La Trobe University Inaugural Lecture

THE PHILOSOPHY OF UNCERTAINTY

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The eleventh inaugural lecture of La Trobe University delivered on 21 July 1969 by Professor B. D. Ellis B Sc, B A (Adel), B Phil (Oxon), Professor of Philosophy

We are all from time to time made acutely aware of the fact that we can be wrong — that we did not know what we thought we knew. And when we make wrong judgements this can often have quite serious consequences. Philosophers, perhaps because they are wrong more often than others, have always been concerned to find a secure basis for knowledge — a basis of certainty from which all other knowledge can be derived. This basis of certainty for which they sought has been variously described, but it is usually thought of either as a foundation or as a super-structure. Empiricist philosophers have generally spoken of a foundation for knowledge, and in doing so, they have expressed their belief that whatever occurs above the foundations, i.e. the structure of theoretical science, is man-made and hence subject to error. Rationalist philosophers, on the other hand, have often spoken of a superstructure. Descartes, for example, sought to find ‘a firm and abiding super-structure for the sciences’ from which all genuinely universal truths about the world could be derived. Science had somehow to be suspended from above.

Descartes’ model for science was Euclid’s Elements. His aim was to discover a set of axioms, like those of Euclidean geometry, from which he could derive as theorems the body of universal truths. Then, the axioms being true, self-evident and hence known to be true, and the proofs consisting of simple logical steps from these axioms, the theorems must be true. And so, once the theorems have been derived, they also may be known to be true.

This rationalist programme for eliminating uncertainty from the sciences must have seemed very attractive. Aristotle conceived of it in the abstract, but Euclid and Archimedes in their books on geometry and statics seemed to have demonstrated that it could be done. They seemed, by their example, to have shown that a priori knowledge of universal truths is possible. The influence of this belief in the power of reason to discover such universal truths a priori was undoubtedly very great. But perhaps most important, it led to a continuing search for more fundamental principles. Western scientists, who took Euclid as their standard, were not content merely to have
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discovered empirical laws, like the law of the lever, or the principle of the wedge or pulley, they wanted some derivation of these laws from more general or more fundamental ones which, hopefully, would turn out to be self-evident. They did not often find principles which satisfied their demands for self-evidence, but they did discover a lot of important scientific laws. And the principles of moments, virtual work, composition and resolution of forces, inertia and conservation of momentum are among them.

It is often said that Aristotelian rationalism, and its exemplification in the works of Euclid and Archimedes greatly hindered the development of Western science. To some extent this is true. After all, if you had to draw geometrical figures and measure their angles etc. in order to discover their properties, you would not have been considered much of a geometer. Likewise if you had actually to measure forces, accelerations etc. in order to discover the laws of physics, you would not at that time have been considered much of a physicist. In the first place, your results were not likely to be correct, and even if they were, you had no guarantee that other figures or dynamical systems or whatever of the same kind would also exhibit the properties you discovered.

In the field of geometry rationalist methodology seemed obviously to be preferred, and since geometry was the model for all physical sciences, rationalist methodology was quite generally to be preferred. Nevertheless, I believe that the negative influence of rationalism has been greatly exaggerated. It is now generally agreed that rationalism was at least as important to the achievement of the scientific revolution of the 17th Century as was empiricism. It was the combination of rationalism and empiricism which really achieved results.

Since the 17th Century, faith in the power of human reason to discover a priori basic universal truths has declined, and rationalist epistemology has been superseded by empiricist. Today it is rare to find any philosopher who accepts that there are any universal truths about the world that we can know a priori. It is widely accepted that the only genuine a priori truths are the laws of logic. And these we can know a priori only because they tell us nothing whatever about anything – i.e. they are factually empty. By the mid-19th Century, it was widely held that at least the propositions of arithmetic and Euclidean geometry, in addition to those of logic, were known a priori to be true. But the discovery of alternative non-Euclidean geometries, and their later use in general relativity theory, destroyed the view that Euclidean geometry had any special a priori status as the theory of spatial relationships. And the last minute failure of the Frege-Russell programme to
reduce arithmetic to logic has cast doubt upon the *a priori* status of arithmetic.

The view that is most commonly held today about the status of mathematical truths is probably Einstein's:

>'How can it be,' he asks, 'that mathematics, being after all a product of human thought which is independent of experience, is so admirably appropriate to the objects of reality? Is human reason, then, without experience, merely by taking thought, able to fathom the properties of real things?' Still quoting Einstein, 'In my opinion the answer to this question is briefly this: As far as the laws of mathematics refer to reality they are certain; and as far as they are certain, they do not refer to reality.'  

With the decline of rationalism, philosophers searched for a different foundation for knowledge, and they hoped that this might be found in sense experience. It was surmised that there must be some things that we know immediately or without inference by perception. And if so, then that which is so given in perception, might form a secure basis of certainty for our system of knowledge of the world. But apart from the difficulty of identifying the set of items of knowledge that make up this basis of certainty, i.e. the objects of immediate awareness in perception, empiricist philosophers were faced with the task of explaining how we could use this knowledge to secure knowledge of anything else. If we identify the basic items of our knowledge as knowledge about our own sensations or sense impressions, it is hard to see how we could have knowledge of anything other than our own sensations or sense-impressions.

In recent years, several sophisticated attempts have been made to find a different empiricist foundation for knowledge, which is not frustrated by such apparently insuperable problems. But most have had this characteristic: they have assumed that there are things of which we are immediately aware, and which we know to exist, and that all else is either an inference from what we know immediately, or something postulated to explain it. It sounds like the doctrine of rationalism all over again but with the basic or primary items of knowledge being about particulars rather than universals.

There is a growing school of thought that knowledge simply does not have a foundation in the traditional sense. We have only a system of beliefs. We hold the beliefs that we do with varying degrees of confidence. About some
things we are prepared to say 'It is certain' and about others that it is only probable. For the most part, we cannot help acquiring the beliefs that we do with the degree of confidence that we have in them. Sometimes we can be persuaded or otherwise caused to change our beliefs or to alter the degrees of confidence that we have in them. Means of persuasion vary from crude non-rational brainwashing techniques to those that we recognize as rational.

Most of this, of course, has never been denied. What is denied in the new epistemology is that our system of beliefs has or could be given any absolute foundation. It holds that no belief can be justified absolutely. If any of our beliefs are challenged all we can do is defend them. There are some ways of defending our beliefs that would be recognized as rational, and others as non-rational or irrational. But in the new epistemology there are no absolute standards of rationality either. The laws of logic are not absolute or a priori truths. Like other laws, they are subject to challenge, and the possibility of such a challenge being successful cannot be ruled out a priori.

In defending any belief, we can never do more than present an argument or try to arrange our environment, e.g. by setting up an experiment or demonstration, which, being observed, will cause our challenger to accept our belief. If we are successful in our aims, we do not thereby show that the belief is true in any absolute sense — we only cause it to become accepted. If we are unsuccessful, our reputation as an observer, or theoretician or our reputation for linguistic competence, or for honesty or rationality might suffer. But our challenger has not thereby established that our belief was false except perhaps to his own satisfaction. The situation is not really changed if we cause something to become widely or even universally accepted. The more widely it becomes accepted, the more difficult it may become later to challenge. But still we have not shown it to possess any absolute characteristic of truth. Universal agreement is no guarantee of truth.

As I understand it, an argument consists of a set of premises and a conclusion. To assert that an argument is valid is to claim that it would be irrational for anyone to accept its premises and, at the same time, to reject its conclusion. But this claim like any other is open to challenge. We may hope to get such a claim widely or even universally accepted. But, of course, this will not show it to be true. Hence our concepts of truth and validity are linked in this way: If there is no way of establishing absolute truth, there is no way of establishing absolute validity either.

Let me just illustrate briefly how there can be dispute over validity. There is an argument-form known as contraposition that has been accepted almost universally as a valid argument-form, at least since the time of Aristotle. Consider the Vice-Chancellor, who has an engineering degree.
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If he is an electrical engineer, then he knows about wiring diagrams

∴ If he does not know about wiring diagrams, he is not an electrical engineer.

Nearly everyone would accept that the argument is valid. It is an argument of the form:

If A then B

∴ If not \( \neg B \) then not \( \neg A \)

This is the argument-form known as contraposition. But now consider the following argument which apparently has exactly the same form:

If the V.C. is not an electrical engineer, then he is an engineer of some kind.

∴ If the V.C. is not an engineer of any kind, he is an electrical engineer.

Intuitively, most of us would want to say that this argument is invalid. But since it appears to be a contraposition, it ought to be valid. So there is a conflict. To remove the conflict we either have to argue that the argument is not, despite appearances, really a contraposition, or that contraposition is after all invalid, or that the conclusion really does follow from the premiss, so that if the premiss is accepted as true, the conclusion must also be accepted as true. Most logicians I have talked to about examples like this have come around in the end to the view that the argument really is valid despite its appearance of invalidity. The conclusion of the argument looks like a contradiction, but really it is true. As they come to see it, the conclusion is a statement like

'If the Vice-Chancellor is not an engineer of any kind, I'll eat my hat', i.e. just an eccentric way of saying that the Vice-Chancellor is an engineer.

Personally, I think that contraposition is not generally valid; but that is not the point I wish to make here. The example illustrates that there can be serious dispute about validity and self-contradictoriness, even when we are dealing with argument-forms that have been accepted as valid for more than 2000 years.

It is well-known that different theories can compete to explain the same things. We may say that they have the same domain of application.
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Alternative logics have long been known to exist. But these alternative logics have seldom been thought of as having the same domain of application as classical or Russellian logic. For reasons I cannot now go into, I believe that viable alternative logics having the same domain of application as Russellian logic do exist. If this is so, then the a priorist view of classical logic must be rejected along with the a priorist view of Euclidean geometry.

The upshot of this is that there is nothing that we can know absolutely to be true, not even a law of logic. But surely, you will say, I must know that \( 2 + 2 = 4 \), or that I have two thumbs. Isn't your conclusion therefore absurd? Certainly I am prepared to say it is true that \( 2 + 2 = 4 \) or that I have two thumbs. There are no claims that I would more confidently make. Moreover, I would be prepared to stake my life on them. I would be prepared to defend them against any arguments that you might bring to show that they are false. I would expect every rational being or competent observer to agree with me. Moreover I would not consider anyone rational or a competent observer if he didn't. But does any of this show that either claim is true? My saying it doesn't make it true, however confident I am. My belief that I would be prepared to defend it indefinitely doesn't make it true. Your agreeing with me doesn't make it true. The whole world agreeing with me doesn't make it true. There is therefore nothing that would show any belief of mine to be true.

We might, therefore, just as well forget about things being true or false and concentrate upon what we may accept as true or false. This may seem only a minor change, but in fact it has important consequences. For example, there is a law of classical logic known as the law of the excluded middle, or more accurately as the principle of bivalence. This is a law to the effect that every proposition is either true or false. But if we cease to talk about what is true or false, then the principle of bivalence, thus interpreted, must be rejected. For obviously, it is not the case that every proposition must either be accepted as true or accepted as false.

The way is therefore open for us to consider that accepting a proposition as probable or improbable does not differ essentially from accepting it as true or false, the only difference being one of reservations. Hence we may consider the various degrees of probability to be truth values intermediate between truth and falsehood. Classical logic is two-valued in the sense that it does not allow for any truth values intermediate between truth and falsity. This system of logic, as I see it, is suitable only to the gods. For only of an omniscient being would it be true that he accepted every proposition as either true or false. However, it is rather a waste of time designing a system of logic for the gods, since they have no need for a system of logic anyway.
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For the most part, we finite beings have to live with uncertainty. There are comparatively few claims of a general nature that we would be prepared to make or accept without some reservations. For the most part, if we are pressed, we would be prepared to agree only that it is probable or very likely that so and so, or that it is highly improbable or very unlikely that such and such. Everyone knows that this is so, but it is astonishing how little account is taken of it. If someone presents an argument, and the premisses seem fairly plausible, we are likely to consider it a good argument in support of its conclusion, if it is valid according to classical logic. But classical logic is a logic of certainty. It is a system of logic that we can derive from the classical probability calculus by restricting the range of possible probability values to 1 and 0, i.e. by making the assumption that every proposition is known either with certainty to be true or with certainty to be false. It is, therefore, by no means clear that if the premisses of a classically valid argument were accepted as very probable the conclusion should also be accepted as probable. Indeed it is demonstrable that this is not so.

There is, for example, a fallacy of protracted argument. This is the fallacy of assuming that if each of the premisses of a fairly protracted argument are accepted as very probable, then it is a good argument for the classically derived conclusion. The well-known "domino theory" is an illustration of this fallacy.

1. If the Americans withdraw from Vietnam, the South Vietnamese government will collapse.
2. If the South Vietnamese government collapses, this will have such and such consequences for Laos and Cambodia.
3. If these things happen in Laos and Cambodia, then . . . and so on . . . .

leading eventually, by classical hypothetical reasoning, to the conclusion that if the Americans withdraw from Vietnam, Australia will eventually be in grave danger of a communist takeover. But unless each of the premisses in this long chain-like argument can be accepted as having a very high degree of probability indeed, the argument is almost worthless. Suppose, for example, that each premiss is agreed to be fairly probable, so that we would assign to each a degree or probability of say 0.7. What should we say is the probability of the conclusion? Suppose that the argument contains eleven steps, then we need only accept that the conclusion has a probability of greater than 0.01 (or thereabouts). But we could have said a priori that it has a degree of
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probability greater than zero. So the argument hasn’t gained us very much. Yet mainly on the strength of this argument, the Australian and American governments have been prepared to destroy or wreck the lives of millions of people.

Secondly, there is the fallacy of contraposition. In the logics of certainty, this argument-form is generally considered valid. But in the logic of uncertainty, it is patently invalid. Contraposition is an argument of the form:

\[
\begin{align*}
\text{If } A \text{ then } B \\
\therefore \text{ If not } \neg B \text{ then not } \neg A
\end{align*}
\]

But if we accept the premiss of such an argument as probable, it does not follow that we must accept its conclusion as probable. For suppose we lived in a society in which most people were Christians, and nearly everyone believed in God. Then we could certainly say of someone that it is probable that he believes in God if he is not a Christian. But it obviously does not follow from this that it is probable that he is a Christian if he does not believe in God.

Thirdly, there is a fallacy of hypothetical reasoning. If I think it very probable that if A then B and also very probable that if B then C, I need not logically also consider it probable that if A then C. Thus, while I may accept it of someone that it is probable that if he is an American he believes in free enterprise, and accept it as probable that if he were a Californian student activist he would be an American, I am not thereby committed to accepting it as probable that if he were a Californian student activist, then he would believe in free enterprise.

This fallacy of probabilistic hypothetical reasoning is well-known. It is less well-known, however, that there is a similar fallacy in the logic of truth claims. For consider the following classically valid argument:

1. If I were a horse, I wouldn’t be interested in philosophy.
2. If I weren’t interested in philosophy, then I wouldn’t be a philosopher.
3. If I weren’t a philosopher, I would want to be a mathematician.

\[
\therefore \text{ 4. If I were a horse, I would want to be a mathematician.}
\]
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For reasons such as these, it is clear that the classical logic of certainty is not adequate for handling arguments involving uncertainty. I do not think it is even adequate as a logic of truth claims — but that is something that I am not now trying to argue. I had originally thought that classical probability theory would provide the required logic of uncertainty. But it is now apparent that this is not so either. The classical probability calculus is not strong enough to serve as a system of logic. The main reason for this is that this calculus contains no means of representing or handling what I would call compound conditional propositions. Suppose, for example, I make the following claims:

(1) It is probable to degree i that he will win if I lose.
(2) It is probable to degree j that he will lose if I win.

What should I now say is the probability of the compound conditional that:

(3) He will either win if I lose or lose if I win?

(1) and (2) are easily enough represented by:

\[(1a) \quad P(q/p) = i \]
\[(1b) \quad P(\neg q/p) = j \]

But to represent (3), it looks as if we should have to write:

\[(3a) \quad P[(q/p)\lor (\neg q/p)] = \ldots ? \]

But (3a) is not even a well-formed probability expression.

For this reason alone, the classical probability calculus is evidently not adequate to serve as a logic of uncertainty. Hence neither classical logic nor classical probability theory provides us with a system of logic adequate for assessing arguments involving subjective probability claims. Clearly, then, there is much work to be done on the logic of uncertainty. And until this work is done, we shall not clearly understand the principles which must govern most of our reasoning.
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It is perhaps unfortunate that logic has been developed as a foundation for mathematics. For mathematics is the one area for which classical logic is ideally suited. It is the only area in which anything like certainty can be achieved — even if it is at the cost of vacuousness. This fact has tended to blind logicians to its shortcomings. But as I see it classical two-valued logic is a degenerate logical system suitable only to gods and mathematicians. In the hands of anyone else it is not only likely to be misleading, it may, as the domino theory so clearly illustrates, be disastrous.

For some time now my main interests in philosophy have been in the foundations of logic and probability theory, and my main concern has been to develop a logic of uncertainty. I cannot pretend that I went into this for any reason other than that I found the problems fascinating. But now, in retrospect, I can see that the need for such a system of logic is really very urgent, if only for the reason that we must become less and less confident of a great many of the assumptions that we have made unquestioningly in the past.

It is well-known that the volume of scientific and technical knowledge is increasing exponentially and has been doing so at least since the beginning of the century. It is difficult to estimate just how fast it is growing, because it is not clear by what criterion it should be measured. But by most reasonable criteria — by the number of papers published, by the number of working scientists, by the number of scientific and technological journals — we may say that the volume of scientific and technical knowledge is growing even more rapidly than the population. If the world population is doubling every 30 years, then the scientific output is doubling roughly every 20 years.

It is evident that this growth pattern cannot continue indefinitely. If it did so for long the population of scientists would soon equal the world population. There is, however, no reason to suppose that the scientific output will not continue to grow in this way at least for the remainder of the century.

Now I assume that if the volume of scientific and technical knowledge is increasing exponentially, so is the pace of technological innovation, and that it is technological innovation which more than anything else changes the kind of society in which we live.

I do not intend to argue for the view that this is a major factor in changing people’s attitudes and opinions. For I do not think I will be contradicted if I merely assert that antibiotics, the computer, automation, the jet engine, television, the pill, the atom bomb and the cracking of the genetic code are developments that have and will further radically change the outlooks of men and the nature of society.
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In the past, ideologies have greatly influenced the course of history. One has only to think of the influence of Marxism — although, since Marxism was a creation of the industrial revolution of the 19th Century, the influence of Marx must be attributed at least partly to the development of the machinery that produced this revolution. In the past 20 years or so, however, there have been perhaps four or five technological developments each potentially as explosive in its impact upon society as the development of the machinery for mass production was in the last century. And in the next 20 years or so we can expect the number of such major developments roughly to double.

This has a number of consequences:

1. that our laws and institutions will either have to change more and more rapidly or become anachronistic. It will not be thought to be a virtue of an institution that it is "time honoured".

2. that the future will become progressively more relevant to the decisions that we have to make today: the past will become progressively less so. No business or government agency can survive without future planning. Reliance upon precedent will become increasingly dangerous, for the circumstances in which the precedents occurred will become more and more remote from those in which the decision has to be taken. We can expect the world of 1989 to be as different from the world of today as that of 1929. The past is thus spread out and the future jam packed.

3. that as planning for the future becomes more and more necessary it will also become more and more complicated and uncertain. For the variety and interactions of the changes of circumstances that will have to be anticipated will also increase exponentially. Simple-minded trend extrapolation may not be enough. An elaborate multidisciplinary technology of future planning may have to be developed. I do not believe that our universities are doing nearly enough to study this need. There is merit in the suggestion that this University should take the lead and establish a school of future planning and research.

4. that we shall see in the course of our lives more fundamental changes than our fathers did, not only in social attitudes and community organization, but more fundamental changes in our physical, social and biological
theories. Adopting a time-scale of major events, we are all living longer and our age is increasing exponentially relative to our natural or physical age. The “generation gap” that we hear so much about has always existed, but it is widening and will continue to widen.

A few years ago Thomas Kuhn produced a book called *The Structure of Scientific Revolutions*, which was a study of the dynamics of science. In it he distinguished between normal and abnormal science. By ‘normal science’ he meant the articulation of a paradigm, by ‘abnormal science’ the creation of a new paradigm. By a paradigm he meant roughly some major work or theory. We may think of Euclid’s *Elements of Geometry*, Newton’s *Mathematical Principles of Natural Philosophy*, Darwin’s *Origin of Species*, Russell and Whitehead’s *Principia Mathematica* or Einstein’s *On the Electrodynamics of Moving Bodies*. Such works he maintains have determined what are or were considered to be the major problems of science, and what are or were acceptable solutions to them.

In a period of normal science, the basic assumptions upon which these paradigms depend remain unchallenged. The challenge is always to adapt the paradigm so that it can be used to solve the problems it creates. Let me take an example from logic. For the past 50 years, the paradigm in logic has been the *Principia Mathematica*. This fundamental work on the logical foundations of mathematics has not only served as the major paradigm in logic, it has radically altered the structure and concept of mathematics. The so-called new mathematics that has recently found its way into our school curricula is a more or less direct outcome of the fundamental thinking about the nature and foundations of mathematics which Russell and Whitehead did more than 50 years ago. The main problems of logic since the *Principia Mathematica* have been roughly:

1. to extend or adapt the formalism of the *Principia Mathematica* so that it can be used to assess the validity of arguments that are not easily handled or cannot be handled with the basic apparatus of this system of logic.

2. to prove the consistency, completeness or incompleteness, independence of axioms, and the existence or non-existence of decision procedures for the various formal systems derived from or proposed as extensions of the *Principia Mathematica*.

The *Principia Mathematica* has thus created the problems of logic and set the standards for their solution. In Kuhn’s sense it is a paradigm, and most of
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the work that has been done in logic since the *Principia Mathematica* is normal science based upon that paradigm.

A period of normal science in a given area can continue for quite a long time. And the paradigm itself is not likely to be questioned seriously by professionals in the field until it runs into serious and apparently insoluble problems. At such a time the basic paradigm comes under attack, and the nature of the scientific enterprise shifts radically. Different schools of thought emerge, there is no longer general agreement about what the important problems are, how they should be formulated, how to go about solving them or what constitutes a satisfactory solution. A period of abnormal science has then begun.

I believe that the increasing pace of theoretical change is bound to usher in periods of abnormal science more and more frequently, and this has implications for the training of scientists and social scientists. Thirty or forty years ago it may have been true that a young graduate could reasonably expect his indoctrination into the basic paradigms of his subject to stand him in good stead for most of the remainder of his working life. But nowadays he can have no such reasonable expectation. The likelihood is that the accepted theory underlying his subject will be radically different in twenty or thirty years time from what it is today.

But what I am saying here about scientists and social scientists applies almost everywhere. Our laws, institutions, social practices and moral codes, just as much as our programmes of experimental and theoretical research in the various sciences are all based upon certain normally unquestioned assumptions. And in this sense, we are all operating on the basis of certain paradigms. It is likely, however, that many of these paradigms will be shattered in the near future. And if we are to continue to understand what is occurring we must understand clearly the bases of our various disciplines.

As I see it, this is what philosophy is all about. The main branches of philosophy concern the foundations of knowledge and belief, reasoning, understanding and judgement — even if we do not believe that there are any absolute foundations. Epistemology is the study of the foundations of knowledge, logic that of the principles of reasoning and inference. Ethics is the study of the foundations of moral judgement and aesthetics that of aesthetic judgement. Metaphysics originally meant the study of the principles of our understanding of nature. But nowadays we must distinguish between traditional metaphysics and philosophy of science. Traditional metaphysics is the study of the problems raised by Aristotle in his *Metaphysics*. It is the investigation of our concepts of space, time, causality, substance, attribute, quantity, quality, etc., i.e. of the concepts used in Aristotelian physics to
describe or explain the workings of nature. Philosophy of science is just modern metaphysics.

Philosophy, like mathematics, is a kind of universal discipline. It is universal in the sense that every rational activity has a philosophy. For if an activity is a rational one, then there are reasons for doing some things rather than others while engaged in it. And once reasons are given, we can investigate logically the adequacy of these reasons, and philosophically the concepts used in stating them. Thus, there is a philosophy of law, of history, of religion, of education, and even, I suppose, of town planning, architecture and literary criticism.

At La Trobe, I have set out with the idea of developing these specialized philosophical studies, in addition to the more traditional ones. At the moment we offer courses in philosophy of history, philosophy of language, aesthetics, philosophy of science, political philosophy and philosophy of mathematics, and I hope that within the next few years we shall be able to offer courses on the philosophy of religion, law and education. I conceive the roles of philosophy in a university to be:

1. to investigate those concepts of thought, reasoning and evaluation that are common to most rational activities.

2. to provide specialized foundational studies of the various other disciplines.

While not wishing to neglect the first of these roles, I have tended to emphasize the second. My reason for doing so is just that I believe that specialized foundational studies will become increasingly important. In the kind of fluid society in which we live, and which I have attempted briefly to describe, if students are to understand the changes that are occurring, and are to be intellectual leaders in this society, they must become very aware of the logical and philosophical foundations of the subject in which they have specialized.

Such investigations are not likely to lead to certainty. On the contrary they are likely to increase uncertainty. But in a world in which we cannot know, it is more rational not to claim to know. We shall have to learn to adjust to uncertainty, and to reason from bases that are themselves uncertain. If we become paralysed by uncertainty, there is a danger that we shall be led by "bigots of various kinds who have never thought deeply enough about anything to realize that they could be wrong."
FOOTNOTE