakatos in his section entitled "Science: reason or religion?" (1970:91-93) writes first of the hallmarks of intellectual honesty. "Boldness in conjectures...and austerity in refutations" (1970:92). Yet on the very next page he conjectures rather too boldly for one committed to 'intellectual honesty'. "Kuhn's position vindicates...the basic political credo of contemporary religious maniacs ('student revolutionaries')" (1970:93 brackets in original). It is fascinating that Lakatos should engage such a blatant emotional and political factor as an argument in theory choice particularly as Kuhn never mentions 'religious maniacs' or 'student revolutionaries'. It is a significant confirming instance of the model being proposed later in this thesis that Lakatos, a committed if revisionist Popperian (Lakatos 1970) should argue in this manner.

Taking another of Lakatos' rather too bold conjectures, in Kuhn's analysis "The new paradigm brings a totally new rationality" (1970:178). Similarly, "There is no particular rational cause for the appearance of a Kuhnian 'crisis'" (1970:178). Yet Kuhn goes to considerable lengths to explain the accumulation of anomalies under normal science, and the dogged persistence of some. A few scientists, in accordance with methodological values they share with other scientists, begin to perceive a crisis which may result in the institution of a new paradigm provided the new paradigm holders can produce
sufficiently compelling arguments.

If one believes in universal timeless standards applied absolutely unproblematically, like the rules of addition in arithmetic, and accept this as an exemplar of rationality, then Kuhn's explanation is irrational. But this confines rationality to logic and mathematics, excluding empirical science both for Kuhn and Lakatos. If standards are problematic (i.e. are values) then Lakatos has no case. Yet this is precisely what he admits when he writes "criticism does not - and must not - kill (a theory etc.) as fast as Popper imagined" (1970:179). When to discard a theory or a research program is thus a matter of opinion ("treat budding programs leniently" (1970:179)). Rationality for Lakatos is no different in principle from rationality for Kuhn.

Watkins attempts to document his irrationalist charge against Kuhn by linking Kuhn's view of science with religion (1970:33). He also attempts to show that Kuhn's version of normal science does not allow for the emergence of revolutions (1970:33-37). He concludes that scientists are not a community of closed minds (1970:37). It is constructive to examine the stages in Watkins' argument and compare these with Kuhn's argument, which is done below. Watkins introduces the five theses summarized below with the words "I begin by recapitulating some Kuhnian theses concerning paradigm change" (1970:34).

a) "Paradigm-Monopoly thesis" which argues that "...one scientist cannot, while under the sway of one paradigm, seriously entertain a rival paradigm" (Watkins 1970:34). Yet is is a fundamental part of Kuhn's argument to posit that anomalies always exist, and continually arise under normal science. Most speculative theories (and these may occur at any time since there are always anomalies) are phantoms which yield to normal science. It is the continued dogged persistence of anomalies which defy normal science that finally allows scientists to make more and more speculative modifications to normal science. In the absence of crisis rival paradigms will probably be ignored. During normal science a paradigm needs no rivals. The paradigm-
monopoly thesis is therefore a naive view of Kuhn's argument.

b) "No-interregnum thesis" which argues that "A scientist does not flounder around...with no paradigm to guide him" (1970:34). It is true that Kuhn makes a similar point but with different emphasis and implication. The scientist does 'flounder around' not without a paradigm, but when in crisis, with the beginnings of doubt about elements of the ruling paradigm.

c) "Incompatibility thesis" which argues that "A new paradigm will be incompatible with the paradigm it supersedes" (1970:34-35). Kuhn does argue in this manner, but incompatibility is only partial.

d) "Gestalt-Switch thesis" implies that "...a scientist's change-over from an old paradigm to a new one must be pretty swift and decisive" (1970:35).

To a certain extent this point of Watkins is valid and poses a difficulty, but before discussion of the difficulty is is necessary to be more specific about what Kuhn actually argued. Watkins shifts from the singular in the above quotation to the plural for his concluding remarks.

"...it takes time - a matter of years rather than hours - to develop a potential new paradigm to the point where it may challenge an entrenched paradigm" (1970:37).

Watkins claims that he is "tolerably well acquainted" (1970:25) with "The Structure of Scientific Revolutions" (Kuhn 1970a) yet Kuhn specifically denies the assertion made by Watkins. Kuhn describes three examples of paradigm revolution then states:

"...breakdown and the proliferation of theories that is its sign occurred no more than a decade or two before the new theory's enunciation (except in the case of Copernicus which took longer)" (1970a:75).

For individuals Kuhn may embrace the instant gestalt switch, but he certainly does not do so for a group; rather there is a slow shift of professional allegiances.

Furthermore the potential new paradigm does not emerge complete with exemplars and a battery of rules. Watkins himself, quotes Kuhn,
"The new paradigm, or sufficient hint to permit later articulation, emerges all at once..." (in Watkins 1970:35 emphasis added).

Elsewhere (eg. 1970a:144-159) Kuhn suggests that new paradigms are generally relatively weak and the scientist must

"...have faith that the new paradigm will succeed with the many large problems that confront it, knowing ...that the older paradigm has failed with a few" (Kuhn 1970a:158).

Kuhn does not argue that the new paradigm emerges relatively complete.

In any case Kuhn's point is an historical one to which he even quotes an exception. Watkins exaggerates the rigidity of Kuhn's explanation and criticizes this rigid structure mainly of his own making.

However, it was stated earlier that Watkins' point had some merit. Kuhn, it is contended, makes too much of the discovery moment. It seems more plausible to argue that a series of insightful flashes precede the emergence of a paradigm. Yet this is an empirical point, which if shown, would detract from the neatness of Kuhn's theory but not its substance. This point receives some attention in the case study to follow.

2.2 The distinction between Normal and Revolutionary Science.

Toulmin, partly by analogy with political revolutions, argues that scientific revolutions are characterized by continuity and small incremental displacements, rather than gigantic 'revolutions'. He argues that Kuhn has now shifted ground and accepts "micro-revolutions" (Toulmin 1970:46, Toulmin's term). This, he suggests, abolishes the normal - revolutionary science distinction, since discontinuities to a greater or lesser extent are always present and therefore 'normal'.

Consider first, Toulmin's charge of inconsistency. Kuhn does argue that revolutions vary in size, degree of incommensurability, and the number of sub-fields they affect. He explicitly discusses discoveries first (1970a: Sect. VI), then new theories (1970a:Sect. VII) and states, a "more profound awareness (of anomaly) is prerequisite to all acceptable changes of theory
(than for discovery)" (1970a:67). This is a clear indication that Kuhn attributes a place to revolutions of very different size and impact. In discussing the scientist's response to crisis he states"...crisis often proliferates new discoveries" (1970a:88). It might be fair to say that some discoveries are micro-revolutions and some new theories or new paradigms are revolutions. Kuhn does not explicitly say so, but clearly he (even in 1962 when the above quotations were written) is talking both of small and large revolutions, and Toulmin's point cannot be accepted.

Toulmin's second argument that the normal - revolutionary science distinction is invalid, is a more telling criticism. Kuhn (in reply) asks "Can we distinguish mere articulations and extensions of shared belief from changes which involve reconstruction?" (1970c:251). Masterman struggles with a like problem in seeking a logical property of crudeness, but without success (1970:79-87). Masterman is able however, to list the properties she attributes to a model or analogue.

"a) a crude analogy is finite in extensibility b) it is incomparable with any other crude analogy c) it is extensible only by an inferential process or 'replication' ...examined by ... 'inexact matching'" (1970:79).

It would appear that no logical distinction has been sustained between normal and revolutionary science. It has been argued that Kuhn, implicitly at least, recognized this fact in 'The Structure of Scientific Revolutions'. Since 1962 he has explicitly acknowledged the existence of intermediate cases (1970c:251). It remains a weakness of Kuhn's formulation that he does not develop a terminology for minor and major revolutions, retaining the one rather misleading term 'revolution' for paradigm shifts of all sizes. To distinguish 'extension within a paradigm' from 'reconstruction of a paradigm' is not purely a matter for "...additional historical research" (Kuhn 1970c:251), it is also a matter of conceptual clarification.

In this thesis the term 'revolutionary exemplar' will be introduced to apply to minor revolutionary episodes where the unit of revolution is a
discovery or a new exemplary practice. The term revolution will be confined to those revolutionary episodes of major proportions including such occurrences as a new theory or set of theories, or a simultaneously introduced set of revolutionary exemplars. This terminology is intended as an extension of Kuhn's terms, not a negation of it, and it is readily admitted that these are relative notions.

There has been a considerable amount of revisionism regarding the normal-revolutionary science division. Popper\textsuperscript{9}, Watkins\textsuperscript{10}, and Lakatos\textsuperscript{11} all admit the existence of two types of science, though their grounds for discrimination differ from Kuhn's.

Lakatos further revises his position, as noted by Bloor (1971) and Sklair (1973). He accepts that falsification has "historical character" (Lakatos 1970:120 emphasized in original). He accepts the existence of "hundreds of readily available anomalies" (1970:121). He accepts two theory versus 'fact' struggles rather than single theory comparison with empirical evidence (1970:181). He states that the choice between two theories depends upon "...the few crucial excess - verifying instances" (1970:121), a position remarkably close to Kuhn's. It is of interest to notice that Lakatos does not discuss the difficulty of deciding between two theories when each has different excess verifying instances.

This discussion will be carried no further. Bloor's article (1971) and the section in Sklair (1973:130-140) pursue this debate in more detail\textsuperscript{12}. It remains to note the remarkable convergence between Popperian philosophy of science and Kuhn's analysis, particularly in the case of Lakatos.

3. Sociological Alternatives

A number of means of classification of the sociology of science and technology have been attempted (eg. see Crane 1972:3-11; Ben-David 1971:1-13; Sklair 1973:58-63; Storer 1969:8-9). Sklair outlines four approaches to the sociology of science. 1) Marxist (it is assumed he would include his own "neo - Marxist position"(1973:64) and sociology of knowledge approaches
under this heading too). 2) Structural functionalist approach. 3) Science policy studies. 4) Residual category including studies of motivation and creativity at the individual level. Sklair's last two categories are of little interest here (see Sklair 1973:61-63) leaving functionalist and sociology of knowledge approaches for consideration here.

Crane too, defines four approaches to the sociology of science: 1) Study of the interrelations between science and other institutions (1972:3-6); 2) Science as a social system (1972:4,6-7); 3) History of science (1972:4,7); 4) Citation studies (1972:4,7-8). Crane's first two categories roughly correspond to Sklair's though Crane's first category includes clearly non-Marxist writers like Ben-David and excludes historians of science as a separate category. Crane does not base her classification scheme on a theoretical basis as Sklair does, but she recognizes and discusses such a distinction (1972:8-11) when she states,

"If the sociologist refuses to consider the content of scientific ideas ...he is implicitly accepting a theory of knowledge" (1972:9).

Ben-David uses a similar differentiation as his first criterion for classifying the literature

"...whether it claims that social conditions influence only the behaviour of scientists and scientific activity or that they also influence the basic concepts and the logical structure of science." (1971:2)

This is a fundamental cleavage in the sociology of science, but it is difficult to see how Ben-David uses his own distinction when he classifies Kuhn as denying that social conditions influence the logical structure of science. Kuhn does not accept that the 'logical' structure of science is independent of the social conditions of its existence. It is a clear message of his work that this is not the case, in fact he states "...in paradigm choice...there is no standard higher than the assent of the relevant community" (1970a:94). Therefore the scientific community makes its own standards, which periodically change. It is true Kuhn does not make it specifically part of his theory that a systematic relationship exists between social conditions giving rise to a theory and the content of a
theory. Nor does he rule out, as Ben-David does (Ben-David 1971:7-14).

Ben-David's other means of classification relates to whether the author uses mainly "interactional" variables studying "the way scientists act towards each other" or "institutional" (1971:2) variables. However this criterion is not of theoretical importance and depends on the object of study as Ben-David himself acknowledges (1971:2).

In the following two sections, a brief review of two main approaches to the sociology of science will be presented with particular attention to the manner in which they compete with, or complement a Kuhnian analysis.

3.1 Functionalist Sociology of Science.

Some mention has already been made of this approach in Chapter II Section 1. A good critique of the functionalist sociology of science may be found in Sklair (1973)\textsuperscript{15}.

This position is relatively well known, and has many eminent advocates, including Storer, Hagstrom, Barber and Merton. For the purposes here it is sufficient to focus on the work of Merton, an important proponent of this approach.

A convenient point of entry into the functionalist sociology of science is its self-imposed limits, as Merton states "...we shall consider, not the methods of science, but the mores with which they are hedged about" (1972:66). Sklair states sceptically "In short, we are asked to believe that nothing we can find out about the social organization of science could have any effect on the scientific or epistemological nature of science" (1973:128). Crane makes a similar remark\textsuperscript{16}. As this point has been argued effectively elsewhere (Sklair 1973) no more than the conclusion will be put here. Science is man's creation, it is a human product. Sociology does not stop at the edge of science but penetrates to
its heart, including its methodological canons (if any) its content and its ethos. Functionalist sociology of science only refers to scientific ethos (eg. Merton 1972:66).

Merton's proposition that "The institutional goal of science is the extension of certified knowledge" (1972:68) is generally accepted by functionalists, though the actual or proposed motivation of scientists has received considerable attention recently. When Merton says 'certified knowledge' he means science (Merton 1972:66) and his above quotation may be translated to 'the institutional goal of science is the extension of science'.

From this may be derived the norms of science: universalism, communism, disinterestedness and organized scepticism. These norms have been defined in various ways since Merton's formulation, but generally they retain similar intent (eg. Cotgrove & Box 1970, Barber 1953:84-100). Universalism decrees that truth claims be subjected to pre-established impersonal criteria, which implies according to Merton, a democratic society and no particularism based on ethnocentrism (Merton 1972:68-72). Science is common property leading to the rejection of secrecy being the norm of communism (1972:72-75). The norm of disinterestedness is used to explain the supposed absence of fraud in science (1972:75-77). Organized scepticism suggests that scientists suspend judgement till the facts are at hand, and are sceptical towards unsubstantiated beliefs (1972:77-78).

The first and perhaps most important point for the sociology of science is the existence or otherwise of 'pre-established impersonal criteria'. If such criteria exist and are timeless, beyond the reach of man, then there is a clear case for expunging the standards and the content of science from sociology. If on the other hand such criteria either do not exist (they may indeed be an artefact of rational reconstruction) or are created and recreated by man, the sociology of science must enter both the methodology (if any) and content of science.
The position put forth here is that no absolute timeless methodological canons exist. Adoption of this approach makes the existence of such canons an empirical question. If methodology is really as unproblematic as the functionalists assume, this would be established.

If methodological canons appear 'objective' it is because we cannot "wish them away" (Berger and Luckman 1972:13). Methodology may be objectified and treated as absolute, but it is just this process which is of sociological interest. Man's reality including his scientific reality is socially constructed. If scientific knowledge is 'objective' to a scientist, it is because it has been socially created that way on the initiative not only of the scientist himself, but out of his interaction (direct or indirect) with others. The creation and 'certification' of scientific knowledge is a social process and has a social reality.

Study from this standpoint should show the influence of all aspects of science (both 'technical' and 'moral' compulsives) on the behaviour of individuals. A sociology of science without consideration of scientific knowledge itself can never explain more than a minor part of a scientist's behaviour. This is one of the main reasons why the work of Kuhn represents such a breakthrough. Kuhn's basic thesis shows (whether the precise details of his thesis are correct or not) how scientific knowledge itself can guide the behaviour of scientists, influencing the manner in which they create and destroy scientific knowledge. It is after all a 'disciplinary matrix' or 'paradigm' to which Kuhn refers, and it contains the full body of his expert knowledge, including his values. This is the primary guiding force directing the scientist's research, and shaping his interaction with other scientists.

This section has considered only a small part of functionalist sociology of science, but this part is an absolutely fundamental part.

The limitations of functionalist sociology of science...
discussed here provide a basis for the next section which asks:
If science is a human product, what kind of social processes are involved in its production? In particular the role of external influences on the production of scientific knowledge is discussed.

3.2 The Sociology of Knowledge.

This section addresses itself to one major implication of the sociology of knowledge, the role of 'external' factors in scientific knowledge generation.21 The single most substantial criticism of Kuhn's work which has been little discussed, concerns his emphasis on the 'internal' dynamics of scientific change. The abundance of philosophical criticism of Kuhn's work has directed attention away from this much deeper issue.

As a first step it is necessary to clarify the role Kuhn attributes to 'external' factors. All page references below refer to Kuhn 1970a.

p.x "...except in occasional brief asides, I have said nothing about the role of technological advance or of external social, economic, and intellectual conditions in the development of the sciences". He goes on "Explicit consideration of effects like these would not, I think, modify the main theses developed in this essay, but it would surely add an analytic dimension of first-rate importance for the understanding of scientific advance".

p.19 "...in fields like medicine, technology, and law... (in contrast with science) the principle raison d'être is an external social need..."

p.69 "...external factors...are principally significant in determining the timing of breakdown, the ease with which it can be recognised, and the area in which ... the breakdown first occurs. Though immensely important, issues of that sort are out of bounds for this essay."

p.79 "The very few (fields) that have ever seemed to...(resolve all their puzzles) become tools for engineering."

P.82 "... an anomaly without apparent fundamental import may evoke a crisis if the applications that it inhibits have a particular practical importance..."

p.96 "...an excessive concern with useful problems, regardless of their relation to existing knowledge and technique, can so easily inhibit scientific development."
p.152 "Some ...reasons (for theory choice) for example, the sun worship that helped make Kepler a Copernican lie outside the apparent sphere of science entirely."

p.161 "...part of our difficulty in seeing the profound differences between science and technology must relate to the fact that progress is an obvious attribute of both fields."

p.164 "...insulation of mature scientific communities... has never been complete."

p. 167 "If authority alone, and particularly if non-professional authority, were the arbiter of paradigm debates, the outcome of those debates might still be revolution, but it would not be scientific revolution" (emphasis in original).

p.185 After describing some scientific values he states: "Other sorts of values exist as well - for example, science should (or need not) be socially useful." (brackets in original).

In his encyclopedia article he is more definite, describing the internal and external histories of science, and characterizing his own as internal. "Only occasionally need the historian take note of a particular concept, problem, or technique which entered the field from outside" (1968:81). He asserts that the combination of the internal and external approaches to science"...is perhaps the greatest challenge now faced by the profession" (1968:76). It is in this spirit that the remainder of this section is enjoined.

So far the terms 'internal' and 'external' have not been subjected to scrutiny, though the quotation marks used might have suggested that they were regarded as problematic. Three possibilities suggest themselves in connection with discrimination between internal and external factors affecting scientific development:

a) the edge of the paradigm (remembering that different aspects of the paradigm will have differing 'communities');

b) the sciences collectively versus other fields;

c) the level of reason: scientific reasons versus religious or metaphysical belief. (This is really an elaboration of criterion b, for example, Kepler's sun worship (Kuhn 1970a:152)).
None of these distinctions necessarily survives a revolution. The new paradigm following a revolution will redraw its boundaries, certainly substantively and probably in terms of its membership. Kuhn himself argues that the science-metaphysical line is likely to have shifted after a revolution. Problems previously defined as metaphysical may become part of normal science and vice versa.

Consider a) above, namely the edge of the paradigm distinction. The edge of the paradigm can only be specified by stating what substantive parts of the paradigm are involved (eg. one paradigm application or a whole set of related paradigm applications). It is uncertain whether Kuhn refers to a set of relatively distinct paradigm sub-fields within which paradigm homogeneity may be assumed, or whether he refers to sub-fields as artefacts without real boundaries from other sub-fields. If the latter is the case then the edge of the paradigm cannot be used as it cannot be defined.

Assuming Kuhn argues for relatively distinct paradigm sub-fields within which paradigm homogeneity may be assumed, it is possible to take the argument further. Consider a set of related paradigm applications (exemplars) all of which are involved in a revolution, and in which only they are involved. The revolution may be confined to one particular relatively homogeneous paradigm sharing group or in the more general case the exemplars concerned in this potential revolution will cross boundaries into other sub-fields. In the former case, a sub-field holds a homogeneous paradigm, the revolution affects only the members of that particular sub-field, and none of the exemplars concerned with the revolution are used in other sub-fields. In this (very special) case it makes sense to talk of an 'internal' revolution according to the edge of the paradigm criterion.
Consider the genesis of a revolution in the more general case where the exemplars involved in the revolution cross sub-fields. The revolution will begin in one of the sub-fields. The members of other sub-groups may 'discover' their own new paradigm for themselves, or by taking an exemplar (or set of exemplars) from another sub-group and relating it to their own speciality. In these cases it is plausible to assume that the beginnings of perception of a crisis lead to a searching in related fields in which the anomaly may already have been solved.

It is therefore argued that most scientific revolutions have their source of discovery outside the sub-group who hold a homogeneous paradigm, and are in this sense external.

The reader may think so far this particular discussion is hypothetical since paradigm sub-field distinction is an artificial concept. Indeed it may be, but even if it is maintained, there is only one very special case in which talk of an 'internal' revolution makes any sense.

Turn now to the other internal - external division; sciences versus other fields, and the associated distinction between scientific and extra-scientific considerations in theory choice (typically science vs. humanities or science vs. religion).

One leg of this argument has already been stated, namely that sociology, politics etc. enter into the heart of science including its content and methodology. The conclusion from this line of reasoning is that scientific content is itself political, albeit with some special features not normally found in more conventional politics. This argument does not depend on showing that funding of research and like matters make science sectionally motivated as some commentators have suggested. Science, even when carried out by ideal disembodied independent researchers is still problematic, and can be described in political and sociological terms.
If this is not the commonsense of scientists it is because, as discussed in section 3.1, scientists objectify scientific knowledge and methodological values and norms. It is thus claimed that the argument put here is a second order construct. On the second order construct level no distinction may be found between 'scientific' and 'extra-scientific' factors, and the internal-external distinction is similarly inapplicable.

The only argument left to examine is on the first order construct level (namely that there is a scientific extra-scientific distinction) and related to whether extra-scientific factors are concerned with scientific development. Reference has already been made to one form of this argument put by Ravetz (see chapter II Section 1). Whether or not the 'golden age' of science and the consequent 'clear' scientific/extra-scientific differentiation ever existed, it will be taken that it does not at present.

The other and stronger form of the argument is the Marxist one, that science is the instrument of the ruling class interest, the ruling class being the class in control of material resources. One of the better known works in this field is an article by Hessen who argues that Newton, the supreme example of a disinterested scientist, resolved "those tasks which have been raised for accomplishment by the historical development of productive forces and productive relationships" (1971:203).

This argument cannot be pursued in depth, nor for the purposes here is it necessary to show exactly what sort of extrinsic effect or determination society exercises over science. All that is necessary is the conclusion that social forces shape science both within science and from without.

This formulation is apparently in contradiction with Kuhn when he says:

"If authority alone, and particularly if non-professional authority, were the arbiter of paradigm debates, the outcome of those debates might still be revolution, but it would not be scientific revolution. The very existence of science depends upon vesting the power to choose between paradigms in the members of a special kind of community" (1970a:167).
Yet Kuhn is not specific about what makes this community so special. One type of answer, the Mertonian universal, communal, disinterested, sceptical scientist is denied. Kuhn (see Kuhn 1972:80-81). He does specify five characteristics of members of scientific communities (1970a:168). The first two do not concern this issue. The last three reduce to the existence of a uniquely competent group sharing training and experience. It is these members who act (Kuhn says 'must act') as exclusive arbiters. Kuhn while criticising Merton's standards implicitly reintroduces similar ones. In view of the preceding argument regarding the existence of extrinsic forces operating on science it is dangerous ideology to believe that scientists really are free from political pressure and are therefore uniquely competent.


This chapter has examined Kuhn's theory of science and some alternatives, with a view to the development of a sociological framework for the study of expertise. Kuhn's theory of 'The Structure of Scientific Revolutions' was generally defended against the criticisms made of it. Many of the criticisms were found to relate to an over rigid representation of Kuhn's position. It was argued however, that no sharp differentiation existed between normal and revolutionary science, a problem which is further discussed in the next chapter.

Functionalist Sociology of Science limits itself to the study of scientific norms, excluding the knowledge content of science. It was contended that science is a human creation and the processes of its creation should be amenable to sociological investigation, not reified as in the functionalist account.

Kuhn's theory of science was generally found to be an 'internalist' account, but the possibility of insulating the study of science in this manner was disputed. The next chapter attempts to formulate a possible approach to the sociological description of the operation of wider social forces on expert knowledge.
1. Science, Technology and Organized Knowledge

In Chapter II it was argued that no distinction exists between science and technology. Normative or ideological differentiation may exist, especially on an institutional basis, but this bears no necessary relationship to the substance of the expert's findings. The following terms were introduced: organized knowledge to replace 'accepted scientific and technological knowledge'; research to replace 'the process of acquisition of scientific and technological knowledge'; expert to replace scientist or technologist whether or not he is engaged in research; and researcher to be used in a way similar to normal usage.1

Organized knowledge provides a guide for action whether this action be research or action in some other sphere. Action in some other sphere may be teaching, plant maintenance or any other form of expert activity. Sklair rightly accuses the functionalists (Merton and Hagstrom particularly) of doing only the sociology of elite or academic science (1973:160). He is fully justified in introducing industrial science, but his approach seems confined to researchers (1973:74). Sklair excludes schoolteachers yet he states "In fact, most people with scientific training work as schoolteachers." (1973:74)

The sociology of organized knowledge should study possessors of that knowledge, not only those engaged in research. Kuhn too, is only concerned with research. Yet it is plausible to argue that if a paradigm can be used to explain the activities of research workers, it can also be used to help explain the activities of others who have been similarly socialized into it. This approach opens new vistas for the sociology of expertise.

2. The Model Outlined

Social variables like class, status and power enter right into the heart of organized knowledge, as do factors like supply of material resources.
It is also true that organized knowledge has consequences for social organization. This relationship could be termed dialectical in that the two inter-related variables, social organization and organized knowledge, are both always in the process of influencing the other, but no causal sequence is specified.²

Below is an attempt to codify this model into a more comprehensive theory, drawing on many of the arguments raised in earlier chapters.

2.1 Material Resources, Power and Status

Possession of material resources, power and status allows the exercise of power over the production of human resources, over the production of organized knowledge and over the use of organized knowledge. This exercise of power is generally not absolute, and may be masked by an ideology.

(a) Possession of material resources (etc.) therefore allows the exercise of some influence over paradigmatic socialization (education). This influence may be indirect or latent rather than manifest.

(b) Possession of material resources (etc.) allows the exercise of some influence over the maintenance of a particular ruling paradigm (often latent or indirect as in (a)).

(c) Possession of material resources (etc.) allows the exercise of some influence over paradigm change (often latent or indirect as in (a)).

Possession of organized knowledge, particularly the appropriate paradigm of organized knowledge, allows the possessor access to material resources, power and status. To make this point more forceful it is instructive to consider the relative career prospects of a Marxist or Capitalist economist in America or the Soviet Union in the 1950's.

Further research is required to specify the precise sociological processes of influence over organized knowledge. The next chapter begins to delineate some of these processes in the forestry discipline. This thesis adopts the position that influences on organized knowledge come from interest groups or vested interests. In most cases, many groups will have an interest in a discipline's knowledge.
Johnson (1972) proposes that tension in the consumer-producer relationship provides the sociological means of exercise of power in relation to professional activity. Johnson's types of occupational control closely relate to the model proposed here, for example the two extremes in the dialectical relationship correspond to Johnson's first two types of control (1972:45-46). In Johnson's terms the forester appears to have a mediated (1972:46) relationship.

There are, however, a number of terminological (as distinct from theoretical) difficulties with Johnson's concepts. It is not always clear precisely what is produced and consumed, by whom and for whom. For example, is it forest products or forestry expertise produced by foresters? A like problem occurs in economics where stages in processing may be a better concept than production and consumption. In view of the foregoing it was decided to use the notion of interest groups, where particular emphasis should be placed on the sociological processes by which interest groups exert influence.

2.2 Organized knowledge in paradigm form

As previously mentioned, Kuhn's concept of a paradigm was initially vague. He developed the concept considerably in his later work but the most impressive formulation came not from Kuhn but Masterman (1970) who documented twenty-one different uses of the term in Kuhn's work 'The Structure of Scientific Revolutions' (1962 see 1970 a). Masterman is able to group these uses of the term paradigm into three different levels of usage - (a) metaphysical paradigms (b) sociological paradigms (c) artefact or construct paradigms (1970:61-66). Table 1 illustrates the relationship between Kuhn's representation of a paradigm, Masterman's, and the model proposed here, which is an extension of Masterman's formulation.
<table>
<thead>
<tr>
<th>Science</th>
<th>Organized Knowledge</th>
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<tr>
<td><strong>TABLE 1: Paradigm Components of Organized Knowledge</strong></td>
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<tr>
<td><strong>PARADIGM or DISCIPLINARY MATRIX</strong></td>
<td><strong>PARADIGMS</strong></td>
</tr>
<tr>
<td>Shared commitments to beliefs, belief in particular models (eg. 1970a:184)</td>
<td>I Metaphysical paradigms or metaparadigms: beliefs, set of principles governing perception, epistemology, etc. (eg. 1970:65)</td>
</tr>
<tr>
<td>Values: accuracy, quantifiability, simplicity, consistency ... (see 1970a:184-186)</td>
<td>II Sociological paradigms: a set of habits (intellectual, verbal, behavioural, mechanical, technological) (see 1970:65-68)</td>
</tr>
<tr>
<td>Symbolic generalizations (see 1970a:182-184, 188-190)</td>
<td>III Artefact or construct paradigms: a crude analogue or model for solving puzzles (see 1970:65,68-71)</td>
</tr>
<tr>
<td>Exemplars (see 1970a: 186-188)</td>
<td></td>
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</tbody>
</table>
The main new concept developed for organized knowledge appears in Table 1 as decision criteria. Decision criteria are those evaluation procedures by which expert decisions are made. There are many different forms of evaluation criteria depending primarily on the nature of the field and the institution concerned (consider for example, medicine, defence, industrial process development, CSIRO forest fire research). The most pervasive and highly developed decision criteria calculus is economic evaluation, though its application may vary greatly.

The notion of decision criteria is clearly a fruitful one for the study of a large body of experts. It is not so apparently relevant to those who were hitherto called pure scientists. The isolation of explicit or implicit decision criteria is partly an empirical question, though a difficult one clouded by an ideological smokescreen (see Chapter II).

It is suggested that decision criteria are an integral part of the paramount reality of everyday puzzle solving for most experts.

If decision criteria are not actually part of the expert's framework, substitution by values which perform in a similar manner, may occur. Decision criteria are, after all values which have been codified and objectified. Kuhn stresses 'scientific' values like consistency, and reproducibility and only mentions values relating to social usefulness in passing (1970a:185) while this model stresses both types of values.

Decision criteria may be latent, for example, when the expert does not appreciate the connections between his work and some manifestation of his labour elsewhere in the society. In this case the concept of evaluation criteria or related values exercising sway over the expert's puzzle solving needs modification. In this case it is necessary to revert to notions of latent or unintended consequences, or perhaps of second order constructs.

One class of experts remain, those who in fact as well as ideology are working on puzzles without formal decision criteria, explicit values which relate the puzzle solutions to other social groups, and without any latent
evaluative procedures. It is suggested that few if any experts fall into this category; however, it is well covered by the Kuhnian analysis.

Evaluation therefore, may be a highly formalized part of organized knowledge, may exist less formally as values, may exist at another (unconscious or latent) level of reality or not exist at all. The first three possibilities may coexist, as an expert may have codified decision criteria, explicit values, and be unaware of some of the consequences of his action. This categorization draws attention to variables of singular sociological and political importance: who benefits from expert decision criteria, values and unintended consequences of expert action, and who is deprived?

This model situates Kuhn's theory as a special case, studying a restricted class of experts.

Before passing to the next section concerning paradigm change, some features of Table 1 need elaboration. Level IIa consisting of shared roles, values, norms and habits is slightly more explicit than Masterman's formulation. At the exemplar level, four different but overlapping types of exemplar are given. The basic concept enunciated by Masterman regarding exemplars as the unit of puzzle solution is retained.

2.3 Paradigm Change

Material resources, power and status allow exercise of influence over the selection, perpetuation, and alteration of the ruling paradigm of organized knowledge. Possession of organized knowledge, particularly the appropriate paradigm of organized knowledge (not always the ruling one) allows access to material resources, power and status. The inter-relations between organized knowledge and material resources, power and status has already been termed dialectical.

Under 'normal' organized knowledge the expert does not examine his own assumptions, but proceeds with the paramount reality of puzzle solving. It is possible to anticipate that experts have a paradigm structure which takes into account the existing distribution of material resources, power and status. As normal organized knowledge solves puzzles, and is relatively
well adjusted to the distribution of power, there is no reason to change it.

For the purposes of clarity, two ideal types of change may be conceived, one where organized knowledge undergoes paradigm change due to pressure from material resources, power and status, and the other where experts perceive connected anomalies and institute a new paradigm (which then may have consequences for social organization). The paradox, and perhaps the reason why Kuhn's model has been so widely read, is that both these change regimes look the same if studied from purely an internalist view. No matter where the change may be thought of as originating, it must be accepted by the appropriate experts, that is, it must be objectified and legitimated. In this dimension too, Kuhn's theory emerges as a special case.

These are indeed idealized types. These two sets of variables are continually in the process of influencing one another and can only be separated for conceptual clarity, and to briefly benefit from the simplicity of causal argument. Resources, power and status need to be studied in each specific discipline, and in the institution concerned. However, it is possible to take further the notion of change in organized knowledge, neglecting for analytic purposes influences arising from the distribution of material resources, power and status.

In particular, where decision criteria are highly formalized there exists a two dimensional process of change within organized knowledge. The two analytically separable change regimes consist of one, under constant decision criteria where the remainder of organized knowledge may change (e.g. technological innovation under profitability criterion); and the other, where decision criteria change under an otherwise constant organized knowledge set. The separation is never clear, as expert knowledge and concepts are likely to be in part a reflection of the ruling evaluation procedures. In forestry however, as with many forms of organized knowledge, there is a relatively clear division between decision criteria (generally economic) and concrete processes, concepts, theories, etc.
(a) Change under constant decision criteria.

Kuhn had two categories of scientific state, which may further be divided introducing revolutionary exemplars for small revolutionary episodes. For organized knowledge a further category must be included. Most experts are not involved with the extension of organized knowledge, but its use in practical situations. They still solve puzzles: experience in solving practical puzzles is highly prized. Almost every puzzle has some element of novelty to the expert, as organized knowledge will not specify solutions in every detail. Such experience may be regarded as the extension of knowledge, but is better separated from the process of research, being generally different in kind. The four classes of change in organized knowledge are:

(i) Maintenance: Use of organized knowledge in specific situations (e.g. teaching, process maintenance, etc.). Organized knowledge is used in accordance with well known practices and relationships, at times requiring considerable skill. Anomalous occurrences will test the skill of the expert, but doubts about the implications for organized knowledge are suspended or explained away.

(ii) Articulation: This refers to the solving of puzzles which are discernable from the organized knowledge framework, in a manner which clarifies or improves already existing techniques or knowledge. It involves using well known tools, conceptual and concrete but extending them to new situations perhaps with ingenious modifications. The puzzles or anomalies articulated under this regime are generally well known to a group of practitioners. This corresponds to Kuhn's category of Normal Science.

(iii) Revolutionary exemplars: A revolution simultaneously destroys and rebuilds parts of organized knowledge. Small destruction-reconstruction episodes, particularly of the type Kuhn refers to as discoveries, are termed revolutionary exemplars. These occur when a puzzle or set of puzzles is solved by an unprecedented procedure, operation or relationship. It is unprecedented in so far as it violates some previously accepted or implicit
aspect of organized knowledge. Although unprecedented it does not challenge
the foundations of organized knowledge, only a relatively small part. This
is of course a matter of degree and judgement, as it has already been argued
is Kuhn's distinction.

(iv) Revolutionary change: this category is continuous with the last
and occurs when a substantial part or all of the experts organized knowledge
is altered in a significant manner. A revolutionary change in organized
knowledge will solve or promise to solve a whole set of pressing puzzles
simultaneously. It may occur for example if a simultaneous and connected
set of exemplars were invented where previously unconnected puzzles or
anomalies existed.

Evaluation criteria may also vary under an otherwise constant set of organ-
ized knowledge, and a similar set of categories are applicable, particularly
where decision criteria are highly formal.

(i) Maintenance of the same decision criteria: the same abstract
criteria are made operational in the same way. The skill of the expert is
continually tested by new situations. Extension to new circumstances is
possible in two cases: either when existing criteria are considered
unproblematic in the new situation, or the new circumstances pose puzzles
which continue to be regarded as mere anomalies.

(ii) Articulation: Development of improved operationalized techniques
of decision-making to approach abstract criteria more closely (e.g. improved
measurement, etc.)

(iii) Revolutionary criteria change: When abstract criteria themselves
are reformulated, this constitutes a revolutionary change in decision criteria.

3. Summary

The sociology of organized knowledge should study experts qua experts in
many different contexts, not only those engaged in research. A classification
scheme was introduced which described the various states of organized
knowledge. Changes could occur in response to pressure by interest groups,
or in response to anomalies and crises as described by Kuhn, or as a combination of both. Internally, changes could be identified as decision criteria changes or changes under constant decision criteria, in those cases where codified evaluation techniques were in use. Kuhn's theory seems to emerge a special case of the model proposed here. A dialectical relationship was posited between social organizational variables (resources, power, status, etc.) and organized knowledge.
CHAPTER V  
FORESTRY AND CONSERVATION

This chapter attempts to summarize some of the major elements of the forestry-conservation debate. There is no absolute unanimity either among traditional foresters or conservationists, but two reasonably differentiated meaning systems or paradigms may be identified. For analytical purposes, this chapter tends to polarize traditional foresters and conservationists. The two paradigms are continually in process and no characteristic of either paradigm should be reified as a necessary trait. The next chapter will show the extent to which analytic separation as presented below is relevant in the minds of final year forestry students.

This chapter draws on published literature, a tape recording of a public meeting and tape recorded discussion sessions with a group of final year forestry students. Occasionally reference is also made to a survey conducted on final year forestry students, described in the next chapter (referenced Survey 1974). The background to the discussion sessions is described elsewhere (Rattray 1974: esp. 40) and quotations from them will be referenced as (Student 1974).

1. Metaphysic: The Concept of Nature

Central to the conservationist critique and the traditional forestry defence is the concept of nature to which each subscribes. Metaphysical beliefs of this kind are not always made explicit, though they are documented below. More commonly they can be seen as implicit assumptions.

If nature is complex, interconnected, in perfect and delicate balance then intervention (especially intensive forestry) is a hazardous business. Man must subordinate himself or least integrate himself into nature as he has no hope of mastering its infinite complexity.

On the other hand if nature is explicitly or implicitly taken as solid and durable in response to intervention, then intervention can proceed. Nature for this paradigm has no special status. Man's activities, even highly technical ones, are seen as just as natural as an 'untouched' ecosystem.

Routley and Routley (hereafter R & R) both of whom are philosophers and conservationists, have written a work of considerable importance to the
conservation paradigm (R & R 1973). They spend some time clarifying their use of the term 'natural' and criticising its use by foresters. The nub of their criticism concerns the "Nothing's Really Natural Argument" (namely) "...What superstitious conservationists regard as natural forests are not really 'natural' at all, for they have virtually all suffered human interference" (R & R 1973:14). They continue "What is important in deciding whether an area is natural is the degree of interference" (R & R 1973:14, emphasis in original).

Closely related, is the "Argument from Change" (R & R 1973:13) which asserts that nature is continually changing so forestry activities are no different in principle from natural changes. It is pointless to attempt to maintain a forest in an unchanging state as argued by 'preservationists'. "(This argument) attempts to persuade us...that because some changes...are inevitable any changes are acceptable" (R & R 1973:14).

Several other arguments described by Routley and Routley fall into the same class. The "Natural Disaster Argument" (1973:16) (eg. "Great Bushfire Argument" (1973:17) ) justifies forestry activities as "no worse than, or only a simulation of, damage from various comparable natural disasters which might possibly occur" (1973:16). The "Interference Improves the Forests Argument" (1973:15) suggests that "...the disturbing activities of foresters are essential to maintain (forests) in health and vigour..." (1973:15). The "Degenerate Forests Argument" (1973:15) asserts that "...selectively logged...and fire ravaged forests...(which) are badly run-down...might as well...be replaced (1973:15).

The 'holy' status of the natural in the conservation paradigm is in contrast to its status in the traditional forestry paradigm. Below some examples with comments are cited. Most examples involve the notion of improving nature. It is man who has the 'holy' status in the traditional paradigm.

"...plans were described to restore old Tasmamian forests to vigorous crops of trees...(Crane said) that the old forests are decadent and damaged. He sees these forests as a great, natural, renewable resource..." (reported from address by A.H.Crane, Chief Commissioner for Forests in Appita 1971:235).

The concept of 'restoring decadent forests' to 'youthful vigour' is self
The notion of renewability will be discussed later, but it would appear that Crane's concept of renewability relates to wood production renewal.

A similar point is made by Jacobs.

"Improvement work in the native forest - other than improved fire protection - must mean the destruction of overmature or defective trees that compete with younger trees" (Jacobs 1968:16).

Florence makes a parallel remark when he states:

"it may be only through...periodic stimulation of forest use, that the forest is maintained in a dynamic and healthy state...occasional conservative logging and silvicultural manipulation of sawlog quality forest within 'complete preservation' areas is desirable..." (Florence 1969:39).

"...the forest, in the national forest or national park, is a living organism and you have either got to treat it sooner or later in some way, or it is going to become just a standing cemetery, and one very dead" (Jacobs 1971:83).

Improvement is not only physical manipulation of tree species, but genetic selection and soil enhancement.

"Greater forest production can be achieved by...soil (and)...tree improvement...a better understanding of physiological aspects, stand dynamics and other ecological considerations" (Hillis 1973:44).

Pryor argues that ecosystems are changing and no specific state of nature has absolute status.

"...it must be recognised that the ecosystems are dynamic and 'natural' might be taken to refer either to the situation without man, or the position with aboriginal man, or present day condition" (1973:321).

A document circulated at the Forwood Conference made a similar point:

"...if you ban the pine because it is exotic you must ban the white man for a start, then all of agriculture...as well as...cattle and sheep...etc...we must revert then to the witchetty grub, the kangaroo and the wurley." (Forwood (9):1).

The conservationist argument that monocultures are more subject to disease than diverse natural associations of species (eg. Tyndale-Biscoe 1969) is disputed.

"...most of the World's serious forest diseases over several decades have not occurred in man-made monocultures but in natural forests" (Forwood (9):1; see also Cromer 1967:53-62).

This too carries the implication that the 'natural' has no special status. It implies rather an inferior status to unmanaged forests.

A number of implications which flow from the concepts of nature outlined above will be apparent throughout this chapter and the next. Some however are
Routley and Routley characterize the "Renewable Resource Argument" (R & R 1973:12) which suggests that the forest is renewable, rendering environmental criticisms invalid. The Routleys argue "...there is mounting evidence that intensive forestry may not enable long-term renewal (even of wood production)" (1973:13). Moreover renewability of wood production capacity is not ecosystem renewal (1973:13). The traditional foresters however disagree.

"...forests and trees are...one of Australia's major renewable natural resources" (Hillis 1973:44), and

"...all this century foresters have been 'conserving' the forest estate, firstly by dedicating as great an area as was possible, and then by managing that area on a sustained yield basis" (Forwood (10):1).

Sustained yield in this quotation should be taken to mean sustained timber yield. The equation of 'conserving' with sustained yield management should be noted. It is only with a limited concept of nature that limited notions of conservation and renewal can emerge. Pryor too confirms this suggestion.

"Forest management in Australia, with scarcely an exception, embraces the sustained yield concept by which forest produce is gathered regularly each year..." (1973:322).

The traditional forestry concept of nature and of renewability is associated with an historical perspective "In many ways, by tradition, forestry is highly conservation-oriented...and much of past Australian forest practice has been highly effective in conserving 'nature' " (Pryor 1973:321). In this quotation Pryor is using the limited concept of nature and of conservation (see 1973:321).

Associated with the concept of nature is that of 'sufficiency of knowledge' applicable to ecosystem intervention. If ecosystems are in delicate and harmonious balance and of intrinsic value a very cautious management policy is implied. If ecosystems are regarded as readily renewable, and only of economic (financial) value, caution is not necessary except in so far as it is needed to maintain productivity and financial returns.
Webb and Byles comment on the research in the various forestry organizations: "...basic ecological research is urgently necessary" (he specifies a large number of areas, Webb 1969:23). "Forestry research needs to be carried out in relation to land-use. The Forestry profession in Australia...has concentrated too much on the timber producing aspects of forestry and the time is now ripe to undertake wider responsibilities" (Byles 1969:23). The conservation paradigm does not have the basic data it needs to press its case and take over forestry operations. The ecological data in particular was not collected and considered of little importance in the traditional forestry paradigm. At a public meeting in Canberra, Carr stressed two major points similar to those under discussion in this section.

"I contend that too little is known yet about the biology and ecology of (the tropical forests) to warrant clearance of native forests (for forestry and woodchip industries)." He went on to coin the aphorism "Before you cut it down, christen it" (Carr 1974a).

He then stated "My second point concerns what I think to be the biased role of government research institutes and the top government advisors in forestry policy. I contend that the direction of the major research institutes on this field is not scientifically objective as it ought to be if they are to serve the nation properly, but is biased in favour of exploitation of the present woodland reserves despite the current state of ignorance of how to manage or regenerate them" (Carr 1974a).

A forester, replying to Tyndale-Biscoe (1974) said:

"(We wanted to know from the wildlife people) what should we do in the forests to help preserve some of the habitats of the...wildlife? They couldn't answer us...As foresters we feel that we can't just - we don't think the community will allow us to hold still and not do anything in the forest while the answers to these questions are being found" (Forester: 1974).

There are other metaphysical commitments that could be listed, some of which could also fall into later sections. Selected ones are given below in dichotomous form.

### Traditional forestry paradigm
- a) commitment to purely technical calculus, quantifiable variables and the like, with reluctant ad hoc adjustments for variables not ammenable or not traditionally

### Conservation paradigm
- a) belief that intangibles are too important to be ignored or made peripheral. Central importance placed on aesthetics, recreation, wildlife etc.
subjected to quantification
(aesthetics, recreation, wildlife etc.).

There is a degree of ambivalence regarding quantification in general (giving a "mechanistically orientated science" Smolicz 1974:1) but in this issue, the existing quantification procedures are seen as highly biased. Alternative quantification including estimates of all tangible and intangible costs and benefits may be found in Routley and Routley (1973:Ch.8, see also environmental pricing pp.221-233).

b) gradualism: commitment to slow incremental change of forestry processes;
c) specialized subdivision of tasks, and ultimate belief in expertise, reductionist science;

This particular dichotomy (c) has not received much attention in the forestry debate. Its inclusion should be taken as an hypothesis in view of its prominence in the general conservation debate (eg. Boyden 1970:15-18; Hill 1974:4; Smolicz 1974).

It is important to note that not all foresters or conservationists can be neatly polarized, as may have been implied in this section.

2. Disciplinary Orientation

A number of elements make up the disciplinary orientation including norms, roles and decision criteria (see table 1) and these will be discussed in turn, although differentiation, particularly between norms, values and roles is to a certain extent arbitrary.

2.1 Norms

A fundamental norm in dispute, and a traditional norm in the sociology of science is the one pertaining to information versus secrecy. This norm was
found to be particularly important in discussions with students. "How much are we going to be trained when we get out to pull the wool over people's eyes because at present that's what's happening in a lot of the Commissions" (Student A 1974) 

"...we are being trained to manipulate the public" (Student B 1974).

One student described how a forester at the Eden Woodchip project told them how they supervised regeneration of compacted landings, bar very steep snig tracks. He then said "We went through that area: we hardly saw any areas that had been ripped up seeded or barred, all along the roads they had selected" (Student C 1974).

These quotations indicate that some students, at least, have a cynical view of the information provided by foresters. Even expert concepts were questioned in this connection: "We... use words from our professional jargon which are designed to impress the public" (Student D 1974).

2.2 Roles

At least two role types may be found, and they divide reasonably clearly into the two paradigms. A major component of the role types concerns the relations with various groups in society, and with the public in general.

a) Cater for all the Public Demands: Conservationists argue that foresters, particularly public ones, should cater for all public demands whether tangible (wood production) or intangible (aesthetics, recreation, etc.). One student believed they did "(I think) we do have the best balanced viewpoint on the conservation issue... it's against what the public in general feel...(that foresters) are there just to get out the logs" (Student A 1974). Notice that the student sees his role in relation to public demands. He significantly went on to say "(that is of) the new generation... I don't think that's true."

Another student vehemently disagreed "I couldn't help comparing those three (recent) graduates from Tumut and their justification for pine planting on high quality... sclerophyll forest...(which was) we need the wood... I don't feel that they were presenting a balanced viewpoint" (Student B 1974).

b) The Market System: Conservationists have called into question the market system and the associated consumer sovereignty, advertising, and profit.
This revolves around the existence of a legitimate capitalist economic role. Doubt is cast on this by the existence of oligopoly or monopoly control over the market which violates traditional capitalist economic doctrine. The argument is a reasonably familiar one with many variations (eg. Marcuse 1972, Galbraith 1968, Routley and Routley 1973: esp. 234-250). The critique has come more from welfare economics and Marxists, but fits in well with the conservationist position.  

The conservationist then, as outlined here,  
a) should oppose promotion of consumption (advertising, market research)  
b) should be sceptical about the relevance or at least continued relevance of the market system.  
c) should want to reduce overall demand patterns, and perhaps realign supply and demand in accordance with ecological considerations (eg. 'environmental pricing' R & R 1973: 221-233)  
d) should be dubious of business interests and commercial pressure groups, particularly when they act or appear to act in accordance with capitalist ideology.  
e) may favour the supply of 'true' needs (typically building materials) rather than 'false' needs (typically paper tissues, wrapping etc.) or may favour the supply of wood products in accordance with what the forest ecosystem will stand not what the market system indicates.  

The initial concentration of the environmental movement on the physical environment has broadened into an attempt at social, political and economic analysis of the basis of the environmental crisis. There are still conservationists who limit themselves basically to discussion of the physical environment (the anomalies) for whom the role type outlined would be inapplicable. It is necessary to stress that the conservation role model outlined is an historical model continually in the process of adjustment.  

The conservationist role position is outlined by Routley and Routley (1973) and will not be repeated here. Perhaps more significant is the attitude of forestry students, some of whom showed considerable confusion.  

The traditional view: "after all it's the public that are doing the knocking of forestry activities and without the public there wouldn't be any need for
forestry. It's only an expression of their desires" (Student A 1974). This appears to be a defence of the market system. Note the lack of differentiation between the 'knocking' public and the consuming public.

The conservation view: "(There is a) need for public education in the optimal use of forest products" (Student B 1974). One student put the choice very clearly: "Should the forester be primarily concerned with the production of forest products...We can see that by agreeing with the current pine planting in Australia we are supporting a rapid and increasing use of paper and packaging and this sort of thing. Should we be responsible to what the public are wanting or seem to be wanting or should we be responsible to what we think they should need. And we know that they don't need those things...Should we say, well, look we're not going to plant any more pines because we reckon you're wasting this renewable resource" (Student C, 1974) "I agree with you but what right have we to be dictators of what people want" (Student D, 1974) "somebody's dictating what they want now" (Student E, 1974) "APPM by their advertising campaign...you've got to have your flour in your three cardboard containers otherwise it's not hygienic" (Student C, 1974). The discussion continued, but the above quotations illustrate the role models outlined.

c) Relations with the Public: Both the prior sections relate to relations with the public, but this section is concerned with a controversial part of the conservation and traditional roles. It concerns public participation in forest management and education of the public. In general it could be said that conservationists should favour both and traditional foresters oppose both. (The term 'education' rather than 'public relations' is used advisedly). However as has already been noted both paradigm role types may be further divisible. In view of this confounding factor further discussion on this point is not fruitful without considerable elaboration.

2.3 Decision Criteria

The discussion now moves to the hub of the conservation critique of forestry: the process of decision making. In the conservation paradigm high emphasis is placed on conserving resources (flora, fauna, soil, water and timber).
Multiple use management is seen as axiomatic, though ecosystem maintenance may not always be consistent with other uses. In multiple use management sufficiently great weight must be assigned to 'intangibles' or those benefits not normally considered commercial products (aesthetics; flora, fauna, soil, water conservation; scientific (eg. genetic) and educational benefits; and recreation (see R & R 1973).

In the traditional paradigm high importance is placed on wood production or profitability of forest reserves. Some concession (especially recently) may be made to multiple use rhetoric as distinct from action. Often adjustments for 'intangibles' are made reluctantly or on an ad hoc basis, after the 'real' business of forestry has been done.

The conservation paradigm faces the enormous difficulty of establishing the legitimacy of inclusion of intangibles in forestry decision making. There is already a complete ideology to establish the legitimacy of profit and wood production, but the conservationists start from nothing, except undeveloped welfare economics. Routley and Routley develop a cost - benefit analysis and a procedure whereby they attach weight to a large number of costs and benefits in their analysis of pine plantations and wood chipping. (1973: Ch. 8 & Ch. 11)

Some documentation is provided below for the traditional forestry paradigm. In the traditional paradigm the main debate concerns the most appropriate aim for forestry, financial profit or wood production volume, both of which are an anathema to conservationists.

"Forest management is largely concerned with obtaining optimum productivity from site capital and labour. To date, attention has been concentrated on increasing the productivity of the site..." (Kerruish 1970:24)

"One target, therefore, (and I suggest it should be the main one) to which other considerations are subordinate, is to maximize values and/or profit, not just at one time or for one operation but for the enterprise as a whole." (Bunn E.H. in Way 1970: 39, brackets in original)

"many...in the past, sought maximum volume production...The proof of the forest is not in...(its) standing volume...The silvaculturalist's mind should be a-whirr with dollars and cents" (Way 1970:39)

"If we are really interested in the efficiency of operations we manage then surely we must be concerned to establish the requirements of our log market and seek to manipulate either our forests (or the market) so that these are..."
matched for greatest profit. 'Industrial forestry' involves the use of the products of forests in associated industries with the maximum profit to the total undertaking. This may require a substantial departure from traditional forest management..." (Edgerley 1970:56).

"As not infrequently happens in forestry, what is considered silviculturally most desirable may not be feasible on economic grounds or because of existing commitments to supply regular volumes of timber to long established industries" (NSWFC 1972:38).

Even in gene pool collections by the Forest Research Institute "Emphasis has been placed on securing seeds of representative populations of species of commercial importance in Australia and overseas." (Turnbull 1971:12, emphasis added).

"The main objectives (of genetic improvement of eucalypts) in decreasing order of priority are:
- To produce seed in large and increasing quantities;
- To establish a good gene pool well adapted to local conditions for a second stage of selection;
- To improve the productivity of the next forest through a higher yield in weight of wood per acre, and straighter stems;
- To search for...outstanding (individual trees)" (Eldridge 1971:15-16).

Some students it seems are ambivalent, and some are forthright followers of the conservation paradigm. The following dialogue may illustrate this point.

"One thing I'd like to (bring up) is the extent to which economics influences forestry practice...The forestry commissions tend to say that...they are there to look after people's resources but basically they're still there to ensure that those people are making money out of forests" (Student A, 1974).

"Is maximizing profit the important criterion?" (Student B, 1974)

"It's not a case of maximizing profit, it's making it. If they send you out on the bush to do an assessment...the criteria for assessment that they quite often give you is: they want to know how much timber is there, so they can cut it down" (Student A, 1974).

"...Some part of the industry has to make a profit if it is going to survive as a wood production industry...You have got to set down how strong this criterion is going to be compared to other criteria" (Student B, 1974).

"I think what (Student A) was talking about was whether a decision should be in terms of dollars and cents" (Student C, 1974).

"...I'd like to suggest that economics, although in the past economics has been a major area...on which we base our management decisions (it) is going to become only one part of a matrix of factors...No where in the course have we been given any basic understanding of the principles behind this sort of decision making" (Student D, 1974).

The students will have to wait for the conservation paradigm, if it can emerge, for that kind of decision making.

The forestry-conservation conflict is not only about the role of profit and timber production, it is also about what is implicit in that debate: how to manage the other values of the forest, and alternative decision criteria.
are being developed. For example, "The key to the survival of wild animals and plants is the preservation of their habitat" (R & R 1973:69).

3. Exemplars

There exist two analytically separable change regimes, as argued in Chapter IV; decision criteria change under otherwise constant organized knowledge, and changed organized knowledge under constant decision criteria (especially revolutionary exemplars). The major thrust of the conservation paradigm and the major anomalies of the old paradigm appear at present to relate most basically to the decision criteria espoused by each paradigm. This must be a speculative statement as the current decision criteria may remain and the anomalies may be 'removed' by some other process (e.g. revolutionary exemplars, exercise of power over information and research).

This part of the argument is not a treatise in forestry, but a sociological view of particular exemplary forestry practices. The space and technical mastery required for examination of a wide range of exemplars precludes detailed consideration here. One particularly controversial area has been selected for discussion, that of pine plantations, and even this is brief, being discussed in more depth elsewhere (R & R 1973: esp. Ch. 7).

Routley and Routley discuss the anomalies of the pine plantation program, which for them are counter instances. The deterioration of soils under pine plantation constitutes an exemplary piece of research for the conservation paradigm (R & R 1973:71; Tyndale-Biscoe 1969:41) and an anomaly for the traditional paradigm (Students 1974). The traditional paradigm shows evidence of articulation to overcome the declining yield in second rotation of pine plantations. Wetter sites are now favoured for pines (R & R 1973:72) and suggestions have been made to improve soil fertility by fertilizer application, fallowing, growing of leguminous crops, or ploughing in slash (R & R 1973:73).

The effect of pines on flora and fauna is similarly controversial. Tyndale-Biscoe for example states "It is clear that (pine) forest is a depauperate ecosystem designed to maximize timber production" (1969:41). Tanton however
argues that pine forests should be thought of as 'different' rather than 'biological deserts'. "Ecologists must view pine forests as an increase in overall habitat diversity in the Australian Forest estate" (Tanton 1973). The research to establish the effects of pine plantation is only currently being done (see Tyndale-Biscoe 1974; Tanton 1973). Already the conservationist paradigm is suggesting exemplary practices designed to overcome or ameliorate the effects of pines on the ecosystem. Tyndale-Biscoe for example suggests foresters "...refrain from felling right into the creeks and steeper valleys" (1969:41). Routley and Routley are more radical in their chapter entitled "Alternative Forestry" (1973:154-233). For further discussion of pine plantations, their anomalies, and the possible frame of the new paradigm (see R & R 1973: esp. Ch. 2,6,7,8,14).

4. 'Externals' - Resources, Power and Status

The primary aim of this section is a simple one; to show that resources, power, status and organizational variables may exercise influence over organized knowledge and expert opinion for the case of forestry. The secondary aim is far more complex: to throw light on the actual sociological means by which influence is exercised. Access to the corridors of power is, almost by definition, only available to those who have undergone the required socialization and obtained recognition as skillful manipulators of the dominant paradigm. This section then must limit itself to suggesting some overt examples of the exercise of power, recognition of status (etc.). It will not be possible to show the processes by which these examples influence the content of the discipline.

4.1 Link to the General Environmental Movement: threats posed to Forestry.

One of the few 'facts' on which foresters and conservationists seem to agree is that the general environmental movement is closely tied to the current conservation 'debate' in forestry, and between foresters and conservationists, for example:

"In this upsurge of interest in the environment, forests are involved and
foresters are being called upon as never before to explain their actions, to defend their policies and to give chapter and verse of their handling of the forest estate in ways other than for the production of a major forest resource" (Wallace 1971:71).

And, "...in recent years...awareness of the forest environment and of ecological problems generally has become more fashionable" (Pratt 1973:66).

Conservationists also commonly situate the forestry issue within the wider environmental crisis, though to them it is more likely to be a genuine crisis rather than merely 'fashionable' (see for example R & R 1973:1).

It is important to notice that the conservation influences on forestry are related to, and perhaps even derived from, wider social considerations. Kuhn's thesis, which stops short of analysis of such 'external' issues can be seen to be lacking in this fundamental dimension (as argued in Chapter III). The model proposed attempts to incorporate all influences on the substance of organized knowledge, including so called external social forces. The question still remains; exactly how do social pressures insinuate themselves into organized knowledge?

Two kinds of pressures seem to be important; disciplinary, and conservation interest groups. From a disciplinary point of view the forester must defend his territory from encroachment by other disciplines. This concept is similar to Bernstein's comments on the importance of boundary maintenance in the control of educational knowledge (Bernstein 1973). The conservation groups may be seen as potential mediators in the consumer - producer relationship; where the consumers of forestry expertise are the public (see Johnson 1972).

Pratt sees the existence of two groups, both linked to the general environmental movement. For polemical purposes boundary maintenance is a serious professional issue to be debated with "well-intentioned colleagues" while conservation groups are more likely to be "ill-mannered and ill-informed eco-louts" (Pratt 1973:66). While debate with professional colleagues must proceed, in public at least, according to traditional scientific norms, interest groups like conservation groups, are fair game for more traditional political tactics.
Wallace links criticisms of forestry to the "upsurge of interest in the environment" suggesting that this has lead to foresters "...being called on as never before to explain their actions" (1971:71).

Other foresters make similar comments, for example

"If foresters are to retain the freedom to make and implement timber management decisions on native forests, they must make balanced decisions in terms of resource use, and all forestry operations be made as environmentally acceptable as possible" (Florence 1974:152).

"There is no doubt that the environmental era has arrived, and this is a fact of which land managing agencies and industry must be very well aware." (Grose 1973:74).

The pressure or even threat, may be seen in specific forestry practices, like recreation:

"Recreation is thus shown to be an important form of forest use. Analysis and planning of forest recreation is both possible and vital. If foresters do not rise to the challenge, other professions will" (Ferguson & Greig 1973:80).

Florence suggests a change in the content of forestry and improved communication with the public.

"If foresters are to retain the right to make and implement management decisions on public forest land, they must broaden the resource use and management planning base, and create or improve lines of communication with the public" (Florence 1974:148).

Cowley critically examines forestry practice in relation to bird life and suggests:

"The non-timber products of Australian forests are being increasingly demanded by the public. Foresters must show that they can consciously produce these products, one of which is birds, if they wish to continue as managers of all forested land" (Cowley 1971:234).

The environmental movement is clearly linked to the current criticism of forestry practice and the present debate in the discipline regarding the issues raised by the emergent paradigm. Foresters perceive a threat from other disciplines, in the sense that other disciplines may enter areas traditionally under the control of foresters. Other disciplines perceive an opening for themselves in forest management and appear to be moving towards relating their disciplinary expertise to the forestry management situation (eg. Tyndale-Biscoe 1969).

The threat to forestry practice may be explained by articulation of the old paradigm. Ferguson and Greig (1973) for example in their article "What Price
Recreation?" attempt to develop a basically traditional model for allocating resources to recreation. Yet it is precisely this market model used by Ferguson and Greig which is at issue in the debate.

The threat from conservation groups who attempt to disseminate their own version of knowledge regarding forestry practice is treated with disdain by the holders of the traditional paradigm (eg. Pratt 1973).

4.2 Control over Research and Education

It has already been mentioned that access to the actual sociological process by which power is exercised is difficult. It is easier to obtain implicit evidence of power relationships through membership of editorial panels, committees etc. A small selection of the possible sources of influence over research and education are discussed in this section.

a) Transfer from Australian Forestry School to Australian National University.

The Australian Forestry School (AFS) in Yaralumla, Australian Capital Territory (ACT) was moved in 1965 to the Australian National University (ANU) to become the Forestry Department in the Faculty of Science. At AFS forestry students were effectively isolated from other students, and the tight knit groups which developed there have been mentioned many times in discussion with foresters and forestry students. As Ovington stated "...the grouping together of forestry students and the comradeship of common purpose has helped to create a remarkably strong feeling of unity between ex-School(AFS) foresters" (1965:3)

The AFS was under the direction of the Forestry and Timber Bureau (FTB) the federal government authority in forestry matters (Ovington 1965:2). Teaching staff were covered by Public Service regulations which could have restricted criticism of forestry policy. Formal regulations of this type of course do not cover staff at ANU.

The historical links between forestry education and practical forestry have been particularly close. At ANU it is plausible to surmise that these links continue, partly in view of the membership of the Advisory Committee on Forestry Education (see later) and partly because "all the teaching staff...
of the Forestry School (AFS) loyalty transferred to the new Department of Forestry" (Ovington 1965:2).

It can be suggested that there are several features of potential importance to the research and educational control of foresters.

i) probable decreased comradeship within foresters educated in the ACT.
ii) increased contact of forestry students with other students ("The past separation of forestry students from the rest of the University has seriously limited the stimulating exchange of ideas and experiences with students of other disciplines" (Ovington 1965:2).
iii) Increased opportunities for research. ("...opportunities for...research have been enhanced greatly" (Ovington 1965:2)).
iv) Reduced influence from the forestry industry on forestry education.
   - No public utterance act covers university staff as it did the previous staff members of AFS.
   - Independent sources of research funds became more available.
   - New staff have been recruited. The recruitment of Professor Ovington himself is of considerable importance in view of his multiple use stance (Ovington 1965).

The complete history of AFS and the transfer to ANU cannot be pursued further. It is clear however, that organizational and power variables were at least potentially significantly altered. It is therefore possible that this factor may have contributed to the current crisis in forestry.28

b) The Advisory Committee on Forestry Education.

When the Forestry Department at ANU opened in 1965 an advisory committee was constituted replacing a similar body at AFS (Ovington 1965:2). Professor Ovington, in his inaugural lecture stated that "...the Department hopes to continue to work closely with the Forestry and Timber Bureau as well as with State Forest Services and private industry" (Ovington 1965:2).

The membership of the committee was laid down to include the Professor of Forestry, four persons chosen by the Faculty of Science, Director-General FTB, and Forest Service heads from New South Wales, Queensland, South Australia, Tasmania and Western Australia (Minute 1965).29 Later the heads of
Access to the minutes of these meetings was made available to the writer, provided that no member of the committee were quoted by name without consent. Therefore academics' comments will be quoted as 'A.' to distinguish them from forest commissioners. Foresters are sensitive to conservation criticisms and there was predictably little evidence in the committee meetings of the explicit exercise of power in relation to conservation. The existence of this committee is an indication of the close links between forestry research and education and industrial forestry. The membership of the committee is a guide to the power structure in forestry education.

It was possible from the minutes to obtain some clues regarding the nature of the rapport and the tone of the meetings. For example in a discussion on the need for field experience,

"(A) said that the staff of the Department felt that field time could be reduced (however)... Members of the advisory committee thought that it was most desirable for students to obtain adequate field experience during their stay in Canberra" (1965:7).

Perhaps more important was the discussion of the proposed new syllabus for forestry education

"(A.) would welcome discussion of the proposed (new) syllabus and the content of the course, adding that the Faculty of Science placed great weight on the advice which it received from the advisory Committee" (1967:3).

One academic argued there was a need for forest entomologists but another said "...the requirements of sponsors...were aimed at producing trained staff for the State Forest Services, the greatest need being for general foresters with a broad training" (Minute 1970:2). A clearer statement of the argument in this section could hardly be found. The academic has acknowledged that foresters with the appropriate paradigm of knowledge are produced at least partly in response to the perceived needs of forest services. Without more (and different) evidence however, it is difficult to show that this and similar influences affect the actual content and structure of forestry knowledge. A plausible case however, has been established that forestry
knowledge is highly selected knowledge, and one factor in that selection process is the perceived needs of forest services.

A basic element in the control of research and educational knowledge in Australian forestry is the selection of the Professor of Forestry at ANU. Recently an electoral committee was appointed to select a new Professor of Forestry. Its members include "representatives of the Australian Institute of Foresters and heads of State Forest Services" (Bachelard et al 1974:8). This is clear evidence that the interests of forest services as represented by their heads of department and the profession through the Institute of Foresters, exert relatively direct influence on this vital selection procedure.

Conservation interests however do not have access to this level of direct influence. It is of considerable interest to note that conservationists have invoked the norms of science, in the hope of increasing their influence (see letters, Carr 1974 b; Brissenden 1974; Routley 1974). Conservationists have campaigned this issue in public (refer the above letters)a tactic quite unnecessary to those with institutionalized access to power.

c) Student Selection and Bonding

Prior to the transfer of AFS to ANU, Alder (1972:41) reports that all students were sponsored, most by State or commonwealth forest services, but some by overseas scholarships (eg. New Zealand, Colombo Plan). The exact sponsorships of students since 1965 is difficult to obtain, though some aggregate figures are available. In the 1972 final year of 34, there were 3 private students (Alder 1972:40). In the 1974 final year of 39, there were 4 private students (Survey 1974). 31

The conditions of these scholarships vary considerably, and have changed in the last few years. Currently scholarships awarded by state forest services entail the student being bonded after graduation. The period of bonding varies from 3 to 5 years with the exception of Tasmania which has only one year of bonding. Tasmania only recently reduced the bonding period from 5 years to 1 year. As a condition of acceptance of some state forest services scholarships, students are restricted in their choice of units towards their
forestry course. They are required to take more than the minimum number of forestry units set down by the Faculty of Science.

Forest commissioners may also exert some indirect influence over the course selections of private students and Commonwealth students. As one forest commissioner said "...Commonwealth and private students who elected to take only minimum forestry units in their course could be handicapped in seeking appointments in the Forest Services. Heads of Forest services could dictate course requirements to their own students but other students would be well advised to check on state requirements before committing themselves to particular courses" (Minute 1969). An academic member of the committee seemed to endorse this remark: "A. said the requirements of sponsors...were aimed at producing trained staff for the State Forest Services..." (Minute 1969).

We have then a conscious policy of inducements offered by forest services to encourage forestry graduates.

At Creswick in Victoria, the situation is more pronounced. "The Forests Commission of Victoria trains its own officers at the Victorian School of Forestry..." (FCV 1972:38). About ten scholarships are awarded annually and approximately ten graduates are produced each year (eg. FCV 1972). Selection of students for the course is by "a selection committee of the Board" (FCV 1972:38). The composition of the committee is not stated, but the school itself is the responsibility of the Forests Commission of Victoria (FCV). The scholarships are particularly lucrative including "...free tuition, board, lodging and an allowance of $6.50 per week" (FCV 1972:38).

Information is not available regarding the number of bonded students studying for a B.Sc (Forestry) at Melbourne University, but the number of graduates there is relatively small, from 7 to 10 annually (Forwood (8) 1974:30). Some of these graduates may have previously completed a Diploma at Creswick. It would appear that the Forests Commission of Victoria maintains close relations with Melbourne University Forestry Department as graduates... are employed by the Victorian Forests Commission" (Forwood (8) 1974:30).

Bonded students are heavily committed to their sponsoring forest service.
They are likely in part at least to select the courses their sponsor wishes or requires; they are likely to undertake Christmas vacation employment with the sponsoring service; they are mostly bonded for a long period on graduation; they owe a considerable financial debt to the forest service; they are likely to have little geographical or occupational choice when they graduate; and if the student is from NSW he will be expected to complete a field year before finishing his course. The forestry student therefore, particularly if he is bonded, faces many constraints, some of which are highly institutionalized and formal. It is plausible to assume that these existential conditions exercise some sway over the opinions, norms and expert knowledge of the forestry student. It is also plausible to argue that these constraints tend to retard the processes of change in the content of forestry knowledge as it is defined by the discipline.

Constraints exist for graduate students as well as undergraduates. Bonded students must obtain permission from their sponsoring state to do an honours year (Students 1974). This permission is not always given readily and may depend on the merit, as perceived by the forest service, of the proposed project. Funding for post-graduate research may be made available by the forest services. Of the 29 students completing honours in 1965, 1966 and 1967, 18 were sponsored by state forest services, 5 by the FTB, and 6 from overseas. In this period then, every student completing honours was sponsored, nearly all by a Forestry organization.

Selection of students to receive scholarships is made by a committee, the composition of which may vary for each sponsoring organization. Invariably it includes officials in a forest service (Survey 1974), but it may also include academic representation.

Since students holding forestry scholarships constitute such a substantial proportion of graduating foresters, forestry organizations exercise a significant degree of control over the entry of students into the forestry profession.
4.3 Occupational Control

No discussion of pressures on the nature of organized knowledge would be complete without consideration of the constraints of the work situation. In view of the concentration of this thesis on the educational part of forestry it is only possible to briefly comment on the work environment of foresters. Even forestry students are exposed to the work situation, indirectly through excursions and directly through vacation employment.

This section will address itself to only one aspect of social control exercised over forestry knowledge. The concentration of power in forest services is in head offices, which generally do not include recent graduates who are required to obtain experience in the 'field', normally an isolated rural town.

"it appears...that all the thinking, all the planning and all the fund allocation is done at a head office by a small proportion of professional foresters" (Some 1966-67 Students see Foresters 1969:34)

and

"Often the years immediately following graduation are spent in small country centres, where professional discourse and fraternization is limited and professional challenge is not very stimulating" (Margules 1970:18)

The threat of transfer to 'Siberia' constitutes a form of social control;

"Traditionally the forester has been a conservative acceptor of whatever his peers decreed was correct. Any criticism of accepted order, or policy, or social events were unspoken or aired where they were ineffective proferring the reason that he did not want to find himself transferred to the back blocks where criticism is ineffectual" (Ryan 1971:3).

There would appear to exist an organizational structure which implicitly includes occupational control. There are many other forms of control (eg. organizational limits on publication) but the above provides a preliminary insight in this connection.

5. Conclusion.

At all three paradigm levels considered, evidence was obtained for the existence of two analytically separable paradigms.

The conservation metaphysic included the belief that nature was complex and in perfect and delicate balance. Man must work within natural cycles as he
cannot master nature. The traditional forestry metaparadigm saw no special status in nature believing that interference may improve degenerate forests and stimulate health and vigour. Forests in any case were renewable rendering conservation criticisms invalid. The conservation metaparadigm incorporated the belief that nature's own path was preferable to the 'improvement' activities of foresters and renewability, if it existed, was of wood productive capacity only, not ecosystem renewal. There was a belief then, that traditional foresters were biased towards wood production. The conservationist tended to believe that current ecological knowledge was insufficient to enable ecologically sound forestry practice.

The disciplinary orientation included norms, role types, and decision criteria. The information - secrecy norm (also valid information versus biased information) was important in paradigm differentiation. The conservationist tended to see forestry information as biased and incomplete. Conversely the traditional forester was liable to perceive conservation information as biased and incomplete.

At least two role types may be found and discussion for the purposes of brevity was limited to these two types. The controversial elements included relations with the public and the market system and associated doctrine. The conservationist tended to be sceptical about the market as a means of resource allocation and favoured increased dialogue with the public and increased satisfaction of public demands.

The hub of the conservation critique of forestry concerned the process of decision making. High emphasis was placed on conserving resources, all the resources of the forest, not just wood resources, and on ecosystem renewal. Multiple use management, particularly land use policy consistent with ecosystem renewal was seen to be desirable. In multiple use management, sufficiently great weight should be given to benefits other than wood production. The traditional forestry paradigm was concerned primarily with wood production and profitability, with ad hoc adjustments for other benefits.

A great number of possible exemplars could be examined, but discussion was
limited to a highly controversial area, pine plantations. There was a clear difference in the concept of pine plantations in the two paradigms, but the policy implications were not so clearly divided.

It was found plausible that resources, power, status and organizational variables did influence the content and change processes of organized knowledge in the case of forestry. Some evidence was also found that possession of the appropriate paradigm enabled access to resources, power and status. There appeared to be a relatively close link between the overall environmental movement and the current debate between foresters and other disciplinary groups, and between foresters and conservation bodies.

A complex web of relationships exerted influence on research and education. These included the transfer of the major forestry educational institution from AFS to ANU, shifting jurisdiction from the Forestry and Timber Bureau to the Australian National University. The membership of the Advisory Committee on Forestry Education was an implicit indicator of the power structure in forestry. Some evidence was found regarding the type of influence exercised. The committee to appoint a successor to Professor Ovington similarly exhibited the nature of power distribution in forestry.

There were a high proportion of sponsored students in forestry education in Australia and many of these students were bonded to the sponsoring body on graduation. There has been a trend towards more liberal conditions being applied to forestry scholarships in the past few years. Sponsored students were heavily committed to their sponsor, financially, for vacation employment, employment on graduation and possibly to complete a field year. Bonded students required approval from their sponsor to do an honours year. Student selection for forestry scholarships was according to requirements set down by the appropriate organization enabling screening of most forestry students.

Occupational control was only briefly discussed but some evidence was found that considerable occupational socialization was carried out in the field, head office foresters generally having field experience or specific expertise. The threat of transfer to isolated uninteresting areas constituted a form of
The next chapter operationalizes the concepts developed here and illustrates the theory proposed in the particular case of final year forestry students at ANU.
1. Background on Forestry in Australia

Forestry in Australia is a relatively small discipline. Approximately 814 professional foresters were employed in the industry in 1970/71 (FTB 1972/73: 74). The Australian National University Forestry Department produces the most forestry graduates of any institution in Australia, and constitutes the only undergraduate training school outside Victoria. A person seeking a forestry degree or diploma has three choices: ANU; Creswick, Victoria; and Melbourne University, Victoria. Table 2 provides a guide to forestry education in Australia, and illustrates the dominant position which ANU occupies.

**TABLE 2: Undergraduate forestry education in Australia**

<table>
<thead>
<tr>
<th>Institution</th>
<th>Time of Course (yrs.)</th>
<th>Certification granted</th>
<th>Number of graduates</th>
<th>Number of post-graduate students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forestry Dept. ANU</td>
<td>4*</td>
<td>B.Sc.(For.)</td>
<td>44 pa.*</td>
<td>about 50* (1/2 M.Sc, 1/2 Ph.D approx.)</td>
</tr>
<tr>
<td>School of Forestry, Melbourne University</td>
<td>4*</td>
<td>B.Sc.(For.)</td>
<td>7-10 pa.*</td>
<td>about 16* (1/2 M.Sc, 1/2 Ph.D approx.)</td>
</tr>
<tr>
<td>School of Forestry, Creswick, Victoria</td>
<td>3*</td>
<td>Dip.For. (Cres.)</td>
<td>10 pa.**</td>
<td></td>
</tr>
</tbody>
</table>

* Information taken from (Forwood (8) 1974: 29-30) numbers of students are approximate only

2. Choice of Study

The decision to study final year forestry students at ANU was made for the following reasons:

a) In a thesis of this type a complete study of foresters in the forestry industry was impossible. In any case, this study which espouses a direct interest in organizational variables, benefitted from the relative organizational simplicity and homogeneity of the situation confronting forestry students.

b) It was very convenient geographically to study ANU students, and ANU, being the major producer of forestry graduates, was the most important educational institute to study. The university poses less difficult problems of access than do private corporations, or forest services which are covered by public service regulations.

c) The potential revolution in forestry expertise appeared to be in the relatively early stages and may not yet be very evident among practising foresters who were socialized into the dominant paradigm some time ago. Practising foresters also appear relatively insulated, organizationally and geographically from the 'external' pressures on the forestry discipline. Student foresters however, are relatively exposed to environmental criticisms, and have considerable knowledge of forestry practice. It is in the educational process that foresters acquire, or under stable paradigm state should acquire, the dominant paradigm. Anomalies always exist, but if they cannot be concealed (more importantly in this case if they are
continually exposed) then students seem most likely to exhibit the state of crisis. 2

d) By final year, forestry students have considerable experience of practical forestry. Excursions are a regular feature of the forestry course. Most students obtain Christmas vacation employment with some forestry body. New South Wales Forestry Commission scholarship holders are obliged to do a field year in their course. The 1974 final year of 39 students have spent an average of 8.5 months in a forestry work situation. Experience in a forestry work situation varies from 2 to 36 months with 65% of students having from 3 to 7 months of experience.

To obtain a B.Sc.(For.) from ANU, a student requires 26 points, 14 of which must be earned in specific forestry units, and 8 are earned in the first year when no forestry units are available to students who do a 'science' first year. Of the remaining four units, a student may take up to three units in specific forestry subjects. In practice students holding forest service scholarships may be subject to further restrictions in their choice of subjects. (Handbook ANU 1973: 382, 430-434, 438). Forestry students have thus completed three years with a high content of forestry subjects.

Contact was made with a group of final year students and a series of discussions were held, with 7 to 10 students attending each time. A brief description of these meetings may be found elsewhere (Rattray 1974). These meetings enabled an assessment to be made of the level of the debate among students. Foresters, even forestry students, are reluctant to discuss the problems of their discipline with outsiders. Without intervention by
the researcher it was possible to hear forestry students who had been together for three or four years discussing the problems they felt they faced as foresters. It was possible to learn the appropriate jargon and the sites of conflict, anomaly and new paradigm perception. Tape recordings made at these meetings were an invaluable source of information. The majority of the problems raised in these discussion sessions were related to the model outlined in the previous chapter.

Following these discussions and the literature review, a questionnaire was developed, primarily to examine the dimensions of paradigm conflict and to obtain more systematic evidence for at least one part of the analysis already undertaken.

3. The Questionnaire

The questionnaire, reproduced in Appendix 1, was in four parts. Items in Section A concerned background information. Section B consisted of 12 items with polar opinions placed at each end of a seven point scale. Section D contained 22 items with scales designed to measure perception of staff bias, student radicalism and perception of internal and forest commission pressure acting on educational policy. Seven point agree-disagree scales were used for all questions in Sections C and D.

Section C contained 37 items each asked in three forms. Section C1 started with the trunk 'the forester I think should...'; section C2 started with the trunk 'the forester is taught to ...'; section C3 started with the trunk 'the forester does ...' Aside from the different trunks the statements were identical. The 'should' section
was designed to measure the student's own paradigm. The 'taught' items were designed to measure the students perceptions of the paradigm they were taught to employ. The 'does' section was intended to measure student perception of the practising forester's paradigm.

The primary intention of these sub-sections was to obtain estimates of paradigm conflict between what the student felt should occur and what the forester did and was taught to do.

4. The Study Results

4.1 Scale construction

While every opinion item had a predicted response and predicted relationship to other responses, it was not possible to pretest the survey very completely. It could be expected that some questions would prove unexpectedly ambiguous, or have highly skewed frequency distributions, and thus prove useless as scale items. In general, these fears proved unfounded. Missing data, the bane of analysis likewise proved a minor problem: of the 39 students over 145 opinion items, only 28 pieces of information were missing, representing about .05%, and no item had more than two pieces of missing data.

Item analysis was conducted on each scale (see Appendix 2). Items were tested for their frequency distribution (highly skewed items being useless as scale items); for their item to complementary mean correlation; for their clumping properties using three factor analytic procedures; and most importantly for their content in relation to the above aids to item analysis.
4.2 Conflict

Originally five conflict scales were conceptualized in section C of the questionnaire: scales of information norms, roles, decision criteria, exemplars and an overall paradigm conflict scale including all the items in each of the other scales. As mentioned in the previous chapter, it was necessary to reformulate the role types, which are not further discussed. The remaining scales are tabulated in Appendix 2 (Tables A7, A10, A13) and the 'should-does' and 'should-taught' conflict item analyses may be found in the same Appendix.

Information norm conflict concerns the supply of accurate and complete information to the public (see Table A7). Both the mean and median responses were that foresters withhold information from the public, use biased information to mislead the public, pull the wool over people's eyes and don't tell the public the whole truth about forestry practices, more than they should do. 4

Decision criteria conflict concerns the objectives to which forestry practice should aim (see Table A10). The mean and median responses were that foresters should adopt multiple use management, consider intangibles, quantify factors, consider aesthetics as a major factor, provide recreation facilities, cater for society's non-timber demands; conserve flora, fauna, natural resources, soil and water; aim less for maximum profit 5 and wood production, and have a more balanced view on conservation than they do at present.

Exemplary concrete practices were specified to estimate the degree of conflict which pertained to them. The mean and median responses were that the forester should leave larger margins near creeks,
drain snig tracks, clearfell smaller areas of Southern Coastal Hardwoods, regenerate compacted landings and plant pines on degenerate farmland more than he does at present.

In a period of 'normal forestry' it could be expected that there would be only minimal conflict, and the conflict could be predicted on quite unconnected areas of anomaly. Conflict does exist and it appears to be on a fairly large scale. Over the twenty four items on the paradigm conflict scale, the mean should-does conflict varies from 0.6 to 2.4 units with an overall average of the mean conflicts of 1.8 units. The standard deviations of the conflict terms are reasonably large varying from 1.4 to 2.9 units.

The existence of conflict in itself does not indicate the emergence of a new paradigm, but conflict between what the forester should and does do, is closely related over the set of items. It is possible to speak of relatively unidimensional conflict and therefore of paradigm conflict (see Table A16).

When students begin to perceive a breakdown of the old paradigm they tend to see it over the whole paradigm. Furthermore they tend to see the breakdown of the old paradigm to a similar extent, relative to other students, throughout the paradigm. It is possible, therefore, to speak of a degree of paradigm conflict (rather than a dichotomous gestalt switch).

Similarly a conflict was found between what students perceived they were taught, and what they felt they should do. For most students, however, this conflict was less than the 'should-does' conflict, previously described. Over the same 24 items, the average of the mean conflict
on each item was about 0.7 units compared with the 'should-does' conflict of about 1.8 units (see also Graph I).

The mean response was that the forester should be more conservation oriented (as defined in the previous chapter) than he was taught on 22 of the 24 items in the paradigm conflict scale.9

Once again the measured conflict was highly inter-related, having a similar pattern to the 'should-does' conflict previously described. Students tended to have a coherent relatively unidimensional level of conflict on 20 of the 24 items in the paradigm conflict scale. Those who responded with high conservation induced paradigm conflict on one item tended to do so on all 20 items, and vice versa. When students perceive a breakdown in the paradigm, which the staff are attempting to socialize them into, they perceive it throughout the paradigm. Students who perceive that the staff paradigm is in accord with their own tend to do so on most items.

In Kuhn's theory, students play a purely passive role in paradigm shifts. Students, Kuhn argues, are not exposed to the substantive problems of the discipline until they are ready to undertake research. It is researchers who are the sole, uniquely capable validators of new knowledge. It might be expected that the teachers, under this theory, would be the initiators of paradigm change in the educational situation being closer to the research process and engaged in research. However, even the average student believes that foresters should be more conservation oriented than he is taught to be, over most of the 24 items in the paradigm conflict scale.

It was postulated that in this case, the awareness of anomalies and the precipitation of crisis derives not from the frontiers of research
but from active criticism of the discipline by other disciplines and conservation groups. In this case it is possible that students could form the leading edge of the new forestry paradigm. It also is suggestive to argue that academic foresters should embrace a prospective new paradigm faster than industrial foresters in view of the differing constraints on the work situation. This argument corresponds to the view of forestry students who more often than not see themselves as more conservation oriented than their teachers who in turn are seen as more conservation oriented than practising foresters.

In Kuhn's model the first stage of a scientific revolution is characterized by the specialty proceeding almost unaware amidst a sea of puzzles, which some scientists will soon perceive as anomalies. The initial perception of anomalies should be confused and disjointed. Anomalous occurrences may be acknowledged but they appear disconnected.

However, where perception of anomalies is partly in response to criticisms of forestry, the rationale, the new (conservation) paradigm, may actually precede the perception of anomalies. It would appear that this is the case here, where even those who have low measured conflict tend to have relatively the same conflict over all items. This implies that there can be a commitment to the conservation paradigm even at the low levels of perceived crisis, whereas Kuhn's theory would suggest that low levels of crisis would be accompanied by disconnected anomalies.

Furthermore, there is no evidence to substantiate the existence of a hiatus between the two competing paradigms. Instead there appears to be a relatively continuous spread of commitment to the two
paradigms postulated. Kuhn’s concept of a rapid and large gestalt switch, therefore, does not find any empirical justification in this study, though a different analytic procedure may be able to reveal two absolutely separable paradigms. The continuum proposed between the change regimes in Chapter IV is consistent with the evidence collected here (see Graph 1).

Some elements of the new paradigm have been outlined in Chapter V. The research has provided considerable evidence of its existence. The questions used to measure paradigm conflict were closely based on the conservation paradigm developed in Chapter V (though there were no items relating to metaparadigmatic commitment which is discussed later). The scoring of items and the direction of conflict directly followed from the paradigms outlined in the previous chapter. The high unidimensionality of the conflict items therefore may be taken as significant evidence of the existence of two paradigm types with a continuum of commitment between them. It should also be noted that conflict ranged over a relatively large universe of meaning yet remained closely inter-related.

The 24 'should-does' conflict items were all significantly related to their complementary mean at the 90% level of confidence. The 22 items used in the scale were correlated with their complementary mean at levels higher than 0.40, the level at which results are 99% significant (see Table A16).

21 of the 24 items in the 'should-taught' conflict scale were significantly related to their complementary mean at the 90% level of confidence. The 20 items chosen for the 'should-taught' conflict scale were all correlated above 0.40 with their complementary mean, therefore
GRAPH 1. SHOULD-DOES Vs. SHOULD-TAUGHT PARADIGM CONFLICT

GRAPH 2. SHOULD-DOES Vs. SHOULD-TAUGHT DECISION CRITERIA CONFLICT
being significant at the 99% level of confidence (see Table A17).

At the beginning of this chapter, it was argued that forestry students had sufficient knowledge of forestry practice to be able consistently to answer the questions commencing "the forester does..." There was no way to test this proposition, however it was possible to check whether any relationship existed between the amount of forestry experience a student had and the measured degree of conflict.

No significant relationships were found. (A typical correlation was that between experience and 'should-does' paradigm conflict of -0.09). It may therefore be argued that the differential experience of final year students bears no relationship to the measured conflict.

4.3 The New Paradigm and Foresters' Competence

The new paradigm scale contained items at a relatively high degree of abstraction (some of the items could be termed metaparadigmatic). The questions, however, were asked in a different form, with students having to weigh up the statement at each end of the scale, and indicate their position along the dimension defined by the two end statements. Particularly given that each question had a statement at each end, it was quite possible that an unexpected paradigm may have emerged even from the set of questions asked.

The emergent paradigm predicted as shown in the answering categories in Table A3 favoured a no-growth economy, maintenance of ecosystem integrity rather than profitability, responsibility to conservation and the public not the organization, and a preference for large and rapid change against small and slow change in forestry practice. It was thought that members of this emergent paradigm would see foresters as primarily concerned with wood production, showing insufficient caution
in view of unknown ecosystem tolerance, generally incapable of making good management decisions alone and adding aesthetic improvements as after thoughts (see Table A5).

It was also predicted that the holders of the new paradigm would opt for an holistic rather than a specialist solution to forestry problems, and perceive man as part of nature rather than in control of nature.

It is clear that the responses to these set of issues could have fallen into a different pattern, and indicated the possible existence of paradigms other than those predicted. Two items were excluded from the original list. The question relating to specialist versus holistic approaches, while significantly correlated with factor 1 in the factor analysis and correlated in the direction predicted with its complementary mean, was excluded as its connection with the other items was considered too weak. Likewise, the question concerning integration of man into nature was related in the direction predicted, but insufficiently strongly for inclusion as a scale item (see Table A2 and further discussion in Appendix 2, Section 2.1).

The remaining items divided into two relatively distinct sets. One set of four items concerned the perceived competence-incompetence of foresters (see Table A5) and the other six concerned the traditional-emergent paradigm (see Table A3). If these two concepts are genuinely independent, it poses a difficulty for a Kuhnian analysis. Paradigm commitment should be closely related to the perception of the degree of competence of foresters. The notion is analogous to Kuhn's concept of a changed historical perspective on the discipline and a new world view accompanying the new paradigm. Before taking the discussion further a cautionary note is necessary.
Firstly, these 6 items may indeed not be part of the emergent (or an emergent) paradigm. However, the unidimensionality of the previous conflict items, which were based on the same underlying paradigm, is evidence in favour of the suggestion that these items are part of the new paradigm. Secondly, the foresters' perceived competence scale is not a really strongly unidimensional scale. Although it meets the same criteria as the other scales, it does so less convincingly (see Table A6). Moreover four items do not make a completely convincing scale of foresters' perceived competence, any more than six taken alone, make a convincing new paradigm scale.

With these limitations in mind, speculation is still fruitful regarding why these scales should be insignificantly related. A Kuhnian model would be forced to revert to ad hoc explanations of this phenomenon. Why should it be that the perceived competence of foresters should be almost independent of degree of commitment to the emergent paradigm? Surely the devotee of the new paradigm would perceive foresters to be less competent. It was perception of these anomalies (in foresters competence) which leads forestry students to crisis and final embrace of the new paradigm, or so the Kuhnian style argument goes. If it is not anomalies which lead the forestry student to crisis, thence to a perception of a pattern to those anomalies, leading to the emergence of new candidates for dominant paradigm, Kuhn's theory has indeed a gigantic puzzle to solve. To press this point: Kuhn's theory faces a counter instance if perception of anomalies is independent of the paradigm to which one is committed.\textsuperscript{12}
The model proposed in this thesis can readily explain the anomaly under discussion. If, as has been argued in the case, pressure for a revolution in forestry comes from outside forestry, then the emergent paradigm may be embraced in its elemental form prior to the perception of anomalies in specific forestry contexts. It is still the case that those who first embrace the new paradigm must persuade their colleagues of the surplus puzzle-solving power of the new paradigm. That is, this model does not deny the existence of a basically internal change process which is remarkably similar to what Kuhn describes. What is added is the relationship between internal crises and revolutions, and wider social forces.

If this argument is correct then it may be hypothesized that those students committed to the new paradigm and perceiving foresters as relatively incompetent, would be those experiencing the greatest paradigm conflict. Conversely those committed to the traditional paradigm and perceiving foresters as relatively competent would experience low conflict. Those students highly committed to the new paradigm but perceiving foresters as relatively competent, would experience intermediate conflict, as would those with low commitment to the new paradigm but with perception of foresters as relatively incompetent.

The above hypothesis may be examined relatively simply and with efficient use of data employing regression analysis using an equation relating paradigm conflict (C) to foresters' incompetence (I) and new paradigm commitment (P) of the form:

\[ C = k_1 I + k_2 P + k_3 \]

Where \( k_1, k_2, \) and \( k_3 \) are constants calculated by least squares regression analysis.
This analysis supports the above hypothesis. Perception of foresters' competence may be treated as independent of commitment to the new paradigm and both variables together account for a significant and reasonably large proportion of the variance of paradigm conflict (see Tables 3 and 4) both in the case of 'should-does' (41%) and 'should-taught' (31%) conflict.

**TABLE 3:**

Regression: Paradigm 'should-does' conflict versus new paradigm commitment and foresters' incompetence

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>Cor.(r) with dependent variable</th>
<th>Regression coeff.</th>
<th>Std.reg. coeff.</th>
<th>t value</th>
</tr>
</thead>
<tbody>
<tr>
<td>new para. commitment</td>
<td>0.50</td>
<td>0.456</td>
<td>0.401</td>
<td>3.0*</td>
</tr>
<tr>
<td>foresters' incompetence</td>
<td>0.50</td>
<td>0.475</td>
<td>0.406</td>
<td>3.1*</td>
</tr>
</tbody>
</table>

Intercept = -2.75; Multiple R = 0.64; No. of cases 39.
* significant at 99% confidence level

**TABLE 4**

Regression: Paradigm 'should-taught' conflict versus new paradigm commitment and foresters' incompetence

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>Cor.(r) with dependent variable</th>
<th>Regression coeff.</th>
<th>Std.reg. coeff.</th>
<th>t value</th>
</tr>
</thead>
<tbody>
<tr>
<td>new para. commitment</td>
<td>0.45</td>
<td>0.379</td>
<td>0.361</td>
<td>2.5*</td>
</tr>
<tr>
<td>foresters' incompetence</td>
<td>0.44</td>
<td>0.378</td>
<td>0.350</td>
<td>2.5*</td>
</tr>
</tbody>
</table>

Intercept = -3.00; Multiple R = 0.56; No. of cases 39.
* significant at 95% confidence level
This hypothesis was based on the premise that 'external' criticisms of forestry practice and social forces are behind the current crisis in forestry. The analysis supports the hypothesis and therefore may be taken as evidence in favour of the underlying premise which was a major component in the alteration of Kuhn's thesis.

**TABLE 5**

Regression: Decision criteria 'should-does' conflict versus new paradigm commitment and foresters' incompetence

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>Cor.(r) with dependent variable</th>
<th>Regression coeff.</th>
<th>Std.reg. coeff.</th>
<th>t value</th>
</tr>
</thead>
<tbody>
<tr>
<td>new para. commitment</td>
<td>0.58</td>
<td>0.566</td>
<td>0.485</td>
<td>4.0*</td>
</tr>
<tr>
<td>foresters' incompetence</td>
<td>0.52</td>
<td>0.485</td>
<td>0.403</td>
<td>3.3*</td>
</tr>
</tbody>
</table>

Intercept = -3.19; Multiple R = 0.70; No. of cases 39.
* significant at 99% confidence level

**TABLE 6**

Regression: Decision criteria 'should-taught' conflict versus new paradigm commitment and foresters' incompetence.

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>Cor.(r) with dependent variable</th>
<th>Regression coeff.</th>
<th>Std.reg. coeff.</th>
<th>t value</th>
</tr>
</thead>
<tbody>
<tr>
<td>new para. commitment</td>
<td>0.51</td>
<td>0.446</td>
<td>0.420</td>
<td>3.1**</td>
</tr>
<tr>
<td>foresters' incompetence</td>
<td>0.46</td>
<td>0.389</td>
<td>0.355</td>
<td>2.6*</td>
</tr>
</tbody>
</table>

Intercept = -3.18; Multiple R = 0.61; No. of cases 39.
* significant at 95% confidence level
**significant at 99% confidence level
It was previously argued that conflict over decision criteria was the hinge on which the potential revolution in forestry turned. If this were the case it could be predicted that more of the decision criteria conflict variance would be accounted for by a similar regression equation than of the overall paradigm conflict variance. Examination of Tables 5 and 6 and comparison with Tables 3 and 4 reveal that this is the case. The regression using the independent variables of new paradigm commitment and perception of foresters' incompetence, accounts for 49% of the variance of 'should-does' decision criteria conflict, and 37% of the variance of the 'should-taught' decision criteria conflict.

4.4 The Different Worlds of those in Conflict

There exist a considerable number of significant relationships between the various conflict scales and scales of opinions on other topics (see Table 7). The student with a high 'should-does' or 'should-taught' conflict is (a) more likely to perceive the staff as biased (see Table A18) (b) more likely to perceive departmental pressure acting on staff constraining their action (see Table A24) (c) more likely to want to see incorporation of humanities into the forestry course (see Table A25) (d) marginally more likely to perceive pressure from forestry commissions on educational policy (see Table A22) (e) marginally more likely to be a 'student radical' (see Table A20). Not all the matrix of relationships defined by this list are significant, but Table 7 indicates those which are.

Some of the qualitative questions, including the question regarding father's occupation have not yet been coded. However, of the background questions coded, none appeared to bear any significant relationship to the measure of conflict.
TABLE 7

Correlations of conflict scales against other scales.

<table>
<thead>
<tr>
<th></th>
<th>Perception of Staff Bias</th>
<th>Perception of Departmental pressure on staff</th>
<th>Perception of Forestry Commission pressure on staff</th>
<th>Radicalism</th>
<th>Desire for Broader Course including humanities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paradigm</td>
<td>.53***</td>
<td>.50***</td>
<td>.21</td>
<td>.17</td>
<td>.36**</td>
</tr>
<tr>
<td>Decision criteria</td>
<td>.59***</td>
<td>.53***</td>
<td>.17</td>
<td>.26*</td>
<td>.36**</td>
</tr>
<tr>
<td>Information norms</td>
<td>.43***</td>
<td>.41***</td>
<td>.26*</td>
<td>.14</td>
<td>.30*</td>
</tr>
<tr>
<td>Exemplars</td>
<td>.18</td>
<td>.19</td>
<td>.10</td>
<td>-.15</td>
<td>.17</td>
</tr>
</tbody>
</table>

Should-Taught Conflict

<table>
<thead>
<tr>
<th></th>
<th>Perception of Staff Bias</th>
<th>Perception of Departmental pressure on staff</th>
<th>Perception of Forestry Commission pressure on staff</th>
<th>Radicalism</th>
<th>Desire for Broader Course including humanities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paradigm</td>
<td>.58***</td>
<td>.47***</td>
<td>.30*</td>
<td>.25</td>
<td>.36**</td>
</tr>
<tr>
<td>Decision criteria</td>
<td>.60***</td>
<td>.50***</td>
<td>.24</td>
<td>.28*</td>
<td>.35**</td>
</tr>
<tr>
<td>Information norms</td>
<td>.46***</td>
<td>.27*</td>
<td>.30*</td>
<td>.33**</td>
<td>.29*</td>
</tr>
<tr>
<td>Exemplars</td>
<td>.26*</td>
<td>.24</td>
<td>.16</td>
<td>-.13</td>
<td>.15</td>
</tr>
</tbody>
</table>

* Correlations statistically significant at 90% level of confidence.
** Correlations statistically significant at 95% level of confidence.
*** Correlations statistically significant at 99% level of confidence.

The most striking variable is the perception of staff bias which is strongly correlated with most of the conflict scales (see Table 7). It is important to note that the perception of staff bias makes no mention whatsoever of the direction of this bias (see scale content in Table A18). In particular there is no implication that this bias concerns conservation bias or paradigm bias. Four of the five questions used relate to the staff having a 'balanced perspective', presenting a 'variety of views', 'indoctrination into one point of view', and being given 'the whole story' in
forestry courses. The other relates bias from being 'strongly conditioned to forestry practice'. These items moreover constitute a highly coherent scale (see Table A19).

If a paradigm other than the conservation paradigm suggested here were emerging, the members of this hypothetical emergent paradigm would presumably perceive staff bias, unless it were the staff who initiated the alternative new paradigm. However, from the reading of staff publications, and discussions with students, it would appear that staff may legitimately be placed between the traditional paradigm and the conservation paradigm, without exhibiting an articulated substantially different alternative.

If a paradigm different from the one proposed were emerging, its adherents should perceive the staff as biased, and this relationship should interfere with the correlations between staff bias and 'should-taught' paradigm conflict. However this correlation is remarkably high (0.58) and provides substantiation for the argument that the conservation paradigm is the potential new paradigm.

There is a reasonably high correlation between the perception of internal departmental pressure on staff and most of the conflict scales. The departmental pressure scale concerns student's perception of 'pressure on staff from other staff towards conformity over forestry policies' and whether 'staff feel hamstrung by the departmental line' (see Table A24).

There is a tendency for those committed to the traditional forestry paradigm to believe the staff are relatively free from departmental pressure, while those having conservation induced paradigm conflict tend to believe that the staff are under pressure to conform.
The strong correlation of staff bias and departmental pressure with paradigm conflict suggests that the nature of the bias and the pressure concern anti-conservation (i.e., traditional forestry) bias and pressure. It further implies that the specific bias and pressure are particularly related to decision criteria (see Table 7) providing further evidence that decision criteria are the most basic part of the conservation critique of forestry practice.

The other variables, perception of forestry commission pressure on staff, student radicalism and desire for a broader forestry course, are only weakly related to the various conflict scales, though some relationships are significant (see Table 7). The new paradigm requires a broader based educational framework than the traditional paradigm. In particular, the difficult decision processes seem to require some knowledge of humanities and social sciences. The significant correlations appear to be a recognition of this situation, but their relatively low values may indicate that the new paradigm has not been sufficiently articulated at this level as yet.

4.5 Pressures acting on forestry education

In Chapter V it was argued that a great number of forces influence the content of the forestry discipline. Students need not be aware of these pressures, but if they were, it would add evidence to that already presented for their existence.

Most students disagree with the statement 'staff are not influenced by the forest services in deciding course content'. Sixty-seven percent of students disagree or strongly disagree with the above statement and only ten percent of students answered on the agree side of the neutral point. Therefore most students perceive that
staff are influenced by forest services in deciding course content. As argued in the previous chapter there are strong grounds to believe that the students' perceptions are valid.

Students are more equivocal regarding whether 'Forest services exert some pressure on staff through research funding' or not. The question posed difficulties in access to knowledge and 33% of students were uncertain or neutral. However 59% of students fell on the agree side of the scale and 7% on the disagree side. Therefore most students felt that forest services do exert some pressure on staff through research funding.

5. Conclusion

Chapter V examined the forestry discipline in some depth and found considerable evidence for the existence of two paradigm types, traditional forestry and conservation based paradigms. These paradigms were articulated using published sources and discussions held with final year forestry students. Chapter VI focused attention on one part of the forestry discipline in order to obtain more systematic evidence for the model proposed in Chapters IV and V. Final year students at ANU were chosen as indicators of the state of the discipline because ANU occupies such an important place in forestry education; the study of a student population is relatively simple and convenient; and final year students have considerable experience of forestry practice and paradigmatic socialization.

Conflict was found at all paradigm levels discussed; information norms, decision criteria and exemplars. More importantly, the level
of conflict experienced on the items was relatively homogeneous. It was therefore possible to speak of unidimensional paradigm conflict both for 'should-does' and 'should-taught' conflict.

It was argued that primarily external criticism of the discipline initiated the crisis within forestry. The apparent lack of existence of disconnected confused anomalies supported this argument. It was also found (with reservations) that perception of foresters' competence was independent of paradigm commitment. This constitutes further evidence, supported by regression analysis, for the argument that the crisis in the forestry discipline is a result of 'external' forces acting on forestry.

Perception of staff bias was found to be closely correlated with paradigm conflict. The questions referring to staff bias do not specify the direction of bias in terms of the two rival paradigms. It is therefore plausible to argue that the conservation and traditional paradigms described previously are indeed the major alternatives facing forestry students.
1. **Science and Technology are Indistinguishable**

The grounds examined for distinguishing scientific and technological knowledge were found to be unsatisfactory.

1.1 **Goals.**

Science and technology are commonly differentiated in terms of their goal: science pursued for its own sake versus technology for some more material purpose. However, both may be pursued for a number of overlapping purposes; the motive of an expert does not specify the substance of his knowledge; in an era of industrial science, the pursuit of knowledge for its own sake is increasingly irrelevant; and empirical evidence although limited, does not suggest conformity to this goal of science or its attendant norms.

1.2 **Limits**

a) Technical or artificial phenomena have been differentiated from natural phenomena: under this criterion science studies natural phenomena, and technology artificial phenomena. However, those otherwise termed scientists very often work with the artificial, while technologists characteristically deal with natural materials.

b) Knowledge in itself may be separated from phenomena and techniques in themselves, but this does not differentiate forms of knowledge.

1.3 **Process or Product.**

Science, applied science and technology may be seen as the process of acquisition of knowledge or the product of that process.

a) Science has been regarded as knowledge and technology its application. However under this criterion, science includes all manner of knowledge and no discrimination is obtained between scientific and technological knowledge.

b) The process of scientific research may cover a long period of time while technological development serves the needs of the moment. Many counterexamples could be cited in relation to this vague and relative test.

c) Science has been construed as abstract and general, and technology as concrete and specific. Since Kuhn (1970a) and Masterman (1970) it is not plausible to argue that science lacks concreteness. Nor is it plausible to
argue that technological knowledge is purely concrete.

1.4 Institutional Location.

Scientists, some have contended, work in universities or conform to academic role types, while technologists work in industry or conform to other role types. This could hardly be claimed to be an absolute means of discrimination. Universities contain many 'applied' disciplines while industry may be engaged in 'basic' research. In any case it was argued that normative differences may occur between institutions, but the substance of knowledge could be regarded as overlapping.

1.5 Means of Communication.

It has been suggested that scientists communicate in public while technologists do so in private or not at all. This suggestion introduces many anomalies which reveal that publication relates more to institutional location than to any inherent concept of science or technology.

2. The Sociology of Organized Knowledge.

Kuhn's theory of the structure of science was generally accepted as an appropriate and fruitful theory for the examination of organized knowledge, though modifications and extensions were made to his theory. In view of the lack of differentiation between science and technology the theory proposed should apply to all organized knowledge (as defined).

2.1 Philosophical Criticisms of Kuhn's Theory.

It was found that most of the philosophical criticisms of Kuhn's work exaggerate its rigidity and were dismissed. Kuhn's tendency to dichotomize normal and revolutionary science and the similarly questionable rapid gestalt switch thesis were examined. It was suggested that no absolute hiatus existed between normal and revolutionary science; and the term 'revolutionary exemplar' was introduced to connote a relatively small revolution involving one exemplar or a set of related exemplars.

2.2 Sociological Options.

Functionalist sociology of science was examined and criticized. The most fundamental difficulty of a functionalist sociology of science concerns its self-
imposed limitation to scientific ethos, excluding the content of scientific knowledge and its methodology. The functionalist approach reifies science excluding those parts most important to a sociological account of science. Science may be objectified, but it is the process of objectification which is of sociological interest.

The sociology of knowledge approaches enter into the heart of organized knowledge, including its methodology and its content. It was argued that organized knowledge is subject to 'external' influences. The concept of 'externality', while a possibility at a commonsense (first order) level of reality, cannot be sustained at the second order level. Even at the first order level as discussed in Chapter III there is increasing perception of the political, social and economic links with organized knowledge. Furthermore it seemed likely that most scientific revolutions have their source of discovery outside the sub-group which holds a common paradigm, and are in this sense external.

2.3 A Sociology of Organized Knowledge.

A conceptual model based on the preceding discussion was proposed for the examination of experts and their knowledge.

The possession of material resources, power and status enables the exercise of influence over the production of organized knowledge. In keeping with this dialectical relationship, possession of organized knowledge enables access to resources, status and power.

The precise sociological processes of influence cannot be specified without further research. However it was suggested that interest groups exercise the influence discussed above.

Organized knowledge may be framed in paradigm form, after Masterman (1970), but decision criteria needed to be added. Organized knowledge may be seen as changing along two analytically separable dimensions. Under constant decision criteria, revolutionary discoveries may occur, for example under the criterion of maximum financial profit, technological change may occur.
Under otherwise constant knowledge, decision criteria, probably with associated norms and values, may change.

3. Forestry, Conservation and the Model.

Relatively distinct meaning systems or paradigms were found which were labelled the traditional forestry paradigm and the conservationist paradigm. The two paradigms existed at all three levels, as described in Chapter V, and summarized below. A range of 'external' influences were found and described.

3.1 Metaphysic

Considerable evidence of the existence of two distinguishable metaphysical paradigms was found in published sources. Metaparadigms were difficult to operationalize, but some evidence of their presence was found among final year students.

The metaparadigms identified appeared to centre on the concept of nature. To the conservationist, nature without technological man was in perfect and harmonious balance. Interference generally produced less desirable ecosystem features, but damage may be minimized with comprehensive ecological knowledge. Ecosystem renewal can only occur if substantially all the salient features of the forest are eventually replaced. Exotics and monocultures were particularly suspect, in view of their potential instability and lack of diversity. Forestry management was believed to be in need of rapid and large change. There was a belief in steady state rather than economic growth.

The traditional forester tended to believe that the forest requires improvement, particularly improvement in terms of wood productive capacity. Sustained timber yield was equated with renewability. Exotics and monocultures were favoured for their high yields. Forestry management, if requiring change at all, only needed incremental change. There was a belief in the possibility and desirability of continual economic growth, where growth was equated with progress.
3.2 Disciplinary Orientation.

3.2.1 Information Norms.

The conservationist favoured the supply of 'complete and accurate' information to the public and believed the traditional forester supplied biased information to suit his own purposes. The traditional forester was likely to perceive information given out by foresters as sufficiently accurate and complete.

3.2.2 Decision Criteria

The conservationist favoured an increasing emphasis on the conservation of all the resources a forest contained, including soil, water, flora and fauna. He was further likely to embrace a decreasing emphasis on profit and wood production, in favour of genuine multiple use management, where so-called intangibles were given considerable weight.

The traditional forester generally endorsed profitability and wood production yield as suitable criteria for forest management. Multiple use management rhetoric may be advanced, but only low weight was given to intangibles like aesthetics, recreation and conservation of non-timber production values of the forest.

3.3 Exemplars

There appeared to be a relatively large number of potential revolutionary exemplars (eg. see R & R 1973), but their detailed examination required further effort than was available for this study. The evidence gathered from the survey appeared to indicate more consistency regarding decision criteria and information norms than exemplars.

3.4 Paradigm Conflict

Considerable evidence was found in literature sources of paradigm conflict. Final year forestry students appeared to experience highly unidimensional paradigm conflict.

3.5 Resources, Power and Status

The current crisis in forestry seemed to be linked to the general environmental movement. Pressure on environmental grounds posed a threat to the
forester, from other disciplines and in regard to the power exercised by the forester over the forest.

Considerable influence or control was apparently exerted on research and education by industrial groups, particularly the forest services. Some weakening of this influence may have occurred as a result of the transfer of AFS to ANU. The membership of the Advisory Committee on Forestry Education indicated the power structure of the discipline, a substantial part of which appeared to reside in the forest services. Similarly, selection of the key position, Professor of Forestry at ANU, involved direct consultation with the heads of forest services and representatives of the Institute of Foresters.

The high proportion of sponsored and bonded students indicated another aspect of the relative forest service hegemony over the forestry discipline. Some sponsored students were restricted beyond the restrictions imposed by the Faculty, and required by their sponsors to take a greater number of forestry units. Forest service scholarships were particularly lucrative, with one (FCV at Creswick) including free tuition, board, lodging and an allowance. Existential conditions like these could be expected to foster conservatism, particularly in the past when forestry was mainly closed and isolated. Sponsored students needed the blessing of their sponsor to do an honours year, allowing potential control over this aspect of the research process.

There was found, with some reservations, to be a low relationship between the perceived competence of foresters and the paradigm commitment of students. Both scales when taken together, using regression, were good predictors of paradigm conflict. This finding was taken to be evidence of the existence of external insinuation of the new paradigm.
4. Conclusions

This thesis has developed a conceptual model for the examination of a wide range of forms of expertise. The empirical basis for the model is however, very limited. Forestry is only one specific form of expert knowledge, and even within forestry the study was not comprehensive. The forestry discipline was considered primarily within Australia, and the historical style of documentation used in Chapter V may be challenged for its selectivity. The most rigorous data collection involved a survey of final year forestry students at ANU. No questionnaire was delivered to practising foresters and only 39 students were questioned, a sample too small for great confidence to be placed in the results. However, within the limitations of the study, a number of statistically significant relationships were found.

The general theoretical chapters of this thesis (II, III, and IV) were restricted too, but in a different manner. It was not possible to illustrate in detail the lack of differentiation between the content of scientific and technological knowledge. It was not appropriate in this thesis to pursue such an argument in the manner in which it perhaps should have been to be fully convincing. However, other writers have similarly noted the convergence of science and technology (e.g. Sklair 1973; Ellul 1964) which reduces the need for elaboration of this point. It was the theoretically based interest in the content of scientific and technological knowledge which led to the necessity to remove the science-technology barrier based primarily on normative differentiation.

The discussion of the various theories of science was considerably simplified and schematic (see Chapter III). In this particular area there was no need to pursue the argument in depth, as a number of other works have already covered similar ground.
The environmental crisis has not received a great deal of attention as a sociological phenomenon. The focus of the thesis has been on one minor aspect of the effect of the environmental movement on expert knowledge. No conclusions may be drawn regarding the state of other disciplines in regard to environmental problems.

Within these limits, evidence collected in the small case study and documentation from disciplinary literature did appear to correspond to the model proposed. The results obtained were sufficiently suggestive to indicate that future work in this field would prove productive.

Whether the model proposed is adequate or not, it is clear that the functionalist sociology of science or of professions could not provide a satisfactory explanation for the phenomena observed in the forestry discipline. The functionalist account reifies expert knowledge, and the methodology by which it was produced, and is therefore unable to delve into the processes of change in expert knowledge. The changing norms and role types exhibited in this case would have been the only features potentially explicable in the functionalist account. In any case the processes of change themselves are difficult to explain using a purist functionalist model.

The effective control of expertise (science and technology) requires a theory of its structure. Kuhn begins to supply such a theory of the social control of scientific knowledge from within science. The sociology of knowledge, particularly the Marxist versions, seek patterns of control over expert knowledge in terms of class interests, power relations and supply of resources. The synthesis of the 'internalist' (Kuhn) and 'externalist' (Marxist) approaches has been one of the aims of this thesis.

A knowledge of the social foundations of expert knowledge is a prerequisite to its re-direction for human purposes. It is the elite with vested interests, hiding behind the facade of value neutral methodology and
knowledge, who play such an important part in the process of objectification and legitimation of expert knowledge.

Ellul (1964) and others who have seen the processes of science and technology as inevitable have neglected the fact that expert knowledge and action are socially constructed and have the capacity to be reconstructed. They only appear to be alien and absolute because they are portrayed that way by those who have the power to do so.

The forestry discipline is a case in point. Pressure on forestry from conservation based groups and disciplines fractured the 'objective' and 'legitimate' nature of the forestry discipline, exposing, particularly to those just entering the field, the biased nature of its expert concepts and practice. Change has begun, and requires further effort for its implementation in the form of the new paradigm, but the objectivity and legitimacy of traditional forestry is no longer unquestioned.

It is the role of a critical sociology to take an active part in examining, and where necessary exposing, social myths and ideology, particularly those which protect the interests of the powerful. The model proposed in this thesis has at least some of the elements required of a critical sociology of expertise.
CHAPTER I

1. Kuhn's work has been explicitly related to the Sociology of Knowledge by Dolby (1971).

2. The term 'expert' is introduced in Chapter II to better represent the lack of differentiation between science and technology.

CHAPTER II

1. The clumsy phrase 'scientists, however operationally defined' will be replaced by 'scientists' in this section, and the usage footnoted.

2. Hagstrom (1965 : 43) states "Those who do not contribute at all through this channel (published articles, books or papers) cannot be considered scientists". He is using a tautological definition based on the communalism norm.

3. See Footnote 1.

4. This distinction is even harder to maintain in the social sphere, as organizational technique or social technique is knowledge. The criterion is further blurred by the existence of intermediate cases like town planning.

5. See Berger and Luckman (1972) for discussion of the process of objectification.

6. The term 'facts' is used advisedly as it has already been argued that these facts only enjoy their status by virtue of their objectification.

7. Kidd quotes several definitions of this type (1965 : 149 - 150).

8. As a metallurgical researcher my experience was that an attempt was made to simulate operating plant conditions, and to develop practical solutions to practical problems. Obviously this work could be separated into theoretical abstraction and concrete components, the point being however that both are involved together and so inextricably mixed that their separation constitutes a linguistic farce.

9. In the Department of Metallurgy, Melbourne University, my experience also indicated that research of industrial interest was the rule rather than the exception: research which could just as readily have been undertaken at the laboratories of the appropriate industrial organizations.

10. Ridgeway (1968) in his study of American universities entitles his work 'The Closed Corporation' to portray his view of the traditional conception of academic norms.

11. CSIRO stands for Commonwealth Scientific and Industrial Research Organization.

12. See Footnote 1.

13. It is not intended to imply that all scientific and technological knowledge is necessarily organized. Much of it may be tacit or intuitive.
14. The customary usage of research implies systematic effort. The acquisition of organized knowledge need not be systematic. To this extent the term research is not entirely satisfactory, but no better term was available.

15. The usage of the term expert will be limited to what would previously have been termed scientists or technologists. While the model proposed may apply to other experts, this thesis is not concerned with them.

16. This terminology is not reintroduced until Chapter IV. In Chapter III, science is generally used in the manner of the particular author under discussion. Occasionally for stylistic reasons, the terminology discarded here may be used.

CHAPTER III

1. The whole of Section 1 is based on the work of Kuhn, particularly (1970a) of the same title, and specific references are not acknowledged.

2. "Kuhn...sees science as the scientist's religion" (Watkins 1970 : 33).

3. 'Normal' science is "...a danger to science and, indeed, to our civilization" (Popper 1970 : 53).

4. "For Kuhn scientific change...is a mystical conversion which is not and cannot be governed by rules of reason" (Lakatos 1970:93).

5. "...truth lies in power" (Lakatos 1970 : 93).

6. "...the aim is the increase of the truth-content of our theories" (Popper 1970 : 57).

7. "I do believe in 'absolute'...truth...and it is a logical point" (Popper 1970 : 56).

8. See the discussion regarding Einstein (Kuhn 1970a : 89).

9. "'Normal' science, in Kuhn's sense, exists...and...it must be taken into account by historians of science...(but) I regard it as a danger to science" (Popper 1970 : 52).

10. "I believe that (normal science) is of considerable sociological importance...(but) methodology...is concerned with science at its best...rather than with hack science" (Watkins 1970 : 27).


12. There are some errors in Sklair's account (1973).

13. Functionalist will be used as shorthand for 'functionalist and structural functionalist'. The implications are slightly different, but such distinctions do not affect the discussion here.

14. Sociology of knowledge is clarified in a later section. This expression has the advantage of including Marxist, neo-Marxist and other approaches having similar epistemological foundations, but with a variety of polemic assumptions.

15. This analysis to some extent follows Sklair (1973).
16. "If the sociologist refuses to consider the content of scientific ideas on the grounds that it is not affected by sociological considerations, he is implicitly accepting a theory of knowledge in which the scientist's decisions about his work are based entirely on logical considerations" (Crane 1972 : 9).


18. Berger and Luckman (1972) make this statement in a different but similar context.

19. For a relatively comprehensive application of these concepts to everyday reality see Berger and Luckman (1972) on which this paragraph is based.

20. It is interesting to note that Merton himself shows a retreat from the normative structure he outlined in 1942 (see 1972) in his article appropriately entitled 'The Ambivalence of Scientists' published in 1963 (see 1965).

21. Sklair's statement is fully endorsed. "Indeed, the greatest weakness of Kuhn's formulation is that it makes the progress of science too exclusively a matter for the scientific community, and neglects to consider the factors external to the scientific group itself which may have a considerable bearing on its theory-choice" (1973:141).

22. It may even be the same person who is a member of more than one applicable sub-field.

23. It could further be argued that scientists very often do use concepts or exemplars from another field. They generally cannot be applied unproblematically in the new field, posing a puzzle to the scientist.

24. Schutz (1967) uses this concept which is in keeping with the earlier analysis based on Berger and Luckman (1972). It is similar to the Marxian notion of false consciousness (e.g. Marcuse 1972) but without the polemical implications.

25. Ravetz states that "...industrialization of science...means...the dominance of capital intensive research, and its social consequences in the concentration of power on a small section of the community. It also involves the interpenetration of science and industry...Further, it implies a large size...with the consequent loss of networks of informal, personal contacts binding a community. Finally, it brings into science the...sense of rapid but uncontrolled change" (1973 : 31).

26. Ridgeway puts the argument in a strong form "...the university looks more like a centre for industrial activity than a community of scholars" (1968 : 3). He also states "The idea that the university is a community of scholars is a myth" (1968 : 215). While one may not concede the rhetoric of Ridgeway's argument it is difficult to escape his conclusion regarding the heteronomy of science.

27. Johnson (1972) discusses the producer-consumer relationship as the interface through which extrinsic forces operate. More discussion of this point is given in the next chapter.

28. "One of the strongest...rules of scientific life is the prohibition of appeals to heads of state or to the populace at large in matters scientific" (Kuhn 1970a : 168).
29. "The group's members...must be seen as the sole possessors of the rules of the game" (Kuhn 197a: 168).

CHAPTER IV

1. 'Science' and 'technology' will still be used when discussing the work of other writers.

2. The term dialectical inevitably introduces difficulties as it has been used in so many different ways. The usage in this chapter should be clear from its context, particularly in this paragraph.

3. Berger and Luckman see the reality of everyday life as paramount reality (eg. 1972: 35). For the expert, acting as an expert, puzzle solving is the paramount reality.

4. All experts use values of one sort or another. In this context the values are those which relate to social groups outside the specific expert clique. For example even traditional scientific values may have latent consequences for other groups.

5. This is stated in anthropocentric terms. Paradigms of expert knowledge have consequences for man's environment too.

6. More precise terminology is introduced for the various states of expert knowledge later in this chapter.

7. This category could be broken down further into minor revolutionary changes in decision criteria and major changes. However, such sophistication was not necessary at this stage of analysis.

CHAPTER V

1. M. R. Jacobs was formerly Director-General of the Forestry and Timber Bureau, and earlier the Principal, Australian Forestry School.

2. R. G. Florence was a Senior Lecturer in the Department of Forestry at ANU (1974).

3. W. E. Hillis was a Visiting Lecturer in the Department of Forestry at ANU (1974).

4. L. D. Pryor was the Professor of Botany at ANU (1974) and holds a Diploma of Forestry from the Australian Forestry School (AFS).

5. D. A. N. Cromer was the Director-General of the Forestry and Timber Bureau (1974).

6. L. J. Webb was an ecologist with the CSIRO.

7. D. J. Carr was an eucalyptologist with the CSIRO (1974).

8. Note the polarization in this dispute. Tyndale-Biscoe only argued for more caution not that foresters 'hold still'. C. H. Tyndale-Biscoe was a Reader in Zoology at ANU in 1974.
9. To retain anonymity student's comments are identified using the letters A, B, C... where dialogue is implied. Any particular student would be unlikely to be identified with the same letter in dialogues in different parts of the thesis.

10. Students also mentioned biased information presented by conservationists.

11. It is possible to further divide these roles into four different types but for reasons of brevity discussion is purely of the two types. In view of this complication, that four types appear to exist not two as originally thought, role questions are not analysed in Chapter VI. The term 'role' is used within the theory proposed in this thesis and should not be taken to imply use of the literature on roles, and role conflict.

12. It has already been noted that more role types may exist than are discussed here. It is possible that some conservationists would not accept this position.

13. M.W.Edgerley was the Director, Forests Branch, Department of the Interior in 1970.

14. J.W.Turnbull was a member of staff of the Forestry and Timber Bureau, Canberra in 1971.

15. K.G.Eldridge was a member of staff of the Forestry and Timber Bureau, Canberra in 1971.

16. M.T.Tanton was a Senior Lecturer in the Department of Forestry ANU (1974).

17. R.W.Wallace was the President of the Institute of Foresters of Australia (1971).

18. There are a number of other identifiable important interest groups acting to maintain the traditional paradigm, which are not discussed (eg. Hoo-Hoo (1)).

19. There are many other mediators or potential mediators in this relationships. Moreover to call any particular group of people the 'ultimate' consumers is an analytic device.

20. B.H.Pratt was a Research Fellow in the Department of Forestry ANU (1974). He is qualified as an Agricultural Scientist, but not as a forester.

21. "In recent years... awareness of the forest environment and of ecological problems generally has become more fashionable. Consequently foresters are being exposed to ever-increasing comment, some from knowledgable and well-intentioned colleagues, professional associates and others, but with some emanating from ill-mannered and ill-informed eco-louts who have mounted what at times have been little more than smear campaigns..." (Pratt 1973 : 66).

22. I.S.Ferguson was a Senior Lecturer in the Department of Forestry ANU (1974).

23. P.J. Greig was a member of staff of the Forestry and Timber Bureau, Canberra (1974).

24. The evidence gained for this point is not systematic, and it must remain at the level of plausibility at this stage.

25. J.D.Ovington was the Professor of Forestry at ANU from 1965 till 1974.
26. ANU dominates the production of forestry graduates in Australia (see Chapter VI). A similar situation exists in the only other state with forestry education, Victoria. The Victorian Forests Commission still administers the Forestry School at Creswick, and maintains close links with Melbourne University School of Forestry.

27. One forester suggested privately that two members of ANU staff resigned as a result of Ovington's appointment, so Ovington's remark may be questionable.

28. It seems unlikely however that any such organizational shift could be solely responsible for the current crisis in forestry. The crisis is apparently a world-wide one (see the examination of American forestry by Routley and Routley 1973).

29. Membership of the Advisory Committee on Forestry Education:

"i) the Professor of Forestry;

ii) one other member of the Faculty of Science chosen by the Faculty;

iii) two persons appointed by the council on the advice of the Faculty of Science, who, in the opinion of the faculty, are well qualified to advise it on academic matters and the attitude of other Australian universities on forestry education;

iv) one other person chosen by the Faculty of Science;

v) the Director-General of the Forestry and Timber Bureau of the Commonwealth of Australia;

vi) heads of the forest services of the states of New South Wales, Queensland, South Australia, Tasmania, West Australia". (Minute 1965).

30. E.P. Bachelard was a Senior Lecturer in the Department of Forestry at ANU (1974).

31. One private student began his course on a foreign scholarship but no longer held it in final year.

32. This remark was made by students in 1974. Students who reach sufficient standard may be granted honours without taking an honours year (Handbook 1974: 391). Some years ago, all honours graduates completed honours concurrently with their course.

33. Some overseas students were sponsored under other schemes. They were the only students not sponsored by a forestry organization.

34. No discussion is provided of the important research funding process. Over the last five years (1969 - 1973) the breakdown of fund sources was as follows:

<table>
<thead>
<tr>
<th>Source</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARGC (Australian Research Grants Committee)</td>
<td>$79,305</td>
</tr>
<tr>
<td>Government bodies and authorities (except Forest Services)</td>
<td>$46,958</td>
</tr>
<tr>
<td>Forest Services</td>
<td>$27,000</td>
</tr>
<tr>
<td>Private Corporations</td>
<td>$18,550</td>
</tr>
<tr>
<td>Other</td>
<td>$7,950</td>
</tr>
</tbody>
</table>

This information was obtained from the Annual Reports printed each year by the Department of Forestry ANU.

35. The forester may distinguish between conservationists. Those who work on anomalies rather than from the new paradigm seem more likely to be accepted.
CHAPTER VI

1. This figure excludes teaching staff, and probably slightly underestimates the number of professional foresters (see FTB 1972/73 : 74).

2. This argument was to a certain extent developed empirically, through published sources and conversations with foresters and students.

3. For descriptions of item analysis procedures and results, see Appendix 2.

4. For stylistic purposes, questions have been summarized in the text. The reader may consult the appropriate table, in this case Table A7, to obtain the exact wording.

5. The question summaries marked with this footnote are as stated for the mean response, but not for the median response.

6. Snig tracks are the furrows left after a log has been dragged away from the felling site.

7. Some sociology of science literature suggests that conflict may exist between internalized academic norms held by students and industrial norms held by practising foresters. This may constitute an alternative explanation for the conflict which exists in this case. It is the author's opinion that this explanation is not as satisfactory as the one offered here, partly in view of the similar but smaller conflict between what the students are taught and what they believe they should do as foresters. The students, it is possible to conclude, are more conservation oriented than their teachers.

8. One unit is the difference between adjacent answering categories on the seven point scale.

9. The two items failing to conform to this pattern both related to information norms. The average response was that the forester should 'occasionally withhold information which may be misinterpreted by the public' (Q.2); and 'sometimes pull the wool over people's eyes' (Q.35) more than he was taught to.

10. In Chapter V the new paradigm referred to the forestry discipline as a whole. In this Chapter, the concept has been operationalized as 'the new paradigm as it is in the minds of some final year forestry students at ANU in 1974'.

11. It would be more correct but clumsy to state that there is 90% confidence that the association is significantly above zero.

12. A number of reasons which may make this 'counter instance' explicable under Kuhn's theory have been mentioned and should qualify this statement.

CHAPTER VII

1. Johnson (1972) defines these groups as producers, consumers and mediators. The preference for 'interest groups' is meant to imply a wider scope of potential influence than suggested by Johnson's categories.
APPENDIX 1

1. In Section B, the seven point scale is shown for the first question as it appeared in the actual questionnaire (aside from slight differences in layout). For the other eleven questions, seven columns were similarly available for the respondents to mark their opinion.

2. In sections C1, C2, C3 and D no scales are shown. In the actual questionnaire, seven point agree-disagree scales were provided at the right hand side of each page. The seven columns were marked from left to right as follows:

- STRONG AGREEMENT +3
- AGREEMENT +2
- SLIGHT AGREEMENT +1
- UNCERTAIN 0
- SLIGHT DISAGREEMENT -1
- DISAGREEMENT -2
- STRONG DISAGREEMENT -3

APPENDIX 2

1. Nunnally provides a useful account of item analysis (1967: 241 - 281). He suggests item to total score correlations for scales with a large number of items, and item to complementary total correlations for smaller scales (1967: 261 - 268). However this does not allow for the damage done by missing data which can be reasonably well allowed for by the procedure used here.

2. A set of seven items in Section D of the questionnaire was supposed to operationalize Kuhn's concept of searching, engaged in by those in paradigm crisis. The scale did not work as predicted and only three items were chosen on a content and statistical basis to form a scale (see Appendix 2, Section 2.3.5)
APPENDIX 1. THE QUESTIONNAIRE AND NOTES ON ITS DESIGN.

This appendix reproduces the questionnaire used in this study. Some notes on its construction and design precede the actual questionnaire. Most of the scale columns printed on the actual questionnaire are not given here, but footnotes (see footnote section) indicate the nature of changes made.

1. Notes on questionnaire design.
These notes should be read in conjunction with the questionnaire which follows.

1.1 Ordering of items within Sections B, C and D.
Items in Section B have opinions placed at each end of the scale columns between. The questions were placed in random order, with opinions randomly assigned to one end. The items in each of Sections C1 and D were placed in random order. Items in Sections C2 and C3 were placed in the same order as Section C1.

1.2 Order of Sections C1, C2 and C3.
It was thought that some bias may occur according to the order in which Sections C1, C2 and C3 were asked. In these sections the trunks of the statements were identical within each section but different in each of the three sections. There are six ways to arrange the three sections in order. To control for this possible bias, questionnaires were collated in the six different ways. Students from a list were randomly assigned one of the versions. Table A1 summarizes this procedure.

<table>
<thead>
<tr>
<th>Version number</th>
<th>Order of sections</th>
<th>Total number of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>C1 C2 C3</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>C1 C3 C2</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>C2 C3 C1</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>C2 C1 C3</td>
<td>7</td>
</tr>
<tr>
<td>5</td>
<td>C3 C2 C1</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>C3 C1 C2</td>
<td>6</td>
</tr>
</tbody>
</table>

1.3 Balancing scale items.
It is desirable to balance the number of items favouring each end of the underlying scale dimension which one is attempting to estimate. This minimizes any response set or halo effect. It was not always convenient to balance the items as the negative wording was sometimes clumsy, ambiguous or liable to misinterpretation. In sections C1, C2 and C3, in which each
question was presented in three forms, it was difficult to word items to operate as desired in all three forms of the question. Improvement in this aspect of the questionnaire could have been accomplished with more complete pre-testing.

2. The Questionnaire.

OPINION SURVEY: FINAL YEAR FORESTRY STUDENTS.

Dear ,

I am asking these questions of all final year forestry students towards a thesis in Sociology at A.N.U. I am investigating your attitudes to your work and your profession, and some more general attitudes. There are of course no right or wrong answers. I am just seeking your opinion.

Your answers will be absolutely confidential and never divulged except in aggregate statistical form. To ensure absolute anonymity you may tear off the front page with your name on it. When you have completed the items please hand in this page whether or not it is still attached to the questionnaire.

Your cooperation is of course optional, but I am sure you would be aware that any students not responding will statistically bias the results I obtain. I am most anxious therefore to obtain your cooperation. I expect the questionnaire will take less than 30 minutes to complete.

Yours sincerely,

Alan Rattray.
Sociology, S.G.S.

IMPORTANT: Please don't discuss the items on this questionnaire with any person until you have completed it. Each person should answer completely independently or statistical bias will be introduced.
SECTION A. BACKGROUND INFORMATION.

PLEASE TICK APPROPRIATE BOX OR WRITE ON THE DOTTED LINE.

PLEASE EXPLAIN DIFFICULTIES YOU HAVE WITH ANY QUESTIONS.

1. Age last birthday.... years.
2. Sex
   male   
   female
3. Marital status
   single
   engaged
   married
   other (specify..............)
4. Place of birth
   Australia [ ] if so which state
   QLD. [ ] VIC. [ ] N.T. [ ]
   N.S.W. [ ] TAS. [ ] W.A. [ ]
   A.C.T. [ ] S.A. [ ]
   Other [ ] Please specify..............
5. Please state your father's present occupation or former occupation if retired or deceased. Please be specific, eg. electrical salesman, wheat farmer, District Forester, Class 7 Commonwealth Public Service.

6. I hold, or during my course have held a
   Commonwealth Forestry Scholarship [ ]
   State Forest Service Scholarship [ ] specify state...........
   Commonwealth Tertiary Scholarship [ ]
   No scholarship whatsoever [ ] if true go to Q. 10.
   Other (specify....................) [ ]
7. Consider each scholarship in turn: (give me the name of each scholarship)

   I was awarded this s.ship before 1st. yr. [ ]
   I was awarded this s.ship before 2nd. yr. [ ]
   I was awarded this s.ship before 3rd. yr. [ ]
   I was awarded this s.ship before or during 4th. yr [ ]
8. Only for holders or former holders of Commonwealth or State Forestry Scholarships:
   I was selected for my s.ship(s) by
   Official in a forest service [ ]
   Other (specify....................) [ ]
   Are you bonded after graduation?
   Yes [ ] if so go to question 9.
   No [ ] if so go to question 10.
9. Bonded students only
a. for how many years are you bonded on graduation?

............years.

b. The following are some of the attitudes about bonding. Rank these in order of importance to you, by placing the numbers 1-8 in the boxes provided.

bonding enabled me to afford university
bonding restricts my occupational freedom
bonding ensures me a secure job
bonding allows the industry to keep its trainees
bonding restricts my geographical freedom
bonding is financially rewarding
bonding ties me down for too long
other (specify............................................)

c. On the balance, knowing what you know now are you glad you decided to be bonded?

Yes [ ]  No [ ]  Uncertain [ ]

d. Do you intend to serve this bond on completion of your course?

Yes [ ]  No [ ]  Uncertain [ ]

If you were uncertain or answered no please specify reason...........

-----------------------------------------------------------------------------------

10. For all students:
Could you please list your work experience in a forestry context.
State  Institution  Time spent  Tick if vac.  Tick if field year.
(months)  employment

-----------------------------------------------------------------------------------

-----------------------------------------------------------------------------------

-----------------------------------------------------------------------------------

-----------------------------------------------------------------------------------

11. Have you already decided what you will do when you finish your course?

Yes [ ] if yes what is it? (be specific eg. Asst. Sub-District Forester, N.S.W.F.C.)

No [ ] if your answer is no what will you probably end up doing? (be specific)

-----------------------------------------------------------------------------------

12. When you complete your course what would you most like to do if you had the opportunity? (be specific)

-----------------------------------------------------------------------------------

13. Where did you live most of your life before coming to A.N.U.?
rural property [ ]
country town (pop. less than 10,000) [ ]
121

country centre (pop. 10,000 - 100,000) __ 
metropolitan centre (pop. over 100,000) __

14. Are you currently an honours student? 
Yes [ ] No [ ] Comment if necessary ..................................................

15. Try to estimate the average mark you have received over all of the courses taken at University towards your forestry degree.

pass __
distinction __
credit __
high distinction __

SECTION B. 1

In this section you are given two views one on each side of the scale below. Plus 3 represents the opinion on the left hand side and minus 3 represents the opinion on the right hand side. Please mark the column which best represents your view with a tick. Don't spend too long on any one question.

1. Forestry practice should change rapidly.

2. Financial profit should be the most important evaluation technique in forestry.

3. Advances in forestry policy should come from those with a general picture of forestry.

4. The forester's primary responsibility is to the organization for whom he works.

5. The forest ecosystem is fairly resilient, so existing safeguards are satisfactory.

6. The forester is uniquely capable of deciding forestry management policy.

7. Economic growth is vitally important.

8. In the past the forester has only conserved timber values.

9. The forester's primary responsibility is to nature conservation.

10. Man should use the natural environment for his own ends.

1. Forestry practice should change but only slow changes are required.

2. Maintenance of an ecosystem integrity should be the basic criterion of evaluation in forestry.

3. Advances in forestry policy should come from those with high specialization.

4. The forester's primary responsibility is to the public.

5. Ecosystem tolerance is unknown so foresters should be more cautious in managing forests.

6. The forester can only make good management decisions in consultation with non-foresters.

7. The sooner man achieves a zero economic growth the better.

8. In the past the forester has always been an ecosystem conservationist.

9. The forester's primary responsibility is to the organization for whom he works.

10. Man should integrate himself into natural cycles.
11. Foresters already have satisfactory techniques of aesthetic improvement.

12. Forestry practice should change but only small changes are required.

11. Aesthetic improvements by foresters are usually afterthoughts.

12. Large changes should be made in forestry practice.

SECTION C1.2

In this section there are a series of opinions about what the practising forester actually does. On the right hand side of the page you are given a range of statements to express your agreement or disagreement with varying degrees of strength.

1. the forester does produce wood and paper that society wants.

2. the forester does occasionally withhold information which may be misinterpreted by the public.

3. the forester does ignore commercial pressure groups.

4. the forester does take notice of wood consumers.

5. the forester does regenerate compacted landings.

6. the forester does consider aesthetics as a major factor in decision making.

7. the forester does normally ignore intangible costs and benefits.

8. the forester does educate the public on the environmental costs of pine plantations.

9. the forester does use biased information to mislead the public.

10. the forester does deplete natural resources.

11. the forester does cater sufficiently for society's non-timber demands.

12. the forester does try to quantify enough factors, tangible and intangible.

13. the forester does usually plant pines on degenerate farmland.

14. the forester does aim for maximum profit.

15. the forester does examine his own assumptions.

16. the forester does take notice of conservation groups.

17. the forester does aim for maximum wood production.

18. the forester does leave inadequate margins near creeks when clear felling.

19. the forester does consider business interests.
20. The forester does leave sufficient flora for fauna repopulation.
21. The forester does allow public participation in forest management decisions.
22. The forester does produce wood and wood products that people really need.
23. The forester does conserve native flora.
24. The forester does support advertising of wood and wood products.
25. The forester does bar snig tracks.
26. The forester does produce wood and wood pulp according to market demands.
27. The forester does have a very balanced viewpoint on conservation.
28. The forester does generally clearfell only small areas at one time in managing Southern Coastal Hardwoods.
29. The forester does educate the public on the benefits of pine plantations.
30. The forester does try to encourage desirable demand patterns.
31. The forester does conserve native fauna.
32. The forester does in most native forests adopt genuine multiple use management.
33. The forester does try to reduce consumption to conserve forest resources.
34. The forester does conserve soil and water even at the expense of timber production.
35. The forester does sometimes pull the wool over people's eyes.
36. The forester does provide sufficient recreation facilities.
37. The forester does tell the public the whole truth about forestry practices.

SECTION C2

In this section there a series of opinions about what the forester is taught to do in the forestry course. On the right hand side of the page you are given a range of statements to express your agreement or disagreement with varying degrees of strength.

1. The forester is taught to produce wood and paper that society wants.
2. The forester is taught to occasionally withhold information which may be misinterpreted by the public.
3. The forester is taught to ignore commercial pressure groups.
4. the forester is taught to take notice of wood consumers.
5. the forester is taught to regenerate compacted landings.
6. the forester is taught to consider aesthetics as a major factor in decision making.
7. the forester is taught to normally ignore intangible costs and benefits.
8. the forester is taught to educate the public on the environmental costs of pine plantations.
9. the forester is taught to use biased information to mislead the public.
10. the forester is taught to deplete natural resources.
11. the forester is taught to cater sufficiently for society's non-timber demands.
12. the forester is taught to try to quantify enough factors, tangible and intangible.
13. the forester is taught to usually plant pines on degenerate farmland.
14. the forester is taught to aim for maximum profit.
15. the forester is taught to examine his own assumptions.
16. the forester is taught to take notice of conservation groups.
17. the forester is taught to aim for maximum wood production.
18. the forester is taught to leave inadequate margins near creeks when clear felling.
19. the forester is taught to consider business interests.
20. the forester is taught to leave sufficient flora for fauna repopulation.
21. the forester is taught to allow public participation in forest management decisions.
22. the forester is taught to produce wood and wood products that people really need.
23. the forester is taught to conserve native flora.
24. the forester is taught to support advertising of wood and wood products.
25. the forester is taught to bar snig tracks.
26. the forester is taught to produce wood and wood pulp according to market demands.
27. the forester is taught to have a very balanced viewpoint on conservation.
28. the forester is taught to generally clearfell only small areas at one time in managing Southern Coastal Hardwoods.

29. the forester is taught to educate the public on the benefits of pine plantations.

30. the forester is taught to try to encourage desirable demand patterns.

31. the forester is taught to conserve native fauna.

32. the forester is taught to in most native forests adopt genuine multiple use management.

33. the forester is taught to try to reduce consumption to conserve forest resources.

34. the forester is taught to conserve soil and water even at the expense of timber production.

35. the forester is taught to sometimes pull the wool over people's eyes.

36. the forester is taught to provide sufficient recreation facilities.

37. the forester is taught to tell the public the whole truth about forestry practices.

SECTION C3.

In this section there are a series of opinions about what you think the forester should do. On the right hand side of the page you are given a range of statements to express your agreement or disagreement with varying degrees of strength.

1. the forester I think should produce wood and paper that society wants.

2. the forester I think should occasionally withhold information which may be misinterpreted by the public.

3. the forester I think should ignore commercial pressure groups.

4. the forester I think should take notice of wood consumers.

5. the forester I think should regenerate compacted landings.

6. the forester I think should consider aesthetics as a major factor in decision making.

7. the forester I think should normally ignore intangible costs and benefits.

8. the forester I think should educate the public on the environmental costs of pine plantations.

9. the forester I think should use biased information to mislead the public.

10. the forester I think should deplete natural resources.

11. the forester I think should cater sufficiently for society's non-timber demands.
12. the forester I think should try to quantify enough factors, tangible and intangible.
13. the forester I think should usually plant pines on degenerate farmland.
14. the forester I think should aim for maximum profit.
15. the forester I think should examine his own assumptions.
16. the forester I think should take notice of conservation groups.
17. the forester I think should aim for maximum wood production.
18. the forester I think should leave inadequate margins near creeks when clear felling.
19. the forester I think should consider business interests.
20. the forester I think should leave sufficient flora for fauna repopulation.
21. the forester I think should allow public participation in forest management decisions.
22. the forester I think should produce wood and wood products that people really need.
23. the forester I think should conserve native flora.
24. the forester I think should support advertising of wood and wood products.
25. the forester I think should bar snig tracks.
26. the forester I think should produce wood and wood pulp according to market demands.
27. the forester I think should have a very balanced viewpoint on conservation.
28. the forester I think should generally clearfell only small areas at one time in managing Southern Coastal Hardwoods.
29. the forester I think should educate the public on the benefits of pine plantations.
30. the forester I think should try to encourage desirable demand patterns.
31. the forester I think should conserve native fauna.
32. the forester I think should in most native forests adopt genuine multiple use management.
33. the forester I think should try to reduce consumption to conserve forest resources.
34. the forester I think should conserve soil and water even at the expense of timber production.

35. the forester I think should sometimes pull the wool over people's eyes.

36. the forester I think should provide sufficient recreation facilities.

37. the forester I think should tell the public the whole truth about forestry practices.

SECTION D. 2

In this section there are a series of opinions given. On the right hand side of the page you are given a range of statements for you to express your agreement or disagreement, with varying degrees of strength as shown.

1. We get insufficient knowledge about people in the forestry course.

2. The forestry staff may be narrow but nearly always their concepts are the best ones.

3. It is very important for forestry students to have more education in the humanities.

4. A lot of staff have been so strongly conditioned to forestry practice that they can't think about things from an unbiased viewpoint.

5. The forestry course should be more vocational.

6. Forestry staff should have a broader education.

7. I think some staff feel pressure from other staff towards conformity over forestry policies.

8. Students should have less say than staff in deciding course content.

9. The forestry course should stimulate you to thinking ideally.

10. In several forestry courses I feel we are indoctrinated into one point of view.

11. I sometimes wonder what I'm doing forestry for.

12. Private forestry companies have very little influence on the forestry department at A.N.U.

13. Forestry students already have enough scope to take courses outside the forestry department.

14. Staff are not influenced by the forest services in deciding course content.

15. Students should never have occupied the chancelry as they did recently.

16. Forest services exert some pressure on staff through research funding.
17. The forestry course should encourage students to think very critically about forestry.

18. I sometimes think that as forestry students we are not given the whole story in some courses.

19. Most of the staff have a very balanced perspective on forestry.

20. Students should have increased influence over the content of the forestry course.

21. I think that some of the staff feel hamstrung by the departmental line.

22. Most of the staff present us with a sufficient variety of views in their courses.
APPENDIX 2  

SCALES AND ITEM ANALYSIS

This appendix lists the methods used to screen items for inclusion in the various scales employed in the body of the thesis (see Sect. 1 below). It further shows tabulation of the statements included in each scale and a summary of the item analysis procedures adopted here (see Sect. 2 below). The purpose of the item analysis is to produce sets of items highly related to each other from the point of view of the model proposed in this thesis, and highly related to each other statistically. The aim then, is to produce coherent undimensional scales.

1. Methods of Item Analysis

1.1 Skewed Distributions

Items with highly skewed distributions are of little use in a scale. These items contribute very little variance or discriminating power to a scale, and their inclusion would misrepresent the scale's content. Exactly how skewed a distribution may be and still be useful, could only be arbitrarily specified. When in any doubt, this criterion was used in conjunction with others given below.

1.2 Item to Complementary Mean Correlation

In this form of analysis the scale item was correlated with the mean of the scale items excluding the item itself. The complementary mean rather than complementary total was used to better allow for any missing data (Nunnally 1967: 241 et seq). This approach has the advantage of simplicity (there is only one correlation coefficient for each item) and allows the application of statistical tests of significance. It has the disadvantage that it does not seek patterns of relationships between the items. A set of items may be multi-dimensional rather than unidimensional as theoretically predicted. A two dimensional set of items for example,
might show low item to complementary mean correlations, but when appropriately divided would reveal relatively independent sets of more highly correlated items. Factor analysis seeks patterns of this type and is discussed below.

1.3 Factor Analysis

Factor analysis is a helpful technique for identifying clusters of highly correlated items. There are however a great number of factor analytic procedures, all allowing choices to be made at various stages of the analysis. Each procedure has its own advantages and disadvantages (Rummel 1970: 101-132) and the choice of procedure is always to some extent arbitrary. Here however, it is used to complement other approaches, and only used for item analysis. In this study three factor analytic procedures were used: component or principle component analysis (Rummel 1970: 112-113; Nunnally 1967: 315-317); varimax orthogonal rotation (Rummel 1970: 391-393; Nunnally 1967: 332-333); and promax oblique rotation (Rummel 1970: 419-420). Rather than specifically justify the use of each of these procedures, especially since component analysis is the only one that features in the argument to follow, the reader is referred to Rummel (1970: 101-132).

1.4 Item Content

No mathematical technique, including those described above, can be used without careful thought being given to the model under consideration. The researcher may have strong theoretical commitment to items which prove recalcitrant in item analysis. In general, weakly related items in each scale were reasonably rare, and readily explained. The one case where a predicted unidimensional scale turned out to be two dimensional (see this Appendix Sect. 2.1) is discussed in the body of the thesis.

2. Tabulation of Scales and Item Analysis Results

All items were adjusted so that a high score represented a 'conservation paradigm' response. For each question the direction which was scored highly
is noted. As might be expected many trials were necessary in analysing items. The results shown merely summarize these trials, showing only the best combinations found. In every case except one\(^2\) the original predicted pool of items is shown so the reader can see which items were deleted, and the reasons for their deletion.

2.1 Paradigm Commitment and Foresters' Competence Scales

Section B of the questionnaire separated into two relatively unrelated sets of items. On the basis of the question content, one set of items related to paradigm commitment while the other related to the perceived competence of foresters. Why these sets of items should be unrelated is discussed in the body of the thesis.

<table>
<thead>
<tr>
<th>Question No.</th>
<th>Component factor analysis on 12 items</th>
<th>Item to complementary analysis on 10 items</th>
<th>Item to complementary analysis on 10 items</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Factor 1</td>
<td>Factor 2</td>
<td>Factor 1</td>
</tr>
<tr>
<td></td>
<td>(28.5%)*</td>
<td>(14.9%)</td>
<td>(32.5%)</td>
</tr>
<tr>
<td></td>
<td>(10.5%)</td>
<td>(9.1%)</td>
<td>(17.8%)</td>
</tr>
<tr>
<td>9</td>
<td>-.79</td>
<td>.37</td>
<td>-.79</td>
</tr>
<tr>
<td>4</td>
<td>-.69</td>
<td>.14</td>
<td>-.72</td>
</tr>
<tr>
<td>2</td>
<td>-.52</td>
<td>.42</td>
<td>-.54</td>
</tr>
<tr>
<td>7</td>
<td>-.56</td>
<td>.14</td>
<td>-.57</td>
</tr>
<tr>
<td>1</td>
<td>-.67</td>
<td>-.08</td>
<td>-.65</td>
</tr>
<tr>
<td>12</td>
<td>-.73</td>
<td>.11</td>
<td>-.70</td>
</tr>
<tr>
<td>5</td>
<td>-.53</td>
<td>-.44</td>
<td>-.49</td>
</tr>
<tr>
<td>8</td>
<td>-.32</td>
<td>-.62</td>
<td>-.33</td>
</tr>
<tr>
<td>11</td>
<td>-.24</td>
<td>-.72</td>
<td>-.30</td>
</tr>
<tr>
<td>6</td>
<td>-.30</td>
<td>-.55</td>
<td>-.34</td>
</tr>
<tr>
<td>10</td>
<td>-.32</td>
<td>.02</td>
<td>.16</td>
</tr>
<tr>
<td>3</td>
<td>-.35</td>
<td>.14</td>
<td>.21</td>
</tr>
</tbody>
</table>

Note: * Under each factor is the percent of total original variance for which it accounts.
Item 10 had a heavily skewed distribution with most students in the two categories adjacent to the end statement; 'man should integrate himself into natural cycles'. This question's lack of discriminating power taken along with its relatively low affinity with the group of items in Table A2 were sufficient grounds to delete it. Item 3 was supposed to measure commitment to holistic versus (fragmented) specialized analysis. The prior version of this question gave trouble when pre-tested, and the question still does not have high face validity. The term 'general picture' in the right hand option does not properly capture the notion of holistic analysis. Furthermore the holistic critique while an important part of some conservation based critiques (eg. Boyden 1970: 15 - 18) is certainly not a necessary part. Item 3 then, while a question of considerable importance (see Smolicz 1974) is not sufficiently correlated with the other items in Table A2 to enable it to be included as part of the conservation paradigm.

**TABLE A3** : Paradigm commitment scale items

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>9.</td>
<td>The forester's primary responsibility is to nature conservation.</td>
</tr>
<tr>
<td>4.</td>
<td>The forester's primary responsibility is to the organisation for whom he works.</td>
</tr>
<tr>
<td>2.</td>
<td>Financial profit should be the most important evaluation technique in forestry.</td>
</tr>
<tr>
<td>7.</td>
<td>Economic growth vitally important</td>
</tr>
<tr>
<td>*1.</td>
<td>Forestry practice should change rapidly</td>
</tr>
<tr>
<td>12.</td>
<td>Forestry practice should change but only small changes are required.</td>
</tr>
<tr>
<td>9.</td>
<td>The forester's primary responsibility is to the organization for whom he works.</td>
</tr>
<tr>
<td>*4.</td>
<td>The forester's primary responsibility is to the public.</td>
</tr>
<tr>
<td>*2.</td>
<td>Maintenance of an ecosystem integrity should be the basic criterion of evaluation in forestry.</td>
</tr>
<tr>
<td>*7.</td>
<td>The sooner man achieves a zero economic growth the better.</td>
</tr>
<tr>
<td>1.</td>
<td>Forestry practice should change but only slow changes are required.</td>
</tr>
<tr>
<td>*12.</td>
<td>Large changes should be made in forestry practice.</td>
</tr>
</tbody>
</table>

* The end marked with an asterisk was scored highly.
TABLE A4: Paradigm commitment scale: Item analysis

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Component factor analysis on 6 items</th>
<th>Item to complementary mean correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Factor 1 (49.5%)*</td>
<td>Factor 2 (20.7%)</td>
</tr>
<tr>
<td>9</td>
<td>-.87</td>
<td>-.12</td>
</tr>
<tr>
<td>4</td>
<td>-.75</td>
<td>-.08</td>
</tr>
<tr>
<td>2</td>
<td>-.63</td>
<td>-.50</td>
</tr>
<tr>
<td>7</td>
<td>-.58</td>
<td>-.53</td>
</tr>
<tr>
<td>1</td>
<td>-.64</td>
<td>.62</td>
</tr>
<tr>
<td>12</td>
<td>-.72</td>
<td>.55</td>
</tr>
</tbody>
</table>

Note * Under each factor is the percent of total original variance for which it accounts.

TABLE A5: Perceived competence of foresters scale items

*8. In the past the forester has only conserved timber values.

11. Foresters already have satisfactory techniques of aesthetic improvement.

5. The forest ecosystem is fairly resilient, so existing safeguards are satisfactory.

6. The forester is uniquely capable of deciding forestry management policy.

* The end marked with an asterisk was scored highly.

TABLE A6: Perceived competence of foresters scale: Item analysis.

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Component factor analysis on 4 items</th>
<th>Item to complementary mean correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Factor 1 (48.5%)*</td>
<td>Factor 2 (19.3%)</td>
</tr>
<tr>
<td>5</td>
<td>-.67</td>
<td>.66</td>
</tr>
<tr>
<td>8</td>
<td>-.73</td>
<td>-.02</td>
</tr>
<tr>
<td>11</td>
<td>-.69</td>
<td>-.58</td>
</tr>
<tr>
<td>6</td>
<td>-.70</td>
<td>-.03</td>
</tr>
</tbody>
</table>

Note * Under each factor is the percent of total original variance for which it accounts.
The remaining items in Table A2 divided fairly cleanly into two scales. Item 5 was the only doubtful one, both from the point of view of content and item analysis results. It seemed however, to refer rather closer to perceived competence of foresters than paradigmatic commitment. The paradigm commitment and foresters' competence scales were both sufficiently homogeneous (see Tables A4 and A6 respectively).

2.2 Conflict Scales

Section C of the questionnaire came in three parts, each with identical wording aside from the verb in each statement. Section C1 was worded 'the forester does ....' Section C2 was worded 'the forester is taught to ....' and Section C3 was worded 'the forester I think should ....'

To obtain estimates of the conflict between what the student felt the forester should do and what the student perceived foresters actually did, the students score on the 'does' item was subtracted from the corresponding score on the 'should' item. For example:

<table>
<thead>
<tr>
<th>agree</th>
<th>disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>score 7 6 5 4 3 2 1</td>
<td></td>
</tr>
</tbody>
</table>

the forester I think should X (7)

the forester does conserve X (2)

the forester is taught to X (5)

In this example the 'should' item score is 7, and the 'does' item score is 2, so the imputed 'should-does' conflict is 5 units. Similarly to obtain estimates of the conflict between what the student felt the forester should do, and what the student perceived the forester was taught to do, the student's score on the 'taught' item was subtracted from the corresponding score on the 'should' item. In this example the 'should' item score is 7, and the 'taught' item score is 5, so the imputed 'should-taught' conflict is 2 units.
2.2.1 Information norms

TABLE A7: Information norms scale items

-2. the forester .*. occasionally withhold information which may be misinterpreted by the public.

-9. the forester .*. use biased information to mislead the public

-35. the forester .*. sometimes pull the wool over people's eyes

+37. the forester .*. tell the public the whole truth about forestry practices.

Notes:
+ indicates that strong agreement was scored highly.
- indicates that strong disagreement was scored highly.
*. to obtain the question wording in the three sections, insert 'does', 'is taught to' or 'I think should' in the place marked.

TABLE A8: Information norms 'should-does' conflict: Item analysis

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Component factor analysis on 4 items</th>
<th>Item to complementary mean correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>-.78</td>
<td>.62</td>
</tr>
<tr>
<td>9</td>
<td>-.81</td>
<td>.65</td>
</tr>
<tr>
<td>35</td>
<td>-.84</td>
<td>.70</td>
</tr>
<tr>
<td>37</td>
<td>-.86</td>
<td>.72</td>
</tr>
</tbody>
</table>

Note: * Under Factor 1 is the percent of total original variance for which it accounts.

TABLE A9: Information norms 'should-taught' conflict: Item analysis

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Component factor analysis on 4 items</th>
<th>Item to complementary mean correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>-.81</td>
<td>.60</td>
</tr>
<tr>
<td>9</td>
<td>-.71</td>
<td>.46</td>
</tr>
<tr>
<td>35</td>
<td>-.69</td>
<td>.44</td>
</tr>
<tr>
<td>37</td>
<td>-.70</td>
<td>.48</td>
</tr>
</tbody>
</table>

Note: * Under Factor 1 is the percent of total original variance for which it accounts.

The scales in tables A8 and A9 are both sufficiently homogeneous.
### 2.2.2 Decision Criteria

**TABLE A10: Decision criteria scale items**

<table>
<thead>
<tr>
<th>Item</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>+32. the forester .* in most native forests adopt genuine multiple</td>
<td></td>
</tr>
<tr>
<td>management.</td>
<td></td>
</tr>
<tr>
<td>-7. the forester .* normally ignore intangible costs and benefits.</td>
<td></td>
</tr>
<tr>
<td>+12. the forester .* try to quantify enough factors, tangible and</td>
<td></td>
</tr>
<tr>
<td>intangible.</td>
<td></td>
</tr>
<tr>
<td>+6. the forester .* consider aesthetics as a major factor in</td>
<td></td>
</tr>
<tr>
<td>decision making.</td>
<td></td>
</tr>
<tr>
<td>+36. the forester .* provide sufficient recreation facilities.</td>
<td></td>
</tr>
<tr>
<td>+11. the forester .* cater sufficiently for society's non-timber</td>
<td></td>
</tr>
<tr>
<td>demands.</td>
<td></td>
</tr>
<tr>
<td>+31. the forester .* conserve native fauna.</td>
<td></td>
</tr>
<tr>
<td>+23. the forester .* conserve native flora.</td>
<td></td>
</tr>
<tr>
<td>+20. the forester .* leave sufficient flora for fauna repopulation.</td>
<td></td>
</tr>
<tr>
<td>+27. the forester .* have a very balanced viewpoint on conservation.</td>
<td></td>
</tr>
<tr>
<td>-10. the forester .* deplete natural resources.</td>
<td></td>
</tr>
<tr>
<td>+34. the forester .* conserve soil and water even at the expense of</td>
<td></td>
</tr>
<tr>
<td>timber production.</td>
<td></td>
</tr>
<tr>
<td>-14. the forester .* aim for maximum profit.</td>
<td></td>
</tr>
<tr>
<td>-17. the forester .* aim for maximum wood production.</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- + indicates that strong agreement was scored highly.
- - indicates that strong disagreement was scored highly.
- .* to obtain the question wording in the three sections, insert 'does', 'is taught to' or 'I think should' in the place marked.

On a content basis the decision criteria could be divided into those specifically concerning conservation (10,20,23,27,31,34) and the remainder of the items. This division proved an unnecessary complication as the two sets of items could be treated together as a unidimensional set of items (see Table A11 and A12).
<table>
<thead>
<tr>
<th>Question Number</th>
<th>Component factor analysis on 14 items</th>
<th>Component factor analysis on 13 items</th>
<th>Item to complementary mean correlation</th>
<th>Item to complementary mean correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Factor 1 Factor 2 (46.9%)* (11.1%)</td>
<td>Factor 1 Factor 2 (49.5%) (9.8%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>-.83 -.06</td>
<td>.77</td>
<td>-.82 -.15</td>
<td>.76</td>
</tr>
<tr>
<td>7</td>
<td>-.65 -.06</td>
<td>.60</td>
<td>-.65 -.07</td>
<td>.60</td>
</tr>
<tr>
<td>12</td>
<td>-.66 -.35</td>
<td>.57</td>
<td>-.67 .31</td>
<td>.59</td>
</tr>
<tr>
<td>6</td>
<td>-.72 .29</td>
<td>.66</td>
<td>-.71 -.30</td>
<td>.64</td>
</tr>
<tr>
<td>36</td>
<td>-.73 -.06</td>
<td>.67</td>
<td>-.75 -.02</td>
<td>.68</td>
</tr>
<tr>
<td>11</td>
<td>-.80 -.09</td>
<td>.75</td>
<td>-.80 .08</td>
<td>.76</td>
</tr>
<tr>
<td>31</td>
<td>-.79 -.05</td>
<td>.72</td>
<td>-.80 -.17</td>
<td>.74</td>
</tr>
<tr>
<td>23</td>
<td>-.72 .03</td>
<td>.64</td>
<td>-.73 -.31</td>
<td>.65</td>
</tr>
<tr>
<td>20</td>
<td>-.55 -.50</td>
<td>.46</td>
<td>-.57 .47</td>
<td>.49</td>
</tr>
<tr>
<td>27</td>
<td>-.53 -.33</td>
<td>.45</td>
<td>-.53 .59</td>
<td>.45</td>
</tr>
<tr>
<td>10</td>
<td>-.75 .04</td>
<td>.67</td>
<td>-.75 .24</td>
<td>.68</td>
</tr>
<tr>
<td>34</td>
<td>-.76 -.08</td>
<td>.70</td>
<td>-.76 .15</td>
<td>.70</td>
</tr>
<tr>
<td>14</td>
<td>-.55 .66</td>
<td>.50</td>
<td>-.52 -.52</td>
<td>.45</td>
</tr>
<tr>
<td>17</td>
<td>-.39 .72</td>
<td>.36</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: * Under each factor is the percent of total original variance for which it accounts.

Only number 17 was deleted from the should-does decision criteria conflict items (see Table A11). It refers to the aim for maximum wood production (see Table A10). It is not clear precisely why this item should diverge from the set of items. It could be however, that some students may have added the rider 'within constraints' that is, maximum wood production as an aim, but only within constraints. Comparison with item 34 (see Table A10) which specifies conserving soil and water even at the expense of timber production, reinforces this suggestion. The affinity of item 17 with 14 (see Factor 2 Table A11) neither of which specify any constraints, further strengthens the above inference.

Number 10 had to be deleted from the should-taught decision criteria conflict items (see Table A12). No satisfactory explanation can be offered for the failure of this item, except perhaps that the expression 'natural resources' (see Table A10) is very vague.
### TABLE A12: Decision criteria 'should-taught' conflict: Item analysis

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Component factor analysis on 14 items</th>
<th>Item to complementary analysis on 13 items</th>
<th>Component factor analysis on 13 items</th>
<th>Item to complementary analysis on 13 items</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Factor 1</td>
<td>Factor 2</td>
<td>correlation</td>
<td>Factor 1</td>
</tr>
<tr>
<td>32</td>
<td>-.81</td>
<td>.08</td>
<td>.76</td>
<td>-.81</td>
</tr>
<tr>
<td>7</td>
<td>-.78</td>
<td>.13</td>
<td>.74</td>
<td>-.78</td>
</tr>
<tr>
<td>12</td>
<td>-.55</td>
<td>-.61</td>
<td>.48</td>
<td>-.55</td>
</tr>
<tr>
<td>6</td>
<td>-.66</td>
<td>.33</td>
<td>.57</td>
<td>-.67</td>
</tr>
<tr>
<td>36</td>
<td>-.66</td>
<td>-.44</td>
<td>.60</td>
<td>-.65</td>
</tr>
<tr>
<td>11</td>
<td>-.77</td>
<td>-.16</td>
<td>.71</td>
<td>-.77</td>
</tr>
<tr>
<td>31</td>
<td>-.88</td>
<td>.06</td>
<td>.82</td>
<td>-.89</td>
</tr>
<tr>
<td>23</td>
<td>-.66</td>
<td>.16</td>
<td>.56</td>
<td>-.66</td>
</tr>
<tr>
<td>20</td>
<td>-.70</td>
<td>.20</td>
<td>.61</td>
<td>-.70</td>
</tr>
<tr>
<td>27</td>
<td>-.62</td>
<td>-.26</td>
<td>.55</td>
<td>-.62</td>
</tr>
<tr>
<td>10</td>
<td>-.32</td>
<td>-.45</td>
<td>.27</td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>-.67</td>
<td>-.02</td>
<td>.60</td>
<td>-.66</td>
</tr>
<tr>
<td>14</td>
<td>-.58</td>
<td>.35</td>
<td>.52</td>
<td>-.58</td>
</tr>
<tr>
<td>17</td>
<td>-.56</td>
<td>.29</td>
<td>.51</td>
<td>-.57</td>
</tr>
</tbody>
</table>

Note: * Under each factor is the percent of total original variance for which it accounts.

#### 2.2.3 Exemplars

### TABLE A13: Exemplar scale items

-18. the forester *. leave inadequate margins near creeks when clear felling.

+25. the forester *. bar snig tracks.

+28. the forester *. generally clearfell only small areas at one time in managing Southern Coastal Hardwoods.

+5. the forester *. regenerate compacted landings.

+13 the forester *. usually plant pines on degenerate farmland.

Notes:
+ indicates that strong agreement was scored highly.
- indicates that strong disagreement was scored highly.
*. to obtain the question wording in the three sections, insert 'does', 'is taught to' or 'I think should' in the place marked.
TABLE A14: Exemplar 'should-does' conflict: Item analysis

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Component factor analysis on 5 items</th>
<th>Item to complementary analysis on 4 items</th>
<th>Component factor analysis on 4 items</th>
<th>Item to complementary analysis on 4 items</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Factor 1 Factor 2</td>
<td>Factor 1</td>
<td>Factor 1 Factor 2</td>
<td>Factor 1</td>
</tr>
<tr>
<td></td>
<td>(43.3%) <em>(23.4%)</em></td>
<td>(52.5%)</td>
<td><em>(24.4%)</em></td>
<td>*(60%)</td>
</tr>
<tr>
<td>18</td>
<td>-.70      -.48</td>
<td>.38</td>
<td>-.76</td>
<td>.53</td>
</tr>
<tr>
<td>25</td>
<td>-.83      .15</td>
<td>.62</td>
<td>-.80</td>
<td>.55</td>
</tr>
<tr>
<td>28</td>
<td>-.69      -.36</td>
<td>.42</td>
<td>-.72</td>
<td>.46</td>
</tr>
<tr>
<td>5</td>
<td>-.63      .27</td>
<td>-.42</td>
<td>-.60</td>
<td>.36</td>
</tr>
<tr>
<td>13</td>
<td>-.34      .85</td>
<td>.12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: * Under each factor is the percent of total original variance for which it accounts.

Question 13 (see Table A13) relates to the planting of pines, which is a controversial component of the conservation paradigm. Pines, it is often argued concentrate undesirable features of forestry in a small but highly productive area. A person may therefore favour or oppose pine plantations for conservation inspired reasons, which makes it an undiscriminating item. The weakness of question 5, just strong enough for inclusion in Table A14 but not Table A15, is not so readily explicable. As a tentative explanation it could be argued that regeneration of compacted landings is a minor conservation measure.

TABLE A15: Exemplar 'should-taught' conflict: Item analysis

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Component factor analysis on 5 items</th>
<th>Item to complementary analysis on 3 items</th>
<th>Component factor analysis on 3 items</th>
<th>Item to complementary analysis on 3 items</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Factor 1 Factor 2</td>
<td>Factor 1</td>
<td>Factor 1 Factor 2</td>
<td>Factor 1</td>
</tr>
<tr>
<td></td>
<td>(37.6%) <em>(24.4%)</em></td>
<td>(60%)</td>
<td>*(60%)</td>
<td>*(60%)</td>
</tr>
<tr>
<td>18</td>
<td>-.68      -.45</td>
<td>.24</td>
<td>-.69</td>
<td>.37</td>
</tr>
<tr>
<td>25</td>
<td>-.85      .09</td>
<td>.58</td>
<td>-.84</td>
<td>.55</td>
</tr>
<tr>
<td>28</td>
<td>-.72      -.04</td>
<td>.37</td>
<td>-.79</td>
<td>.44</td>
</tr>
<tr>
<td>5</td>
<td>-.41      .46</td>
<td>.24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>-.08      .89</td>
<td>.01</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: * Under each factor is the percent of total original variance for which it accounts.
2.2.4 Paradigm conflict

The above scales (information norms, decision criteria and exemplars) are combined in Tables A16 and A17 into a paradigm conflict scale. Question 15 relating to examination of foresters assumptions is added.

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Component factor analysis on 24 items</th>
<th>Item to complementary mean correlation</th>
<th>Component factor analysis on 22 items</th>
<th>Item to complementary mean correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Factor 1</td>
<td>Factor 2</td>
<td>Factor 1</td>
<td>Factor 2</td>
</tr>
<tr>
<td></td>
<td>(40.5%) *</td>
<td>(8.3%)</td>
<td>(43.1%)</td>
<td>(7.8%)</td>
</tr>
<tr>
<td>Information Norms</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>-.60</td>
<td>.45</td>
<td>.54</td>
<td>-.60</td>
</tr>
<tr>
<td>9</td>
<td>-.60</td>
<td>.34</td>
<td>.56</td>
<td>-.60</td>
</tr>
<tr>
<td>35</td>
<td>-.69</td>
<td>.25</td>
<td>.63</td>
<td>-.70</td>
</tr>
<tr>
<td>37</td>
<td>-.77</td>
<td>.25</td>
<td>.72</td>
<td>-.77</td>
</tr>
<tr>
<td>Decision Criteria</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>-.79</td>
<td>-.08</td>
<td>.74</td>
<td>-.80</td>
</tr>
<tr>
<td>7</td>
<td>-.61</td>
<td>.08</td>
<td>.57</td>
<td>-.61</td>
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<td>12</td>
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<td>.13</td>
<td>.53</td>
<td>-.61</td>
</tr>
<tr>
<td>6</td>
<td>-.68</td>
<td>-.34</td>
<td>.64</td>
<td>-.68</td>
</tr>
<tr>
<td>36</td>
<td>-.75</td>
<td>.25</td>
<td>.71</td>
<td>-.75</td>
</tr>
<tr>
<td>11</td>
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<td>.09</td>
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<td>-.76</td>
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<td>.10</td>
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<td>-.78</td>
</tr>
<tr>
<td>23</td>
<td>-.73</td>
<td>-.03</td>
<td>.69</td>
<td>-.73</td>
</tr>
<tr>
<td>20</td>
<td>-.56</td>
<td>.25</td>
<td>.51</td>
<td>-.57</td>
</tr>
<tr>
<td>27</td>
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<td>.13</td>
<td>.51</td>
<td>-.57</td>
</tr>
<tr>
<td>10</td>
<td>-.70</td>
<td>.13</td>
<td>.63</td>
<td>-.71</td>
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<td>34</td>
<td>-.76</td>
<td>-.07</td>
<td>.73</td>
<td>-.75</td>
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<td>14</td>
<td>-.54</td>
<td>-.40</td>
<td>.50</td>
<td>-.51</td>
</tr>
<tr>
<td>17</td>
<td>-.40</td>
<td>-.69</td>
<td>.38</td>
<td></td>
</tr>
<tr>
<td>Exemplars</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>-.50</td>
<td>-.36</td>
<td>.44</td>
<td>-.50</td>
</tr>
<tr>
<td>25</td>
<td>-.56</td>
<td>-.50</td>
<td>.55</td>
<td>-.54</td>
</tr>
<tr>
<td>28</td>
<td>-.44</td>
<td>-.21</td>
<td>.40</td>
<td>-.44</td>
</tr>
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<td>5</td>
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<td>-.51</td>
</tr>
<tr>
<td>13</td>
<td>-.32</td>
<td>-.02</td>
<td>.28</td>
<td></td>
</tr>
<tr>
<td>Other (Examine Assumptions)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>-.74</td>
<td>.00</td>
<td>.69</td>
<td>-.74</td>
</tr>
</tbody>
</table>

Note: * Under each factor is the percent total original variance for which it accounts.
In Table A16 items 13 and 17 are deleted. Why these items should not conform has already been discussed under the decision criteria and exemplar headings. In Table A17 items 10, 5, 13 and 18 are deleted. The only item not previously discussed is number 18, and no really satisfactory explanation can be offered for its lack of relationship with the other items.

TABLE A17: Paradigm 'should-taught' conflict: Item analysis

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Component factor analysis on 24 items</th>
<th>Item to complementary mean correlation</th>
<th>Component factor analysis on 20 items</th>
<th>Item to complementary mean correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Factor 1</td>
<td>Factor 2 (37.0%)</td>
<td>* (8.0%)</td>
<td>Factor 1</td>
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<td>-.59</td>
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<td>-.33</td>
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<td>5</td>
<td>-.21</td>
<td>.15</td>
<td>.20</td>
<td></td>
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<tr>
<td>13</td>
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<td>.54</td>
<td>.19</td>
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<td>.15</td>
<td>.69</td>
<td>-.75</td>
</tr>
</tbody>
</table>

Note: * Under each factor is the percent of total original variance for which it accounts.
2.3 Other Scales

The scales in this section are taken from Section D of the questionnaire.

2.3.1 Perception of Staff Bias

TABLE A18: Perception of staff bias scale items

<table>
<thead>
<tr>
<th>Question</th>
<th>Component factor analysis on 6 items</th>
<th>Item to complementary mean correlation</th>
<th>Component factor analysis on 5 items</th>
<th>Items to complementary mean correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Factor 1 Factor 2</td>
<td></td>
<td>Factor 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(61.7%) *(20.0%)</td>
<td></td>
<td>(71.5%)</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>-.88      -.31</td>
<td>.79</td>
<td>-.90</td>
<td>.84</td>
</tr>
<tr>
<td>4</td>
<td>-.68      -.27</td>
<td>.75</td>
<td>-.89</td>
<td>.81</td>
</tr>
<tr>
<td>10</td>
<td>-.85      -.30</td>
<td>.71</td>
<td>-.88</td>
<td>.79</td>
</tr>
<tr>
<td>22</td>
<td>-.85      -.19</td>
<td>.78</td>
<td>-.83</td>
<td>.73</td>
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<tr>
<td>19</td>
<td>-.75      -.40</td>
<td>.65</td>
<td>-.72</td>
<td>.59</td>
</tr>
<tr>
<td>2</td>
<td>-.41      .84</td>
<td>.30</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: * Under each factor is the percent of total original variance for which it accounts.

The perception of staff bias scale items are remarkably homogeneous, once item 2 is removed (see Table A19). It can readily be seen that item 2 is a double barrel question and could be deleted on those grounds alone (see Table A18).
2.3.2 Student Radicalism

TABLE A20: Student Radicalism Scale items

-8. Students should have less say than staff in deciding course content.
-15. Students should never have occupied the chancelry as they did recently
+20. Students should have increased influence over the content of the forestry course.

Note:
+ indicates that strong agreement was scored highly.
- indicates that strong disagreement was scored highly.

TABLE A21: Student radicalism: Item analysis

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Component Factor Analysis</th>
<th>Item to complementary mean correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>on 3 items</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Factor 1 (70.7%)</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>-.86</td>
<td>.67</td>
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<tr>
<td>15</td>
<td>-.84</td>
<td>.63</td>
</tr>
<tr>
<td>20</td>
<td>-.82</td>
<td>.60</td>
</tr>
</tbody>
</table>

Note: * Percent of total original variance accounted for by factor 1.

The items in the student radicalism scale are highly coherent (see Table A21) and require no modification.

2.3.3 Perception of Forest Service Pressure on the Forestry Department at ANU.

TABLE A22: Perception of forest service pressure on forestry at ANU scale items.

-14. Staff are not influenced by the forest services in deciding course content.
+16. Forest services exert some pressure on staff through research funding.
-12. Private forestry companies have very little influence on the forestry department at ANU.

Note:
+ indicates that strong agreement was scored highly.
- indicates that strong disagreement was scored highly.
Initially it was planned to have a scale of external political pressure (from forest services and private forest interests) but the question relating to private forest company pressure was marginally related to the other items (see table A23). The remaining two questions refer to pressure from forest services, and being sufficiently related to each other (correlation coefficient = .52) they are taken together as a scale.

TABLE A23: Perception of forest service pressure on forestry at ANU: Item Analysis.

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Component Factor Analysis on 3 items</th>
<th>Item to complementary mean correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Factor 1 (56.7%)*</td>
<td></td>
</tr>
<tr>
<td>14**</td>
<td>-.81</td>
<td>.41</td>
</tr>
<tr>
<td>16**</td>
<td>-.84</td>
<td>.51</td>
</tr>
<tr>
<td>12</td>
<td>-.59</td>
<td>.28</td>
</tr>
</tbody>
</table>

Note: ** Percent of total original variance accounted for by Factor 1. The two items marked were used as scale items.

2.3.4 Perception of Internal Political Pressure acting on Staff in the Forestry Department at ANU

As there are only two items, item analysis is inappropriate. However, with a correlation coefficient of 0.54 between the two items they may be taken together as a scale.

TABLE A24: Perception of internal departmental pressure on staff.

+7. I think some staff feel pressure from other staff towards conformity over forestry policies.
+21. I think that some of the staff feel hamstrung by the departmental line.

Note:
+ indicates that strong agreement was scored highly.
- indicates that strong disagreement was scored highly.
2.3.5 Desire for a broader Forestry Course with more knowledge of the humanities.

TABLE A26: Desire for knowledge of humanities scale items.

+6. Forestry staff should have a broader education.
+3. It is very important for forestry students to have more education in the humanities.
+1. We get insufficient knowledge about people in the forestry course.

Notes:
+ indicates that strong agreement was scored highly.
- indicates that strong disagreement was scored highly.

TABLE A26: Desire for knowledge of humanities: Item analysis.

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Component factor analysis on 3 items Factor 1 (63.8%)*</th>
<th>Item to complementary mean correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>-.89</td>
<td>.68</td>
</tr>
<tr>
<td>3</td>
<td>-.75</td>
<td>.45</td>
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<tr>
<td>1</td>
<td>-.75</td>
<td>.45</td>
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</tbody>
</table>

Note: * Percent of total original variance accounted for by Factor 1.
REFERENCES


BACHELARD E.P. et al 1974 "Forestry Staff Viewpoint" in ANU Reporter Vol. 5, No. 20, December, p. 8, signed by 18 ANU Forestry Department staff members.


CARR D.J.1974a Speech delivered at a public meeting organized by the South Coast Committee, Canberra.


CRANE D. 1972 Invisible Colleges University of Chicago, Chicago.

CROMER D.A.N. 1967 "Management" in Unasylva Vol. 21 (3-4), Nos. 86-87, pp. 46-64.


FCV 1972 "Life at the School" in Tyalla p. 38, December, anonymous.


FORESTER 1974 Comments made by a forester at a public meeting organized by the South Coast Committee, Canberra.

FORESTERS 1969 "Criticism of Australian Forestry Education" in The Forestry Log No. 2, p. 34, anonymously signed '(SOME) 1966-67 Students.'

FORWOOD (1) to (8) 1974 Eight volume report of Forwood Conference

FORWOOD (9) 1974 "Exotics and Monocultures" a single page article distributed without author's name at Forwood Conference Canberra.
FORWOOD (10) 1974 "A sidelight on the FORWOOD Conference" a single page article distributed without the author's name at the Forwood Conference Canberra.


HOO-HOO (1) Undated and anonymous pamphlet entitled Why the Timber Industry Needs Hoo-Hoo (4p).


KORNHAUSER W. 1962 Scientists in Industry University of Calif., Berkeley and Los Angeles.


OVINGTON J.D. 1965 The Role of Forestry The Australian National University, Canberra.


RYAN P. 1971 "Editorial" in The Forestry Log No. 4, p. 3.


SKLAIR L. 1973 Organized Knowledge Paladin, St. Albans, U.K.


STORER N.W. 1966 The Social System of Science Holt, Rinehart and Winston, U.S.A.

STUDENT 1974 Discussions held with final year students, tape recorded.

SURVEY 1974 This references the results of a questionnaire delivered to final year forestry students in 1974.


TYNDALE-BISCOE C.H. 1974 Speech delivered at a public meeting organized by the South Coast Committee, Canberra.


