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TIME AND TIME TRAVEL.

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by

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This work is entirely my own insofar
as its critical and expository aspects are concerned.

P. B. Balaban

ABSTRACT.

This work is an exploration of the idea of time travel in relation to general theories of time. It is neither a defence nor a repudiation of time travel, but seeks to find ultimate grounds for the plausibility of the idea. Consequently it attempts to set up the concept of time travel as securely as possible, and does so by emphasising that travel has ultimately an analogical sense.

Having thus established time travel without the supposition of any general theory of time, the work goes on to consider general theories of time in order to locate the idea of time travel within them.

Of special interest is the theory of space-time, which is eminently suited to the idea of time travel. My concern there is not however with the establishment of time travel, but rather with the conflict between the philosophy of space-time and the philosophy which bases the theory of time on the nature of the human experience of it. The character of the opposition between these philosophies renders them complementary, and consequently one or other should be capable of excluding time travel.

The conclusion is that the plausibility of time travel rests on the fact that neither of these philosophies is capable of excluding time travel on general metaphysical or epistemological grounds.

In finishing the work discusses the facts and logic of human power and knowledge, and points to the possible existence of a general epistemological principle the lack of which is the reason for the survival of time travel.

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SECTION ONE.

AN EXPOSITION OF TIME TRAVEL.

CHAPTER ONE.
A SURVEY OF THE LITERATURE.

One of the most eccentric topics of modern speculative thought is time travel, for its paradoxes and curiosities delight the writers of science fiction. Consequently, time travel appears as hardly worthy of philosophical investigation. Nevertheless, an amount of effort and ingenuity has in recent years been expended by philosophers on the idea, partly no doubt because some of them are in love with speculative fiction, but also for a much more substantial reason, for Kurt Gödel, of mathematical notoriety, found in 1947 that there is a solution of the fundamental equations of relativistic cosmology that could only be interpreted as permitting time travel. Time travel became respectable intellectual business.

What then is time travel, and what is its importance as an idea? The first question can, I think be answered without too much difficulty, though not as easily as some suppose, but the second is much more troublesome, and constitutes the main business of this thesis.

The first and most basic point to be made about time travel is that it is a concept that is introduced by analogy with ordinary spatial travel. It cannot therefore be dismissed by pointing out that the analogy is incomplete, nor can it be dismissed by showing that time travel abuses the logical grammar of the language of time or travel. Analogies are permitted to do such things, although they have the corresponding weaknesses as well, for they cannot appropriate unquestioningly all the structure and apparatus of their correlatives. Apart from the exact nature and limits of an analogy, it is normally drawn within a definite conceptual framework and with definite purposes in mind. These matters concerning time travel as an analogy will be treated of in chapter two.

The reason for this deferral is that it will be useful to first of all conduct a brief survey of the literature on time travel, a survey which is intentionally far from complete, but is, I hope, representative. The purpose of this survey is to set the scene for time travel, to show the variety of contexts within which it occurs, some contexts being designed to favour it, others to discredit it. Many of the authors quoted will not treat of time travel as of an analogy, but will rather treat it as a deduction from other concepts, which tends to obscure the truth.

I have organised the survey into three sections intended to represent roughly the dialectical development of the idea. I begin with the arguments for time travel, proceed to those against, and then describe an exemplary case in defence of it. I hope that as a result certain themes will begin to coalesce.

THE ARGUMENTS FOR

H.G. Wells

Wells is the original writer on time travel, and his exposition of it is the one which has most captured the popular imagination. From him spring directly J.W. Dunne, the later fiction writers, and such proponents of time travel among philosophers as Meiland and Lewis, who will be mentioned later on. Further, it is to the notion as put forward by Wells that the criticisms of philosophers such as Williams and Smart are directed. Consequently I reproduce here much of the first chapter of The Time Machine, in which the case for time travel is put.

'Clearly,' the Time Traveller proceeded, 'any real body must have extension in four directions: it must have Length, Breadth, Thickness, and - Duration. But through a natural infirmity of the flesh, which I will explain to you in a moment, we incline to overlook this fact. There are really four dimensions, three which we call the three planes of Space, and a fourth, Time. There is, however, a tendency to draw an unreal distinction between the former three dimensions and the latter, because it happens that our consciousness moves intermittently in one direction along the latter from the beginning to the end of our lives.'

*

'Now, it is very remarkable that this is so extensively overlooked,' continued the Time Traveller, with a slight accession of cheerfulness, 'Really this is what is meant by the Fourth Dimension, though some people who talk about the Fourth Dimension do not know they mean it. It is only another way of looking at Time. There is no difference between Time and any of the three dimensions of Space except that our consciousness moves along it. But some foolish people have got hold of the wrong side of that idea. You have all heard what they have to say about this Fourth Dimension?'

*

'Well, I do not mind telling you I have been at work upon this geometry of Four Dimensions for some time. Some of my results are curious. For instance, here is a portrait of a man at eight years old, another at fifteen, another at seventeen, another at twenty-three, and so on. All these evidently sections, as it were, Three-Dimensional representations of his Four-Dimensioned being, which is a fixed and unalterable thing.'

'Scientific people,' proceeded the Time Traveller, after the pause required for the proper assimilation of this, 'know very well that Time is only a kind of Space. Here is a popular scientific diagram, a weather record. This line I trace with my finger shows the movement of the barometer. Yesterday it was so high, yesterday night it fell, then this morning it rose again, and so gently upward to here. Surely the mercury did not trace this line in any of the dimensions of Space generally recognized? But certainly it traced such a line, and that line, therefore, we must conclude was along the Time-Dimension.'

'But,' said the Medical Man, staring hard at a coal in the fire, 'if Time is really only a fourth dimension of Space, why is it, and why has it always been, regarded as something different? And why cannot we move about in Time as we move about in the other dimensions of Space?'

The Time Traveller smiled. 'Are you so sure we can move freely in Space? Right and left we can go, backward and forward freely enough, and men always have done so. I admit we move freely in two dimensions. But how about up and down? Gravitation limits us there.'

'Not exactly,' said the Medical Man. 'There are balloons.'

'But before the balloons, save for spasmodic jumping and the inequalities of the surface, man had no freedom of vertical movement.'

'Still they could move a little up and down', said the Medical Man.

'Easier, far easier down than up.'

'And you cannot move at all in Time, you cannot get away from the present moment.'

'My dear sir, that is just where you are wrong. That is just where the whole world has gone wrong. We are always getting away from the present moment. Our mental existences, which are immaterial and have no dimensions, are passing along the Time-Dimension with a uniform velocity from the cradle to the grave. Just as we should travel down if we began our existence fifty miles above the earth's surface.' (1)

We can expect nothing but sophistry in the account by Well Time Traveller, for the author himself has said, particularly in discussing Dunne's work, that it was not to be taken seriously (2). Its literary purpose was to introduce a form of eye-witness prophecy into fiction, and this it did enormously successfully. Despite the apparent frivolity, however, there is for many people something very attractive in the view of time described by Wells.

Note first of all that the sections I have quoted proceed by analogy, albeit covertly so. We are invited to draw analogy between spatial

(1) The Time Machine, H.G. Wells, first published 1895.

(2) c.f. An Experiment With Time, J.W. Dunne, Faber & Faber, London, 1939, p. 211 (First Ed. 1927.).

cross-sections and a series of photographs as a temporal cross-section. Similarly we are invited to compare life to motion. Admittedly Wells' Traveller boldly asserts these analogies to be exact truths, but that must be regarded as artistic license. As the traveller tells it, the introduction of time travel is in five stages.

1. A discussion of four dimensional spatial geometry.
2. A proof that time is a dimension of the extension of bodies and therefore the fourth dimension of space.
3. A description of our consciousnesses as moving at various rates through time.
4. An assertion that this motion is constrained as a matter of physical law not of logical or conceptual necessity.
5. The production of a machine which, purportedly, travels in time.

Clearly enough nothing up to 4. prepares for 5. Wells can get away with a great deal because his approach is, as I have pointed out, that of disguised analogy, and one may accept much of the argument as a kind of extended metaphor. If we take him literally, as he invites, then we run into problems, for nowhere has an argument been given to justify material time travel, though the conclusion of 'mental' time travel is a possibility. We therefore have the choice of interpreting the argument as establishing only the possibility of the 'travel' through time of consciousness, or as really an argument about the possibility of bodily transport through time. In this latter case we get the 'time travel' argument as follows:

1. Time is a dimension of extension, and is therefore spatial.
2. Objects, especially people, do move through time.
3. This movement is constrained only by physical law.

Wells has relied, sophistically, on the normal identification of consciousness with a material body, namely a person. Of course this is not condemnation of Wells, for he is employing artistic license.

Note that the Wells' presentation of time travel does not require that the past be changeable, or rather is not intended to require this. The Time Traveller says, of a series of portraits of a man at different ages:

'All these are evidently, sections, as it were, Three-Dimensional representations of his Four-Dimensional being, which is a fixed and immutable thing.' (1)

This point is discussed further in the second chapter of The Time Machine where it is asserted that a machine which travelled into the past was in fact there at intermediate earlier times, even though it cannot be perceived at those times.

J.W. Dunne

Dunne is a curious writer who enjoyed some popularity in the thirties and forties. His books are a mixture of amateur science and philosophy with a flavour of the occult. Despite the eccentricity of his work it has its significance for the notion of time travel. Dunne's motivation is twofold: he wishes to provide a theory adequate to the (for him proven) facts of apparent precognition; and he wishes to characterise temporal motion.

Dunne's theory, which he calls 'Serialism' is developed primarily in two books An Experiment with Time and The Serial Universe. I shall only treat of these insofar as they are relevant to my topic.

Serialism asserts that the notions of time, of an observer and of reality all involve an infinite regress, and that such regress is not vicious. In An Experiment with Time Dunne begins by demonstrating the regress of time.

If, begins Dunne, we examine the ideas on time of the man in the street we find two implicit aspects: that time is a continuum of extensions; and that we and other things move through time.

'All the practical, everyday questions he asks himself regarding Time are questions embodying the assumptions that Time has length, that states of the physical world are positioned along that length, and that he experiences these events in succession' (2)

According to Dunne the idea of the succession of present moments implies the notion of the present, and this implies that time is a continuum. Moreover motion through time implies a further independent time which is the measure of this motion. Now Dunne asserts that the succession of present moments is essential to time. Thus his

(1) Chapter 1

(2) An Experiment with Time, pp 125-6

argument develops a regress. On the basis of this regress Dunne asserts three 'laws':

1. Every Time-travelling field of presentation is contained within a field one dimension larger, travelling in another dimension of Time, the larger field covering events which are "past" and "future" as well as "present", to the smaller field.
2. The serialism of the fields of presentation involves the existence of a serial observer. In this respect every time-travelling field is the field apparent to a similarly travelling and similarly dimensioned observer. Observation by any such observer is observation by all observers pertaining to the dimensionally larger fields.
3. The focus of attention in any field has the same number of dimensions as has that field, and is a dimensional centre of the foci of attention in all the higher fields. (1)

The peculiar temporal overview here suggested is evidently perfect for believers in reincarnation and 'planes of existence' and such like. It is to such people that Dunne's theory mainly appeals. Dunne's view also goes some way to explain such otherwise odd fiction as A.E. Van Vogt's Book of Ptath or M. Moorcock's The Eternal Champion where the idea of a person with multiple personalities who have temporally mixed up experiences is used, which is understood as meaning that reincarnations need not be temporally sequential.

Although Dunne's regress may be significant for an analysis of time, time travel as a form of reincarnation is not of itself philosophically interesting. However a further description of the basis of Dunne's work will be fruitful.

Dunne believes that there is empirical confirmation of his model of time, in the form of dreams of the future, premonitions and the like. Indeed he believes such dreams require his model of time, though there are independent and, he says purely logical, grounds for holding to it.

In The Serial Universe Dunne reinforces his temporal regress with an independent regress, that of the self conscious observer. This regress is generated by joining the ownership model of mental states with the reflexivity of consciousness. Thus, 'I am conscious of myself'

(1) op cit, pp 153-9

implies that there is some object, namely myself, which I am conscious of as owner, and am therefore distinct from. But since I am conscious of 'owning' myself, I am conscious of the owner of myself, and by the ownership model this cannot be me (or myself). And so on to infinity. Dunne is quite explicit in his belief that consciousness involves a form of ownership:

The only "self" that you could be aware of, in a rational world, would be something which was an object to the ultimate, real you. But your self consciousness does not lie merely in your being aware of such an object - it involves the recognition of the object as yours. (1)

Because of Dunne's method of presentation and his predilection for regresses, the self contradiction involved in this particular regress escaped him. For according to Dunne the regresses cannot be vicious because they are only 'mathematical', that is not real, whereas this regress implies an indefinite ontological multiplication of owners and owned, since owner must be a distinct object from owned. Nevertheless the germ of the idea of the moving present can be found in the ownership model of mental states. For if the owner is not to be identified with anything he owns (in this case, is conscious of), then he can exist independently of anything he owns (is conscious of). In the case of time it follows that the owner can exist at other times than what he owns (is conscious of). But this possibility apparently implies a form of mobility, wherefore the analysis of time in terms of motion. The structure of The Serial Universe suggests that Dunne is adopting such an approach there, but he does not do so explicitly. An Experiment with Time proceeds differently, and infers the independent existence of each member of the series from the temporal regress.

Dunne makes one further point of relevance. In considering time as a dimension of physical extension he says,

time order must change to space order at each stage of the infinite regress of real time. (2)

Thus, time is not only a continuum, but a spatial one. For Dunne the marks of spatial continuum are that its elements are:

(1) The Serial Universe, J.W. Dunne, Faber & Faber, London, 1942
(First Ed. 1934)

(2) *ibid*, p. 90

- '(1) Of the same class
- (2) Equally real
- (3) Parts of a continuum
- (4) Equally present
- (5) Associated with an independently existing thing which changes from one to the other' (1)

These criteria of a spatial continuum are classic ones much stressed by writers such as Bergson, but of no relevance to a mathematician, for whom space is distinguished by topological, ie structural features, not metaphysical ones.

J.W. Meiland

Meiland is representative of those proponents of time travel who picture it as involving a two dimensional structure for time rather than the assimilation of time to space as asserted by Wells and Dunne. Meiland's model for time is based on the assertion that the specification of a time demands not one but two coordinates which are independent in the mathematical sense (2).

The model is explicitly set up as

'a passage model of time, that is, a model which allows motion through time'. (3)

The principle which generates Meiland's model is that the past can change with time, that is, the past can be different at different times. Therefore, to specify the date of a past event one must specify which time it is past of. The intuition underlying this model is given by Meiland, who says

'...my theory embodies a significant part of our ordinary concept of the past. Far from being paradoxical, my theory is part of, or at least follows directly from, our ordinary views of time. Briefly put, my position is that the past itself is a continuant. Being a continuant, the past exists at different times and therefore can be different at one time from what it is at another time. And I claim that this view is a large part of our ordinary view of the past. We normally think of the past as a continuant, as existing at each of several times, as "there" to be talked about at successive moments.' (4)

Meiland does not claim that his model is the correct one, only that it could be, that it is self consistent and does not contradict the facts. In fact Meiland allows that any higher number of temporal

(1) op cit, p.90

(2) 'A Two-Dimensional Passage Model of Time for Time Travel'. J.W. Meiland Philosophical Studies 26 (1974) pp 153-173

(3) ibid p 153

(4) ibid, p 160 - Section 5 'The Past as a Continuant'

dimensions may be necessary. This approach to a multiplicity of time dimensions does not imply a regress as does Dunne's, but it does face the difficulty that there is no good reason why one should stop at any particular number of dimensions even though one can, by the device of asserting that the n -dimensional time is fixed and unchanging.

A two dimensional view as described is fundamentally different from that suggested for time by Wells or Dunne, even though Meiland presents it as a model of Wellsian time travel. This is because Wells and Dunne would consider it possible to travel over and over again over precisely the same stretch of time, just as if it were a stretch of road, which does not itself change. Meiland's view of time is more suited to those stories which postulate parallel universes, such as A.E. Van Vogt's Quest for the Future.

T.E. Wilkerson

Wilkerson, like Meiland, is concerned in his little paper 'Time and Time Again' to present a two dimensional model of time to cater for time travel of the sort Wells describes. (1) He differs from Meiland, however, in that he presents the model as a method of coordinating the otherwise incompatible histories of observers rather than by postulating a changeable past. This model grows out of the lessons of Relativity geometry.

He begins by hypothesising the true records of various observers' experiences. He finds that the differences between them cannot be accounted for by spatial considerations, but finds also that they can be systematically organised using two dimensions of time, in the same fashion that global positions are organised using latitude and longitude. The topology of events in this two-dimensional continuum is a matter for investigation, and can be inferred less or more accurately from the observers' records.

This paper is related to a long discussion in the journals which originated in a paper by A. Quinton called 'Spaces and Times' which argued, against a Kantian position, that we can quite coherently entertain the idea of ourselves existing at different times in spaces which are themselves spatially unrelated, and that consequently the unified nature of space is an empirical matter.

(1) 'Time and Time Again' T.E. Wilkerson, Philosophy, Vol 43 no 164, 1972

Quinton argued that we cannot similarly conceive of temporally unrelated times. It was out of this contention that most of the discussion arose, much of which rested on a confusion between the independence of temporal dimensions and the unrelatedness of times.

K. Gödel

Interestingly enough, support for the idea of time travel comes not only from speculation based on the idea of motion through time, but also from Relativity Theory. What form of support is implied will need to be made clear, but Gödel in an article called 'A Remark About the Relationship Between Relativity Theory and Idealistic Philosophy' cites the consistency of time travel with the relativity postulates in order to deny the objectivity of time. (1)

The essential postulate of Relativity Theory is that all observers are equivalent, or that the laws of nature are strictly universal, so that there is no privilege frame of reference. Under these circumstances it becomes an empirical matter whether the Newtonian world scheme is correct, and in particular whether it can be uniquely determined which events are simultaneous. Gödel is concerned to extend this indeterminacy, since there are, despite relativity theory, technical methods of choosing privileged observers, namely

'those which follow in their motion the mean motion of matter' (2)

Gödel shows that relativity theory calls into question not only the simultaneity of spatially separated events, but also the time order of temporally separated events. Einstein agrees with this, though unwilling to commit himself about idealistic philosophy. (3) Gödel, however, makes a rather stronger point, and asserts that in certain sorts of possible worlds one could bring about such indeterminacy.

Gödel bases his reasoning on certain solutions, which he calls metaphorically 'rotating universes', to the cosmological problem of general relativity. (4)

(1) In Albert Einstein: Philosopher-Scientist, ed. P.A.Schilpp, The Library of Living Philosophers, Evanston, Illinois, 1949 pp 557-62

(2) *ibid* p 559

(3) *ibid* p 687

(4) *ibid* p 560 footnote 10

I quote:

'There exist cosmological solutions of another kind than those known at present, to which the...[mean motion] procedure of defining an absolute time is not applicable, because the local times of the special observers...cannot be fitted together into one world time. Nor can any other procedure which would accomplish this purpose exist for them; ie, these worlds possess such qualities of symmetry, that for each possible concept of simultaneity and succession there exist others which cannot be distinguished from it by any intrinsic properties, but only by reference to individual objects, such as, e.g. a particular galactic system.

Consequently, the inference drawn...as to the non-objectivity of change doubtless applies at least in these worlds. Moreover it turns out that temporal conditions in these universes...show other surprising features, strengthening further the idealistic view point. Namely, by making a round trip on a rocket ship in a sufficiently wide curve, it is possible in these worlds to travel in to any region of the past, present and future, and back again, exactly as it is possible in other worlds to travel to distant parts of space.' (1)

Gödel is thus quite unequivocal about the sense of travelling into time; he goes on to calculate the amount of fuel needed for such a rocket ship.

What is the significance of our ability to coherently describe such a world? Is it merely a flight of mathematical fantasy? Gödel concludes:

'The mere compatibility with the laws of nature of worlds in which there is no distinguished absolute time, and therefore, no objective lapse of time can exist, throws some light on the meaning of time also in those worlds in which an absolute time can be defined. For, if someone asserts that this absolute time is lapsing, he accepts as a consequence that, whether or not an objective lapse of time exists (ie, whether or not a time in the ordinary sense exists), depends on the particular way in which matter and motion are arranged in the world.' (2)

A. Einstein

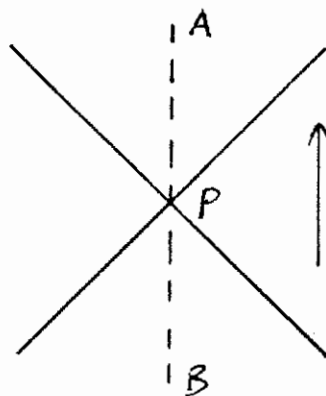
Einstein comments on Gödel's paper, putting the relationship between cause and temporal order succinctly. I reproduce his remarks in full:

'Kurt Gödel's essay constitutes, in my opinion, an important contribution to the general theory of relativity,

(1) op cit p 560

(2) op cit, p.562.

especially to the analysis of the concept of time. The problem here involved disturbed me already at the time of the building up of the general theory of relativity, without my having succeeded in clarifying it. Entirely aside from the relation of the theory of relativity to idealistic philosophy or to any philosophical formulation of questions, the problem presents itself as follows: If P is a world-point, a "light-cone" ($ds^2=0$) belongs to it. We draw a "time-like" world-line through P and on this line observe the close world-points B and A , separated by P . Does it make any sense to provide the world-line with an arrow, and to assert that B is before P , A after P ? Is what remains of temporal connection



between world-points in the theory of relativity an asymmetrical relation, or would one be just as much justified, from the physical point of view, to indicate the arrow in the opposite direction and to assert that A is before P , B after P ?

In the first instance the alternative is decided in the negative, if we are justified in saying: If it is possible to send (to telegraph) a signal (also passing by in the close proximity of P) from B to A , but not from A to B , then the one-sided (asymmetrical) character of time is secured, i.e., there exists no free choice for the direction of the arrow. What is essential in this is the fact that the sending of a signal is, in the sense of thermo-dynamics, an irreversible process, a process which is connected with the growth of entropy (whereas, according to our present knowledge, all elementary processes are reversible).

If, therefore, B and A are two, sufficiently neighboring, world-points, which can be connected by a time-like line, then the assertion: " B is before A ," makes physical sense. But does this assertion still make sense, if the points, which are connectable by the time-like line, are arbitrarily far separated from each other? Certainly not, if there exist point-series connectable by time-like lines in such a way that each point precedes temporally the preceding one, and if the series is closed in itself. In that case the distinction "earlier-later" is abandoned for world-points which lie far apart in a cosmological sense, and those paradoxes, regarding the direction of the causal connection, arise, of which Dr. Gödel has spoken.

Such cosmological solutions of the gravitation-equations (with not vanishing Λ -constant) have been found by Dr. Gödel. It will be interesting to weigh whether these are not to be excluded on physical grounds. ⁽¹⁾

(1) Albert Einstein: Philosopher Scientist, p 687-8

Clearly, then, the Gödel presentation of time travel depends intrinsically on the definition of time order in terms of causal order, where the cause of an event is not by definition earlier; that is, which events cause which can be decided independently on their time order. Thus the considerations which decide this question locally to some space-time point do not decide the temporal relations between causally more 'distant' events. In a chain of causes, 'later' and 'earlier' may only make sense for events nearby in the chain.

This same point is explored by H. Reichenbach, whom I will discuss much later.

What we have justification for here is not directly time travel, but for various apparent paradoxes such as circles in time. We learn from Einstein, then, that the paradoxes of cause which will be discussed later are due not to the notion of travel in time as such, but to certain 'geometries' of time which are specifiable without the notion of travel.

THE GROUNDS FOR TIME TRAVEL

I have not spent much space on the various arguments for time travel, for I think that in the long run their detail is not very important, and certainly for the purposes of my investigation of the epistemological grounds for time travel they are not important. I hope that I have nevertheless given a fair and representative selection of the kind of arguments that are used.

The primary argument is that of Wells, that the passage of time is a form of constrained motion, and that the constraint is a matter of alterable fact, not necessity. Apart from this argument which, as we will discuss later, has fatal flaws, there are two other primary types; of the Gödelian kind which introduce time travel as a feature of the structure of space-time; and of Meiland's kind, closely related to those of Dunne's, which introduce time travel via the human temporal perspective. Now none of these arguments for time travel consider the consequences of it, and the most immediate objections to time travel are based on its consequences.

The objections to time travel, then, take the form that any world in which time travel is possible, must be self contradictory. As a result most of the effort of supporters of time travel have been devoted to showing that there is a conceivable world in which time travel is possible. The most powerful evidence that this is in fact so is Gödel's relativistic model of space-time, for it uses an accepted means of describing possible worlds. But even such a well-founded argument as Gödel's is subject to the accusations of self-contradiction on grounds of causal paradox, as will emerge in the following pages.

Again, I have only reported arguments against time travel in summary, for I do not believe that objections to time travel other than those of a causal nature need cause the least pause to a proponent of time travel, though certain elementary confusions need to be sorted out. Before investigating this matter, let me present some representative objections to time travel.

THE ARGUMENTS AGAINST

D.C. Williams

Williams, in an article called 'The Myth of Passage', argues for a 'manifold' picture of the universe, that is that the universe is a four dimensional continuum and nothing more. He argues incidentally that time travel is impossible. (1)

The article is called 'The Myth of Passage' because it explicitly denies that there is any sense to the passage of time over and above the ordered extension of events. In relation to time travel he says:

The doctrine of the moving present has some startling applications, notably in the idea of a time machine. The theory of the four dimensional manifold seemed already an invitation to the notion of time travel, and the additional idea that we move with respect to time confirms it. For if I normally voyage through time at a fixed rate, I can hope to make a machine which will enable me to voyage slower or faster or backwards. (2)

(1) 'The Myth of Passage', D.C. Williams, The Journal of Philosophy, Vol. XLVIII, No. 15, 1951, pp457-72. (Reprinted revised in The Philosophy of Time, Richard Gale)

(2) Ibid p.462

Thus Williams introduces time travel in exactly the same fashion as Wells. He then criticises the idea of passage, saying in essence:

Time 'flows' only in the sense in which a line flows or a landscape 'recedes into the west'. That is, it is an ordered extension. And each of us proceeds through time only as a fence proceeds across a farm: that is, parts of our being, and the fences, occupy successive instants and points, respectively. There is passage, but it is nothing extra. It is the mere happening of things, their strung-along-ness in the manifold. (1)

On the basis of this he criticises time travel, saying:

Time travel, then, is analysable either as the banality that at each different moment we occupy a different moment from the one we occupied before, or the contradiction that at each different moment we occupy a different moment from the one which we are then occupying - that five minutes from now, for example, I may be a hundred years from now. (2)

Having thus objected to the idea of travel in time, Williams constructs the regress of times constructed by Dunne, and then continues:

We hardly needed to point out the unhappy regress to which the idea of time's motion commits us, for any candid philosopher, as soon as he looks hard at the idea, must see that it is preposterous. 'Taking place' is not a formality to which an event incidentally submits - it is the events very being. World history consists of actual concrete happenings in a temporal sequence; it is not at all necessary or possible that happening should happen to them all over again. The system of the manifold is thus 'complete' in something like the technical logical sense, and any attempted addition to it is bound to be either contradictory or supererogatory. (3)

I do not believe that Williams' objections to the concept of temporal passage are as damaging as he believes to the concept of time travel, but more of that later. Here I note merely that Williams makes it quite clear that exposition of time travel in the style of Wells depends on adopting the continuum and passage models of time together, for only under those circumstances can passage be plausibly interpreted as literally motion.

Strangely, after soundly berating the idea of time travel and apparently banishing it, Williams ushers it back in, using the same rationale as that of Gödel, picturing it as a structural feature of the space-time manifold. He says, when discussing what such structural features might be that they are minimal, so much so that,

(1) op cit p.463

(2) op cit p. 463

(3) op cit p. 464

It is...conceivable, though doubtlessly physically impossible, that one four-dimensional area of the manifold be slewed around at right angles to the rest, so that the time order of that area, as composed by its interior lines of strain and structure, runs parallel with a spatial order in its environment.(1)

As a consequence, a man might live his life backwards:

We might...conceive a reversal of every cell twitch and electron whirl, and hence suppose that he experienced his own life stages in the same order as we do ours, but that he observed every one around him, moving backward from the cradle to the grave. (2)

H.G. Wells would have been delighted. The Wellsonian metaphysical foundation is gone, but Williams substitute is equally good for Wells' objects. The manner of this is taken up in Lewis' defence of time travel.

J. Harrison

'Dr. Who and the Philosophers' is an intriguing exploration of the ramifications of time travel. (3) It is subtitled 'Time Travel for Beginners', and that sums up its content very well. Harrison introduces the idea in the fashion of Wells, then mentions the prima facie objections to it and discusses the manner in which proponents of time travel might answer these.

The main difficulty Harrison has with time travel is that it seems to imply that propositions about the past can change in truth value. His example of time travel is of entering a machine, pulling levers, waiting two minutes by his watch, then stepping out into what appears to be the England of the Great Exhibition of 1851, according to all the information he gathers. He says:

All of this, of course, is possible - in the minimal sense that its description is not contradictory- and it can quite easily be depicted on the screen. But should this happen to me, am I compelled to believe that I now find myself actually transported to the reign of Queen Victoria? There are a number of very compelling reasons why I should not believe this.(4)

He goes on:

(1) op cit p.468

(2) op cit p.469

(3) 'Dr. Who and the Philosophers, or, Time-Travel for Beginners', J. Harrison, The Aristotelian Society, Supp. Vol. XLV, 1971, p.1

(4) *ibid* pp 1-2.

For one thing, I can argue as follows. I am as certain as I can be of anything that I was not alive in 1851, and did not witness any events that took place at that time. Hence the events that I am witnessing, whatever they may be, are not the events of 1851.

It is worth noticing that an analogous argument will not apply to ordinary travel. Where this is concerned, one cannot argue that because up to now I have never been to the top of Mount Everest, this place at which I find myself cannot be the top of Mount Everest. It may be true up to the time of completing my journey thither, but subsequently false, that I have never been to top of Mount Everest, it cannot be true up to the time of my ostensible journey into time that I did not visit the Great Exhibition of 1851, but after this time true that I did visit it. (1)

Thus Harrison is making two related assertions: that the past cannot change (equivalently, that propositions about the past cannot change in truth value); and that in consequence there is an important disanalogy between time and space travel. He discusses further difficulties in his paper concerning memory, route, velocity and scenery, backward causation and personal identity.

Harrison rightly does not conclude that time travel is altogether impossible. He concludes rather that since the past cannot change it will always be true that at least up to say 1971 no time travel occurred, but it may nevertheless be that time travel will occur, although it would never be to any year earlier than 1972. That is, he makes it a condition of time travel that if someone will have visited some event which is now past, he has already done so. Though Harrison does not draw the conclusion, it is implicit that time travel cannot be voluntary, since its results have to be foregone.

R.A. Heinlein

Two stories by Heinlein, both excellent yarns, illustrate some of the paradoxes of time travel. These stories, 'By His Bootstraps' and 'All You Zombies', depict graphically the circles of cause that arise. In these stories Heinlein makes devastating use of the causal paradox where events turn out to be their own causes. (2) I shall only describe

(1) op cit pp 1-2

(2) 'By His Bootstraps' first appeared in Astounding Science Fiction 1941, under the pseudonym 'Anson MacDonald', reprinted in The Astounding-Analog Reader, Ed. H. Harrison and B.W. Aldiss, Sphere Books Ltd. 1973.

'By His Bootstraps', for it makes Heinlein's point sufficiently well. The story begins with a man who 'accidentally' goes through a 'gate' in time, ending up 30,000 years later, where after many adventures including existing in four places at one, he sets up the 'gate', and the 'accident' occurs accidentally. Thus the only reason for his time travel is, ultimately, that he does.

Heinlein is poking fun at a particular attitude to time travel and other such speculations. He has his hero writing:

...(it is not) valid to assume that a conceivable proposition is necessarily a possible proposition, even when it is possible to formulate mathematics which describes the proposition with exactness. A case in point is the concept 'Time Travel'. Time travel may be formulated under any and all theories of time, formulae which resolve the paradoxes of each theory. Nevertheless, we know certain things about the empirical nature of time which preclude the possibility of the conceivable proposition...

A moment later the time traveller appears. Heinlein's story is an extended joke, as was Wells'. It makes fun both of the attitude quoted and also of time travel, the former because the story shows that time travel, however weird on the larger scale need not contradict what is known empirically about time on the individual scale, and the latter because it shows that the difficulties with time travel are conceptual ones.

The story ends with the hero in a paradoxical situation. He has set the time 'gate' and his 'earlier' self has just fallen through, to his surprise, and he realises that all the characters in the story are himself. Heinlein writes:

...he had work to do, work which must be done meticulously, without mistake. Everyone, he thought with a wry smile, makes plans to provide for their future.

He was about to provide for his past.

And a little later:

...Wilson knew that the time had come when he must insure his past. He was not worried; he felt the sure confidence of the gambler who is 'hot', who knows what the next roll of the dice will show.

There are various paradoxes, subsidiary to the story, such as a phrase book from which Wilson learns the future language and which is never compiled but only copied. Heinlein comments:

Who wrote the notebook? Who started the chain?
He felt the intellectual desperation of any honest philosopher.

None of the paradoxes of circularity that Heinlein uses are logical ones. There is no contradiction involved except if a certain view of time is logically necessary. Nevertheless the difficulty is a conceptual one.

A further paradox is that none of the events of the story, except the original 'accident' happen by anything other than free will. Heinlein has Wilson thinking:

Free will was another matter. It could not be laughed off, because it could be directly experienced - yet his own free will had worked to create the same scene over and over again. Apparently human will must be considered as one of the factors which make up the processes in the continuum - 'free' to the ego, mechanistic from the outside.

The basis of the theory which Wilson develops to account for time travel goes as follows:

By sheer necessity he was forced to expand the principle of non-identity - 'Nothing is identical within anything else, not even with itself' - to include the ego. In a four-dimensional continuum each event is an absolute individual, it has its space co-ordinates and its date. The Bob Wilson he was right now was not the Bob Wilson he had been ten minutes ago. Each was a discrete section of a four-dimensional process. One resembled the other in many particulars, as one slice of bread resembles the slice next to it. But they were not the same Bob Wilson - they differed by a length of time.

When he had doubled back on himself, the difference had become apparent, for the separation was now in space rather than time, and he happened to be so equipped as to be able to see a space length, whereas he could only remember a time difference.

In order to give a mental picture of time travel Heinlein has Wilson use the idea of n-dimensional space which is a mathematical generalisation from 3-space.

The lesson we learn from Heinlein's tale is that there is a large gap between good story telling and empirical possibility. Though it may well be true that conceptual, and mathematical, models can be constructed which cater for time travel, this is not enough to enable us to conclude its possibility, and the reasons are not empirical, nor strictly logical, but rather to do with general presuppositions of

human thought. Thus it is difficult to say how a phrasebook which is only copied but never compiled is impossible, or why one cannot provide for one's past, when one regards these things as physical events, and independent of human knowledge. The story thus shows how time travel creates epistemological paradoxes.

Though the paradox of the phrasebook is only a subsidiary one in the story, it is in fact more important if less spectacular than the major paradoxes, for it epitomises the possibility time travel allows of the continual transmission of human knowledge, without that knowledge ever having been gained or worked out in any way, and without it being innate. The phrasebook represents knowledge that ought to have been painfully worked out by somebody, but never was, it was only ever copied. Time travel rocks not only our conception of the external world, but the theory of the gaining of knowledge, that is, epistemology.

C.D. Broad

Broad takes issue with J.W. Dunne's An Experiment with Time.⁽¹⁾ He allows that beginning with the movement of the present through a continuum does generate a regress, but he asserts against Dunne that either the regress need not begin or it is vicious.

Broad explains admirably the suggestion by Hinton⁽²⁾, which motivated Dunne, to the effect that all motion can be reduced to the movement of the space of the present moment along a fourth dimension of space, traversing material threads in this dimension which intersect the space of the present in a point.

This model of the universe is the one which D.C. Williams attacks.⁽³⁾ Dunne claims that it is necessary to adopt it, and also the regress of times, on the grounds that otherwise we have no characterisation of succession. There are two propositions involved

(1) Mr. Dunne's Theory of Time, C.D. Broad, Philosophy Vol X, 1935, pp168-85

(2) The Fourth Dimension, Hinton

(3) The Myth of Passage, D.C. Williams.

in this,

1. That extension in time is equivalent to extension in space.
2. That succession of times requires motion through time.

Broad points out that there is no logical compulsion to these. Certainly Dunne gives no logically compelling reason to believe them. 'The Serial Universe', as Broad notes, makes the regress that of McTaggart, which certainly is vicious.

A related point Broad makes is that the regress of observers is vicious, for if there is to be an observer at any stage, that is in virtue of there being observers at all later stages, and thus there can be no ultimate observer and action cannot begin.

G.J. Whitrow

Whitrow, in his book 'The Natural Philosophy of Time', defends the passage of time as a viable and necessary interpretation of the mathematical physical sciences. In relation to time travel he criticises Gödel. He says:

Gödel's highly original work was immediately welcomed by Einstein as an important contribution to the General Theory of Relativity and to the analysis of the concept of time. On the other hand, at the Relativity Conference at Bern in 1955, H.P. Robertson argued that it would be a defect in the field equations of General Relativity if they allowed solutions to the cosmological problem in which the whole universe has an intrinsic absolute rotation, but he admitted that there seemed to be no argument by which these solutions could be excluded a priori. Nevertheless the possibility that closed time-paths could be described in these models does seem to be a serious objection, despite Gödel's belief that their realisation is likely to remain forever beyond the abilities of our rocket engineers. For the theoretical objection to the possibility of their existence is unaffected by this argument.(1)

This theoretical objection is that if there be closed timeline paths then it becomes possible to bring about a contradictory past state of affairs. This objection is quite independent of relativity theory and the natural sciences, although Whitrow obscures this point.

(1) The Natural Philosophy of Time, G.J. Whitrow, Thomas Nelson & Sons Ltd. London, 1961, p.260.

The special objection to Gödel's model which is countenanced by cosmological theory is that it offends against the principle of isotropy, which states that the universe shows the same features in all directions. However the principle of isotropy, however desirable, is far from inviolate.

We are left with the objection being a logical one. Closed time-like paths, or equivalently, closed causal chains, are impossible, Whitrow asserts, on general logical grounds.

Whitrow is committed to maintaining this, for if it is not true, and Gödel's model is logically tenable, then the existence of an absolute objective time order is an empirical and suprising fact about the world, and no sense can be attached to the passage of time except relative to an observer.

I. Asimov

The adventure story The End of Eternity adds one difficulty to a theory of time travel, for it shows that the causal paradoxes cannot be avoided simply by introducing a second dimension of time, as Meiland does, in order to make sense of time changing with respect to time.(1)

Asimov calls his second temporal dimension 'physiotime', and relative to this dimension it is possible to travel anywhere in ordinary or 'real' time. The four dimensional manifold of space and realtime Asimov calls Reality. Reality changes from physiotime to physiotime due to the interference of men who live by physiotime. That is, Reality is regarded as analogous to an ordinary spatial object which endures through realtime and can be changed. Note that Meiland is committed to a similar view when he regards the past as a continuant.

The paradox that Asimov presents concerns the original discovery of and entry into physiotime. The event of entry is an event

(1) The End of Eternity, Isaac Asimov, Panther Books, London, 1959.

both in real time and in physiotime, and therefore an event in physiotime is caused by an event in real time, namely its discovery. But this event, is, by hypothesis, open to change, and therefore the causal paradoxes recur.

The paradoxes arise directly from an application of the law of the indiscernability of identicals, that is, in usual symbols, $(Fa, a=b) \rightarrow Fb$. To see how the paradox arises, denote physiotime by T and realtime by t . Now by hypothesis t -events are T -objects, thus the law of the indiscernability of identicals holds for t -events. Since Reality endures in T we have, for an unchanging Reality, that the t -event that 'occurred', that is existed, at T_0 is the t -event that 'occurred' at T_1 . This is a statement of the identity of two T objects. If we then assume that the t -event that 'occurred' at T_0 is the cause of a T -event that occurred at T_0 , by substitution we have directly that the t -event that occurred at T_1 is the cause of the T -event that occurred at T_0 . Thus the inhabitants of T can, by altering T objects, alter the causal antecedents of past T -events.

The conclusion that is to be drawn, is, presumably, that either one must surrender the possibility of causal connection between t -events and T -events, in which it could never be possible for us to time travel even though such a divine dimension such as physiotime might exist, or one must deny that t -events are T objects.

It would seem, though this paradox is not mentioned by Asimov, that it is the possibility of time travel that must go. For suppose that entry into physiotime is possible. Then if precisely similar t -conditions should ever recur in physiotime, another precisely similar entry will occur. Therefore, since T -subsequent t -conditions must be closely similar to the T -original t -conditions if there is to be anything analogous to time travel, a closely similar entry must recur infinitely often by T time. That is, if the causal connection is allowed between the two times, the reduplication in T time of t -events implies the reduplication of T -events. It follows that such a connection disallows any conception of physiotime as analogous to ordinary time.

Finally, I note that Asimov like Heinlein introduces epistemological paradoxes, most spectacularly in the form that knowledge of how to time travel was never discovered or worked out, but only transmitted by teaching. In this case the knowledge that is transmitted is of the means of time travel itself, so that knowledge of time travel is never invented or discovered, only passed on. This knowledge turns out in the story to have been planted in the past.

Again this epistemological paradox plays a minor part in the story and again it is the most difficult.

THE CASE AGAINST TIME TRAVEL

As we have seen from the last section, the results of time travel can be most peculiar. What is more, if we accept that no account of any possible world can be logically self-contradictory, then this places definite restrictions on what time-travel can be like. But must we therefore conclude that any form of time travel is of necessity impossible? It does not seem so, as the next section will show.

There are, however, other problems with time travel. These are problems that arise not from logical contradictions but from causal circles, that is chains of events in which each event is its own at least partial cause, and which are therefore, paradoxically, events which cause themselves, and are therefore, so far as the ordinary world is concerned, not caused at all. The apparent paradoxicality of such events can be lessened by recollecting that divine miracles, which are caused events, are nevertheless so far as we are concerned uncaused, they have no prior causes. Again, if some theories of human action are correct, some events, namely free actions, are caused but have no prior causes, and are therefore, in the same sense as events in causal circles, uncaused. Such recollections do not remove the paradox entirely, however, for miracles and free acts do have causes, albeit not efficient ones, whereas events in causal circles have only efficient causes, though not only prior causes. More serious, however, are the variants on the causal paradox which have epistemological consequences, consequences for the nature of human knowledge and learning. For if time travel is allowed,

things which seem to be necessarily results of human learning, such as books and theories of time, turn out not to be so. Something seems to have gone drastically wrong, but it is not so easy to say what.

Enough of this for the moment. It is time to present an excellent example of how time travel can be defended against its critics. I shall present only the one, as it seems to me to be both the best and representative.

A PARADIGM DEFENCE OF TIME TRAVEL.

D. Lewis

The paper 'The Paradoxes of Time Travel' serves as a useful paradigm defence of time travel against its critics.(1) In it Lewis shows how time travel can be built in to the manifold or 'block' universe. The paper has three stages; it presents the world view within which time travel is defended, the criteria for asserting that time travel has occurred, and a method for dealing with the causal anomalies.

The best way of showing Lewis' world view, which is that of D.C. Williams, is to quote:

The world - the time traveler's world, or ours - is a four dimensional manifold of events. Time is one dimension of the four, like the spatial dimensions except that the prevailing laws of nature discriminate between time and the others - or rather, perhaps, between various timelike dimensions and various spacelike dimensions. (Time remains one-dimensional, since no two timelike dimensions are orthogonal.) Enduring things are timelike streaks: wholes composed of temporal parts, or stages, located at various times and places. Change is qualitative difference between different stages - different temporal parts - of some enduring thing, just as a 'Change' in scenery from east to west is a qualitative difference between the eastern and western spatial parts of the landscape. (2)

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If change is qualitative difference between temporal parts of something, then what doesn't have temporal parts can't change.(3)

(1) David Lewis, The Paradoxes of Time Travel, American Philosophical Quarterly, Vol.13, No.2.

(2) *ibid* p.145-6

(3) *ibid* p. 146.

Lewis rejects the multidimensional approach to time taken by others such as Meiland, and instead distinguishes external, or world, time and personal time. He says:

...we need a functional definition of personal time: it is that which occupies a certain role in the pattern of events that comprise the time traveler's life.(1)

An individual's personal time is thus the string of events from his birth to his death. Lewis adds two qualifications to this: firstly, the individual's properties must change continuously through the string (that is, no sudden jumps or discontinuities; by Lewis' definition of change this amounts to saying that neighbouring events in the string must be closely similar); and secondly, this string of events forms a causal series. The reason for these additions is that without continuity there is no reason to assert time travel, and without causal connection there is no way to distinguish time travel from the fortuitous similarity of two different individuals.

From this definition of personal time we obtain the criterion for asserting that time travel has occurred; that the continuous causally connected series of events comprising some individual's life, and defining his personal time, be incommensurable with external (that is, ordinary time). The substance of this criterion, despite the dressing up in terms of personal time that Lewis gives it, is that, as measured by external time, that is by ordinary time, there are events related by cause where the effect precedes the cause, and the cause involved is an efficient one, in the Aristotelean sense.

A / Clearly the notion of cause with which Lewis is working cannot have the usual temporal direction of it built in; Lewis uses an analysis of cause in terms of counterfactual dependence, but does not depend on it in this paper, all that is required here is that the notion used be temporally neutral.

After introducing time travel in this fashion, Lewis attempts to deal with the causal problems. The circles of cause, where each event in the chain has a cause but the whole circle is inexplicable, Lewis

(1) op cit p.146

deals with quite peremptorily. He says of the case where the knowledge of time travel is only transmitted and never originated:

But where did the information come from in the first place? Why did the whole affair happen? There is simply no answer. The parts of the loop are explicable, the whole is not. Strange! But not impossible, and not too different from inexplicabilities we are already inured to. Almost everyone agrees that God, or the Big Bang, or the entire infinite past of the universe, or the decay of a tritium atom, is uncaused and inexplicable. Then if these are possible, why not also the inexplicable causal loops that arise in time travel? (1)

This response, attractive as it is to one who likes the idea of time travel, is nevertheless quite unsatisfactory. Firstly, what are the grounds for supposing the circles to be possible? Certainly, when the temporal order normally associated with cause is dropped it becomes unclear how to formulate the impossibility of such circles, but does a *prima facie* coherent description imply the possibility of what is described? Not necessarily. More is needed. Unfortunately the appeal to so-called uncaused events does not supply what is needed. For conventionally: God is his own cause; the Big Bang was caused; it is either a category mistake to ask for the cause of the entire infinite past of the universe or God caused it; and the decay of the tritium atom is caused, though there are quantum limits to the possibility of describing the process of decay.

There is indeed a genuine problem about causal circles, especially in formational ones, which cannot be dismissed as a mere oddity. For the sources of human knowledge are generally thought to be wisdom gained from experience, and, perhaps, revelation, but in the time travel story the knowledge of time travel is neither inferred at something from experience nor revealed - it is only taught. Is it possible that human knowledge should have no origin? Lewis does not discuss this point at all.

Despite his inadequacy on causal circles, Lewis does deal satisfactorily with the more common objection, that time travel implies that we cannot do what we evidently can do. Lewis uses as an example Tim, who travels back to 1921 to kill his Grandfather, who was then alive. 'It is logically impossible that Tim should change the past by killing Grandfather in 1921. So Tim cannot kill Grandfather.(2)

(1) op cit p.149

(2) op cit, p.150

Lewis makes two points concerning this, after granting that it is true in a way. Firstly, the sense in which Tim would change the past is exactly the sense in which we normally act to change the future, namely from what it might be going to be to what it is going to be. Secondly, the logical impossibility of Tim's action does not imply that he is unable to do it, merely that he does not; in other words, 'can' is ambivalent. What is logically impossible is the conjunction of 'Tom killed Grandfather in 1921' and 'Grandfather did not die in 1921'. It does not follow that 'Tom killed Grandfather in 1921' is logically impossible. A similar point holds about the future. It may well be inevitable that I die before I reach 100, it does not follow that it is logically impossible for me to live for a thousand years, or that I am unable to - I simply won't. (1)

CONCLUSION

A result of our brief survey of the literature on time travel is that it is much harder than one might have thought either to prove or disprove its possibility. Despite the simple origins of both the case for and the criticism of time travel, the argumentation becomes extremely complex, as both sides retreat to finer and finer points. That this familiar pattern should emerge for time travel is somewhat surprising, for time travel is hardly an idea with an impeccable metaphysical pedigree. It is, in its original conception, a mongrel, which despite all the obvious defects of its birth has shown a remarkable ability to survive. What, then, is there to the idea, and what importance is it in the aristocracy of metaphysics? The key to an answer I think is to be found not in weighty matters of metaphysics, but in epistemology. But that is the subject of this thesis.

In the introduction to this chapter I stressed that time travel is, in essence, a concept introduced by analogy. As a result, it is a fluid notion without precise definition, a condition which goes some way to explaining its ability to survive. More importantly, the analogical nature of the idea means that it has certain key features upon

(1) Similar points are made by other authors, for example, P. Horwich, 'On Some Alleged Paradoxes of Time Travel', Journal of Philosophy Vol LXXII, No.13, 1975.

which it ultimately rests, while much else can be discarded. When an analogy is made it may well not be clear just how far it can be taken; such precision is not in the nature of analogical conjecture. Consequently, to come to an understanding of the fundamentals of the idea of time travel, we must first investigate the nature of the analogy, and its limits.

An important facet of this investigation is the move and countermove in the offense against and defence of time travel, for out of this debate comes a clearer understanding of those features of the world from which the analogy is drawn. Ultimately, I believe, the causal paradoxes are the most important in this respect, and they certainly must be dealt with. The investigation of the analogical nature of time travel and the relevance of the causal paradoxes will be the subject matter of the next chapter.

Many issues that have been casually raised in this first chapter briefly surveying the literature will not be raised again, or if they are, only peripherally or incidentally. That is because I believe that they are only incidental. The next chapter is designed to demonstrate that belief. I hope that out of it the important issues will emerge.

We must not forget however that the overt foundations of the concept of time travel are metaphysical. Godel argues for the possibility of time travel on grounds drawn from modern cosmology, and aims to support the idealistic thesis that time is unreal. Wells argues for it from the accepted Newtonian wisdom of his day, essentially in order to provide a pseudo-scientific support for prophesy. Dunne argues for it from similar grounds in order to provide a genuinely scientific support for precognition. Heiland aims to correct the Wellsian argument to accomodate the partial discrediting of the Newtonian view of time. Even those who are supposedly enemies of time travel, such as Williams, in fact allow it. It seems that there can be many metaphysical supports for time travel. The further investigation of this matter is subject matter for chapter three.

CHAPTER TWO
TIME TRAVEL AND ANALOGY

As I have foreshadowed, the aim of this chapter is to give as positive a description of time travel as is possible. The most humble description we can give if we wish to defend time travel is that there are, or at least could be, phenomena which by analogy with ordinary travel in space we would wish to call travel in time. We could jump to all kinds of conclusions from this, but we would have no immediate justification in doing so, for as yet we have said precious little. First of all we must explore the nature of the analogy, and the limits we must put upon it.

In the use of analogy as a literary or as a propaedeutic device, analogy is, in the nature of the enterprise excused from the normal requirements of philosophical discourse, which are that an idea be clearly defined, rigorously consistent, and accurately placed in the relevant sphere of discourse. The drawing of an analogy is intended to highlight certain features of a concept, a group of concepts, or an area of discourse and is used for its psychological effect through the purposeful association of ideas. Evidently considerations of philosophical rigour go by the board in these cases, and the analogy cannot be pressed as if it had such rigour.

The use of analogy in relation to time travel, however, is of quite a different sort. Here a concept, that of travel, is being extended by the use of an analogy between the structure of time and that of space. This analogy, if, as it is intended to be it is to be capable of extending a concept, and not just illuminating conceptual structures as does a literary or propaedeutic analogy, must be a rigorous one.

Someone might say, carpingly, that if an analogy has this

rigour it ceases to be an analogy at all, in the ordinary sense of the word which excuses lack of rigour. There are, however, excellent reasons for insisting that such a concept-extending analogy is a genuine analogy. Firstly, and most importantly, the concept-extending analogy shares a paramount feature with ordinary analogies - in neither case are the two terms of the analogy asserted to be identical. Identity may perhaps be concluded from study of an analogy, as Wells, for example, or Williams or Quine conclude that time is a dimension of space, but the original analogy does not assert this, it only draws attention to a structural similarity. Secondly, when a concept is extended by use of an analogy, many features of the original concept may drop out. This happens, for example, when we try to extend the use of the concept of intelligence beyond the human sphere, trying to apply it to other animals or guessing about possible extraterrestrials. Thus an analogy may draw attention to the wider applicability of a generalised or more abstract form of the concept. This form of generalisation is the usual form of extension of a concept, and has the result, as does the drawing of an analogy, that a certain lack of rigour as to the original concepts is permissible, since many aspects of these concepts are irrelevant. Thus we have yet a third similarity between our concept extending and ordinary analogies. Consequently I believe that we are correct in calling these first analogies.

The sort of analogy involved in the postulation of time travel must, then, be rigorously demonstrated. This is the concern of the first part of this chapter. Of course what appeared to be one analogy will as is usual in such cases multiply into several possibilities which are quite distinct although related in definite ways. The natural place of these various interpretations in various dominant metaphysical systems will occupy the remainder of the chapter.

THE GROUNDWORK FOR THE ANALOGY

As we have seen, time travel was introduced by Wells explicitly by analogy with ordinary travel in space. It was Wells who invented the idea of time travel, using the technique of an identification of time as a dimension of space. This was a trick, for the support for this identification was ultimately in analogies. As the passages I quoted in the last chapter show, these analogies were basically three, which I shall list:

1. Time is compared to spatial dimension
2. Temporal persistence is compared to spatial extension
3. The passage of time is compared to spatial motion (1)

These three comparisons are introduced as a sort of conceptual justification for time travel, but to what extent are they necessary? Kurt Gödel's version of time travel eliminates the need for the third, although General Relativity on which it is based, appears to accept the first two. But then the sort of time travel involved in Heinlein's story seems to dispense with all the three, for the hero there simply steps through a sort of doorway which opens on a distant time.

In order to discover just what analogy or analogies are being drawn we need to consider the elements involved in the postulation of time travel. As I said at the beginning of this chapter, the minimum we can say here is that there are, or at least could be, phenomena which by analogy with ordinary travel in space we would wish to call time travel. The conception of time travel is not quite as bald as this however, and goes more along the lines that there could be a machine of some sort or other which one enters, sets in motion and then leaves after a length of time, at which time one finds oneself in the past (or distant future). This popular

(1) pp 2-3. The three analogies are intertwined in this quote.

presentation can be pared down somewhat for philosophically speaking the machine is quite unnecessary even though conventionally it provides the magical element necessary for that suspension of disbelief which allows a story to proceed. Once the machine is eliminated (it can equally be eliminated, conceptually, from Gödel's time travel) it becomes clear that time travel is popularly considered to be analogous to any form of ordinary travel, such as walking somewhere, but has the consequence of arriving at a time rather than at a place.

Relating this description of time travel to the minimal one, which was the claim that there are, or at least could be phenomena which by analogy with spatial travel we would wish to call time travel, we can see that there need be no definite claim as to what features of ordinary travel are to be preserved in time travel. ~~the~~ the claim is only that whatever these may be they are sufficient to render the name 'time travel' appropriate. But to make any decisions about this matter, we must first of all be clear what constitutes ordinary travel. So let us briefly outline the constellation of ideas surrounding travel.

Travelling is, I must emphasize, a human activity, a controlled and deliberate one, and is therefore to be distinguished from simple motion or change of location. Such a distinction is necessary since the modern scientific revolution made continuous motion natural to the world by denying that something which moved required a force to keep it moving. Previously the doctrine of the Aristotelian tradition that all motion required something which could move itself had rendered motion a subordinate form of travel. It was, for example, conjectured, that a thrown stone was pulled through the air by a vortex created by the act of throwing it. (1) Since all motion was understood to be originated by and maintained by something which had the power to move itself, it was natural to construe all

(1) c.f. The Sleepwalkers, Arthur Koestler

motion on the example of the human power to move. Such a construal ignored many plain facts, such as inertia, which is the tendency of things to keep moving, the actual shape of trajectories, the forces obvious in the collision of inert bodies, and so on, but it had the result of explaining motion in terms of purpose because when a man moves he does so in order to do something, or in order to get somewhere. Consequently, when the Aristotelian characterisation of motion was finally discredited by the new mechanics and cosmology in the Newtonian synthesis, it was equally natural for purpose to be discounted in explanations of motions of any sort. The modern temper, which acknowledges efficient, that is prior causes as the explanation of physical motion (which is, paradigmatically the motion of inert bodies) tends to explain human motion in similar terms, ignoring purpose. The result is unfortunate for my purposes, because the different paradigms of motion lead to different characterisations of the central features of motion, and it is these which must guide the drawing of any analogy from travel. In order to deal with this difficulty I separate the idea of travel from that of motion, attributing explanation by purpose to the former but not to the latter. This separation is proper I think, because travel is familiarly a human activity.

The conditions governing motion are well known, the primary one being that if an object moves from A to B then it moves through every point on some route between A and B. Further, if any point is marginally farther on the route to B than another, then it is reached marginally later in time than that other point. Motion is, in summary, spatio-temporally continuous. Other important conditions are, for example, those of impenetrability and causal interaction. The first of these is the requirement that if a thing moves, it displaces whatever is in its way, it does not go through them, in other words, objects which can move are impenetrable. The second condition, that of causal interaction, is that an object is part of the environment through which it passes, and so subject to all

the influences of that region as well as having influences upon that region.

To turn now to the idea of travel as a human activity, one point is paramount. If a person travels from A to B, then his purpose is to get to B. There are many apparent counter examples to this, but one should suffice to explain how they are dealt with. Imagine that a plane is hijacked to Algiers from Rome. The passengers it would seem, have then travelled from Rome to Algiers although they did not intend to, contradicting the thesis that travel is always purposive. The hijack situation is, however, not clearly enough delimited to allow this conclusion to be drawn. For, I assert, either they did intend to go to Algiers, or they did not travel. Admittedly the passengers played no direct part in the decision making which got them to Algiers, but that does not matter, for in boarding a vehicle one does not drive oneself, one surrenders one's power of carrying out one's purposes to the discretion of the driver. Now the pilot of the hijacked plane when faced with the hijackers threat, whatever it may be, forms the intention to fly to Algiers. That he is coerced does not alter the fact that he forms such an intention, and, most importantly, that he does so on behalf of the passengers because by the contract of journeying, they have delegated this power to him. Consequently, the passengers do intend to fly to Algiers, and so do purposely fly there, even though this intention is a derivative one. The situation in a hijacking is complicated by the delegation of powers by the passengers onto the captain (pilot), but ultimately resolves itself to action under threat, where the purpose to act still exists, but is not formed autonomously. Not all hijackings need follow the conventional pattern however. The hijackers might have killed the crew and flown the plane to Algiers themselves. In this case neither the passengers nor the delegated authority, the captain, has the purpose of going to Algiers. Then, I assert, the passengers do not travel there, even though they go there. My reason for asserting this is that under such circumstances the passengers retain no power of action at all, either to assist in getting to Algiers, or to prevent it. The passengers are effectively in the same position as a man who is rendered unconscious and transported somewhere. He has not travelled there, he was taken. If he had been conscious and had driven there at the point of a gun, he would have travelled there,

and purposely, albeit against his will. The loss of power to act for or against the journey means it must be discounted as travel. This does not mean that passengers, who by definition do not have this power, cannot travel, for they only lack this power by having delegated it. To sum up then, either the passengers in the hijacked plane intend to go to Algiers, (because their pilot does) or they do not travel there (they are taken). Similar considerations apply to all apparent counterexamples to the thesis that all travel is purposive.

Once we accept this thesis, certain important consequences follow. Since travel centrally involves intending to reach a destination, its important features become those to do with this intention, namely the departure, the intended destination and the arrival. What happens between is peripheral. Thus it is that people can truly be said to be travelling although they have not the least interest in the route or mode of transportation; these are merely the means by which the intention is carried out. Since travel as such is indifferent as to the actual motion by which it is executed, the notion can survive even where there is no such motion of any kind whatsoever. So long as there is an activity of departing, an activity of arriving and an intention to arrive at the destination, one has travelled. This indifference of travel to the nature of motion is what allows the concept of a matter transmitter or of teleportation to take root. For either of these ideas takes as a premise that one may travel from A to B without traversing the space between, thus breaking the fundamental condition of motion, that of spatio-temporal continuity, but satisfying the conditions for travel, since these are indifferent as to how a journey is accomplished.

Travel, then, depends on a connection of distinct places by the purpose of the traveller, and not on spatio-temporal continuity. But the matter is not so simple, for a serious problem arises, since if either motion or travel is to occur, then that which arrives must be the same thing as that which departs. In the case of motion the criterion of identity is straight forward, in being just that of spatio-temporal continuity, but by the very nature of travel this criterion of identity cannot be used for it. What criterion of identity is applicable to travel then? The answer is to be found,

I think, in an examination of the concept of a matter transmitter.

A matter transmitter is an updated, scientific version of teleportation. Its primary assumption (which is, I believe, coherent) is that we might develop a technique by which we record all the information necessary to recreate a physical body complete in every detail. This information would be of two sorts: firstly the nature of each and every atom (or other particle) in the body and its exact relationship to every other; and secondly the precise state of motion and excitations of every particle relative to all the others. The amount of information involved would be enormous but finite. From it, by putting the right materials together in the right way, we could exactly recreate the body. It would be the same body, although numerically distinct, because it would have exactly the same materials, structure and states of motion and energy. Because it has all of these, the body behaves as if it had the entire past history of the original body. The effects such a technique would have on our concepts of man and his identity have been discussed in the literature, where matter transmission is just one of a wide range of anomalies which disturb our notions of personal identity (1). Given the possibility of such a matter transmitter, it becomes possible to travel from one place to another using the technique, and so defying the continuity criterion of identity. What guarantees that one is the same person when one arrives is that one is structurally the same in all respects down to the last detail, so that one has all the memories, thoughts, anticipations, emotions, feelings and so on that one had before. Such a criterion of identity, which we may call the structural one, is a standard one, and is used for purposes of identification, being the reason why descriptions give identifying marks. This criterion is in fact used as commonly as that of continuity, for it is often impossible to establish a continuous history of an individual. A case where the structural criterion is the most important one is that the identity of a conscious being, since consciousness is frequently interrupted without affecting the identity of the conscious being, while structural change, such as that due to amnesia or brain damage does affect this identity.

(1) c.f. for example B.A.O. Williams, 'Personal identity and Individuation', Journal of the Aristotelian Society, March 1957, p 229-252.

To sum up the discussion of travel so far, we have distinguished travel, which is purposive, from motion, which is not, and have also distinguished different criteria for identity applicable to each case, that of spatio-temporal continuity being proper to the latter while that of structure is proper to the former. These distinctions give us enough information to be able to construct the analogies which generate time travel.

TEMPORAL ANALOGIES OF TRAVEL

The fundamental analogy between time and space that is necessary if any concept of time travel or motion is to be developed is between times and places. There must be a temporal equivalent of a spatial location. The natural analogy to draw is between a temporal instant and a spatial point, or a duration with a spatial length. This analogy is the basis of the claim that time is a fourth dimension (1). Despite its simplicity and attractiveness, the analogy shows serious defects when pursued, because one of the assumptions by writers about time travel is that when one travels to a temporal location and remains there one evolves with the people of that time. But this implies that one changes one's temporal location, which defeats the analogy of instants with point, for if one travels to a given point and remains there, one does not move from that point. To cater for this failure of the analogy we might say that everyone of the time to which we travel is time travelling at a natural rate, and that we desire not to remain at the time we travel to, but to remain with all these time travellers. This is the solution that Wells and Dunne adopt. To remain at a temporal location would then be to stay at an instant for a certain length of time. But here we have the familiar problem, for an instant cannot be a length of time, so that the applicability of 'instant' and 'length and time' to the one time implies two independent measures, and therefore dimensions, of time. We must conclude, therefore, that either a multiplication of time dimensions is needed or that the analogy is defective. Certainly other analogies are possible.

(1) This claim will be examined at greater length in Chapter Four.

In line with the characterisation we gave of travel, what is important is the point of departure, the point of arrival and the intention and means to arrive there (though the nature of the means is not relevant). If we can dream up temporal correlatives for these, then we have the basis of the analogy on which time travel can be based, and we can simply abandon the troublesome temporal analogy for remaining at a place because, as I remarked earlier in this chapter, the analogy between space and time does not have to be complete, only sufficient. What we need for a temporal analogy for travel is not to find analogies in time for all the features of space, but rather to find temporal analogies for points of departure and points of arrival, and as it turns out instants are perfectly satisfactory for this. The concept of the matter transmitter is useful to demonstrate how this comes about.

If a person is recorded in the way I have imagined for matter transmission, the information can be transmitted by radio, say, and he be reconstituted elsewhere. This would be a form of travel from place to place. Equally, however, the information could be stored and the man reconstituted at a later time. If this were done regularly it could come to be regarded as a sort of travel in to the future, and it would be without philosophical complications beyond those inherent in the matter transmitter. Motion into the future can be similarly conjectured, since by the use of cryogenic techniques a man's metabolism can be slowed to virtually zero, and if our technology were better, perhaps it could at some later time be returned to normal. Such a resurrection whether by matter recording or cryogenics could well come to be regarded as having a point of departure and a point of arrival, since there would be definite activities which constituted the 'departure' and the 'arrival'. The conjecture involved in time travel would then be based on an analogy between such instants of departure and arrival and spatial points of arrival and departure.

The analogy must be extended however, for it is an important feature of travel that one can in principle travel from

anywhere to anywhere else; it is conceivable that one should travel to the centre of the earth, even though not practically possible. By analogy travel should be conceivable from any instant of time to any other, not just to future times. Admittedly we cannot begin to envisage how to extend the mechanisms for travelling into the future to include the past, but this is not important for the analogy for travel, since, as I pointed out, the means of travelling are not important to the concept of travel, unlike that of motion. All that is necessary for the viability of time travel is that it be conceivable that there be such means.

Time travel, then, is construed by analogy with spatial travel to give the following characterisation. It is possible that people might perform an action which constitutes leaving a given instant, and perform an action which constitutes arriving at any other instant they have chosen, and remain the same person according to the structural criterion, that is the person who arrives is structurally identical with the person who leaves, to the extent that it is as if the person who arrives has the entire history of the person who leaves. This characterisation of time travel is minimal in the sense that all versions of time travel must be correctly described so, but some versions require a stronger characterisation, in particular they require temporal motion and spatio-temporal continuity. The virtues of this way of introducing time travel are thus two: firstly, all the actions required are normal actions with a normal temporal sense; and secondly, there is immediate need to introduce temporal motion.

Nevertheless, having thus introduced time travel, we must turn to motion through time, **since** it has been the central concern of writers attempting to justify time travel. Motion through time has to be related to travel through time in a parallel fashion to the relationship between ordinary motion and ordinary travel. That is, motion through time must count as a temporal journey meeting similar temporal conditions as motion through space meets spatial conditions. Again we must remember that as with time travel, temporal motion does not have to be an exact analogy, it need only be sufficient to render the name 'motion' appropriate.

ANALOGIES FOR TEMPORAL MOTION.

As Wells' and Dunne's theories prove, the great pitfall in attempting to present temporal motion is to fall into the regress of using motion to explain motion. We know, however, that this pitfall can be avoided because Kurt Gödel's mathematics for his model of time travel are consistent(1). How then is temporal motion to be introduced?

The requirements to be met by temporal motion are essentially by analogy to those of spatio temporal continuity for ordinary motion. That is, we must find a temporal analogy for the following criteria: (i) if an object moves from A to B then it moves through every point on some route between A and B; and further, (ii) if any point is marginally farther on the route to B than another, then it is reached marginally later in time than that other point(2). There are two problems in trying to create an analogy from this. The first I have already mentioned, for the criteria use the language of motion and so cannot form the basis of a characterisation of motion. The other problem is that the second criterion sets down a rule of temporal precedence which the proponent of time travel specifically wishes to deny. The first problem is easily dealt with, but the second is more difficult. In order to deal with the first we observe that the language of motion is redundant so far as the needs of continuity are concerned. We can without loss amend the criterion to read: if an object moves from A to B, then it is at some time at each and every point on some route between A and B.

In order to deal with the second problem we need to find a way of expressing the requirement for ordinary travel that the traveller pass each point of the route successively but which does not imply that successive points on the journey are reached later in time. For if temporal motion is to be possible, then it must be possible for later points on a journey to be earlier in time. When we examine the way ordinary travel works, we find that two potentially independent

(1) c.f. Chapter One.

(2) c.f. p. 34

ideas coincide. When we travel, events happen to us one after the other until we reach our goal, so that we get there later in our life and after an accumulation of some experience. Besides this, we find that our journey has taken a certain amount of time, that we arrive at a later objective time than we left, by the clocks, and that the clock times which are given to the events we experienced on the way form the same sequence earlier to later as those experiences do. It comes as no surprise that we find this correspondence between our experiential history and recordings of clocks, indeed we normally regard such a correspondence as necessary. While we will concede differing subjective evaluations of lengths of time, of the durations of events, as having equal validity, and understand what it means to prefer such an evaluation to a clock-registered duration, nevertheless we do not allow that events could really happen in a different order in experience to that in which they occur objectively. Rather than accept this, we say that we get the order of our experiences confused in memory, and that it is the objective order which gives us the order of our memories. Thus, for example, I do not know subjectively the order of many of my childhood experiences to the objective order. As a result of this apparently necessary correlation between experiential time order and objective time order, it seems that it must be impossible to separate the objective temporal order from the traveller's history. But not so.

The conditions under which it would be possible to make this separation would have, as I have shown, to supply another criterion for putting the events of an individual's history into order other than that of their objective order. Such another criterion is available to us as a result of our earlier discussion of time travel. It is a development of what I called the structural criterion of identity and it runs along the following lines: if one state of affairs is the structural outcome of another, then that other state is earlier in the evolution of affairs. This principle is similar to the causal one that if a causes b then a is earlier than b , but is different in one important respect which I shall explain in the next section.

THE PRINCIPLE OF CAUSAL CONTINUITY

In connection with the idea of a matter transmitter we found two principles of identity, one based on continuity and the other on structure. The structural principle did not require any continuity of an object in order to conclude its identity, although there was a causal connection in the form of an information transmission. I did not discuss then if such a connection was necessary since it was not a necessary part of the formulation of the structural principle, nor shall I discuss the matter yet. In the case of time travel I used this principle to establish identity across time without temporal continuity because it enabled me to establish a sound sense in which discontinuous states of affairs could nevertheless form a continuous series. The same principle will allow us to give a sound sense to temporal motion.

Given a set of events, we could order them either according to their times and places to give spatio-temporal continuity, or we could use other structural principles. For example the set of events which constitute the flashing of a lamp we could arrange in order of light intensity, or the state of the mechanism which generates the flash, or both and so on. Such an arrangement would give us a qualitative or a structural continuity. The difference between such a form of continuity and a spatio-temporal one is that the structural one is an internal one, relating only to the disposition of parts in the lamp and the relationships of these parts. These factors of disposition and relationship have implications for what the preceeding and succeeding states of the lamp are. Spatio temporal continuity, on the other hand, locates the lamp and its history in a spatio-temporal environment, where its place amongst other things has implications for its succeeding and preceeding places. Now if all we are given is these two criteria as they stand, there is no guarantee that strange things are not possible, such as instantaneous qualitative changes like an immediate transition from black to white while maintaining spatio-temporal continuity, or such as sudden discontinuous changes of place or time while maintaining a qualitative continuity. Indeed the modern quantum physics seems to be one of combinations of such discontinuities.

In order to tame the world into the kind of continuity we expect of it, the two principles I have mentioned need to be tied together. The principle that achieves this marriage or harmony is that of causal continuity, namely that if a causes b, b is the result of a or whatever, then there is a continuous process connecting the event a with the event b. This principle could also be known as that of infinitesimal differences, for the idea of a continuous process is that if a causes b, then there is a c such that a causes c and c causes b and, speaking roughly, c is qualitatively part way between a and b. Evidently by the same rule the same considerations apply to 'a causes c' and 'c causes b'. One result of this principle is that nothing can happen instantaneously, since instantaneity implies an abrupt qualitative change. Another result is that since any change in a state of motion is caused, this change cannot be abrupt and there cannot be, in this case, an instantaneous change of place. Thus, paradoxically, the idea of inertia follows from a perfectly general metaphysical principle.

The use of the principle of causal continuity cannot, however, be extended too far. It is very tempting to use it as a generalisation of the other principles of identity through time, since it apparently guarantees that any changes which occur will occur gradually. But this is not so. Certainly it guarantees that any changes which are caused will occur gradually, but it does not guarantee the same of uncaused ones. In a world in which every change is caused this lack of guarantee causes no problems, but that is not the world of modern science. Nor do we need to look to esoteric modern physics for examples. Newton's first law, that anything will continue to move uniformly in a straight line unless acted upon by an external force is a sufficient example. Such an object needs no cause of its motion, it simply moves. Similarly we need look for no cause of the endurance or continued existence of a thing, it simply exists. As a consequence, spatio-temporal continuity cannot be subsumed under causal continuity as many writers have supposed. Reichenbach, for example, says:

The direction of the causal chains is also the direction of the world-lines of objects which remain identical with themselves and which therefore represent special cases of causal chains. (1)

- (1) H. Reichenbach, The Philosophy of Space and Time, Dover Publications, New York, 1958, p.270.

Within the limits of his definition of causation, Reichenbach is correct, for he says:

Different states can be genidentical (identical through time) only if they are causally related. This conception agrees with our definition of causal connection, which considers the causal chain a signal, that is, the transmission of a mark.(1)

Such a use of causation defeats the purpose of the insight of the Enlightenment into dynamics which saw that things do not need forces or causes to keep them moving, thereby making motion natural to the world rather than requiring a hierarchy of angels and a prime mover. It is as erroneous to think that some thing must occur which has the effect of keeping a thing in existence as it is to think that something must occur which has the effect of keeping a thing in motion.

The confusion between change and causation, which ought to have been cleared up by the gradual sophistication of the idea and scope of relativity from its seventeenth century origins, has, I think, been perpetuated by the often interchangeable use of the ideas of process and cause. Where, for example, one enquires into the reason an object reached a certain place, one might say that this was caused by its motion, meaning that its motion was what brought it there, that there was a process the end result of which was that the object reached that place. We can in such contexts use the ideas of cause and process pretty much interchangeably, but not entirely so without a great loss in our capacity to differentiate different circumstances. For while it may be true that the object was caused to reach that place, equally it may not be true. If it was caused to reach that place, then an event occurred the effect of which was to direct the object to that place. But this need not be true, because motion is natural to the object, and its natural motion may take it there.

One way in which Reichenbach's usage of causation might be maintained is by asserting that the absence of causal influences, or forces, is a special case of causation. The grounds for this are that the presence or absence of such forces is a matter of the choice of frame of reference, and General Relativity allows us to choose one with or one without such forces as we please. But this point is,

(1) op.cit. p.271.

I believe, sophisticated. Whichever frame of reference we choose, some motions will be natural to that frame. In the modern terminology they will be universal forces, much as gravitation was seen in ancient times.

1 A universal force is not genuinely a force at all, for it does not
 differentiate motions. In the Aristotelian system, where motion under gravity was considered as natural, it was not necessary to imagine this motion as the result of a force or a cause. Causation is not merely the explanation of change but of the relative influence of one thing on another. Universal forces and uniform motions can be eliminated by
 1 the proper choice of frame of reference in a way that causal influences cannot because they are so relative. Consequently I conclude that the absence of causal influences is not a special case of a causal influence.

The result that identity through time is not a special case of causation now follows from a further consideration of relativity. According to Newtonian relativity, the state of rest or the state of uniform motion are alternative descriptions of the behaviour of the same object depending on one's point of view. Rest or motion, then, is simply equivalent to the continued endurance of the object. (This lesson from Newtonian relativity carries over into Einstein's relativity). Consequently, if neither rest nor motion are forms of causation, endurance is not either.

To return now to the principle of causal continuity, which was the object of the discussion, we have shown that it cannot be taken too far, because there are processes, in the series of series of events, or motions, or changes, which are not causal processes. In particular, the continued existence of a thing is not a causal process. What, then, is the general form of continuity which we would require in order to make sure that our two principles of identity, the spatio-temporal and the structural or qualitative, correlate? Evidently we must include not only those processes which are causal but all those which are not. Thus the general requirement of continuity becomes that all changes are continuous. If this is true then the world is tamed to the kind of orderliness that we wished of it, but it is not at all evident that it must be true. While it is plausible that the action of any force, however sudden, cannot be instantaneous, it is not so plausible to suggest that no change can be instantaneous. We may well believe so if

we eliminate chance from the world and have a Laplacean determinism, but chance is sudden by its very nature, one would think.

However that may be, once we have renounced cause as the fundamental criterion of identity through time, as I think we must do, we are faced with the question of what this criterion can be. Here we return to the point at which we concluded the last section. There I said that the structural criterion of time order, which asserts that if one state of affairs is the structural outcome of another then that other state is earlier in the evolution of affairs, was not simply an obscure way of stating that causal precedence implies temporal precedence. I can now explain what I meant.

Consider an object which is moving uniformly in the absence of any forces. Its state of motion at any time is, as I have demonstrated, not the cause of its state of motion at any later time. Nor is its existence the cause of its later existence. Nevertheless the object's motion at any time is the outcome of its previous motion, and its structure is the outcome of its previous structure, even though these are not the effects of the previous state of affairs (since ex hypothesi there are no forces or influences at work). Consequently, as I have said, the object's state of affairs at any time is the outcome of the structure of its affairs at previous times, but is not the effect of those affairs. Evidently there is an intimate connection between this structural criterion of time order and the causal order, since wherever the second applies the first does also, but I shall not go further into an investigation of cause here.

One possible interpretation of this characterisation of endurance is that it implies that the state of motion of a system can be determined from what is true of it at an instant, which may be denied(1). This interpretation is not necessary, however, for the state of motion can instead be derived from a series of instantaneous states, as their structural outcome. The same point applies here, that the resulting state is the outcome of the series, but not caused by it.

(1) by Russell, for example; c.f. Chapter 4, p. 107

The structural outcome of a series is then a determinate result of the series, but is not determined by it. The mathematical equivalent of the idea of structural outcome is that of limit, for the limit of a series is a determinate result of the series of which it is limit, but its existence is not determined by the series. That is, the fact that the series is properly convergent and behaves as if it converged to a single number does not guarantee that that number exists. Similarly the structural outcome of a series of states of affairs, or of a motion, or of a change, can be regarded as the 'limit' of the series, as a state of affairs which is as a result determinate in character, but whose occurrence is not guaranteed, that is not caused by the series, motion of change.

The important result of the discussion for our immediate purposes is that the distinctions drawn in this section enable us to draw the analogy which generates temporal motion.

TEMPORAL MOTION AGAIN

The analogy upon which temporal motion was to be based was with the two features of ordinary motion, that of a continuous route and that of successive passing of the points on that route. The problem with any kind of analogy drawn with these was that succession could only be defined in temporal terms by the ordering of events as earlier and later. This necessitated finding a means by which succession could be characterised which was not specifically temporal in character. The necessary characterisation is found in the concept of structural identity.

The requirement for a journey or for motion that further points on the route be reached later in time can in the first instance be replaced by substituting 'later in an individual's history' for 'later in time'. This substitution is not adequate as it stands, however, because it moves the problem a step backward, since on the face of it 'later in an individual's history' has to be explained in terms of 'later in time'. The avoidance of this implies the necessity of some way of relating events in an individual history as forming a series other than by referring them to the temporal series.

The point of the discussion of continuity rules was to establish the viability of connecting events serially other than by temporal order

or causal order. To this end I showed that endurance or mere continued existence should not be interpreted causally, but by what I called the structural outcome of a state of affairs. The structural outcome of a state of affairs can be read off from that state of affairs (although influences from outside the system cannot be so read). This simply means in practice that a system will continue as it is unless external influences interfere, or will work out its original influences according to definite rules unless interfered with.

In order to construct our temporal analogy for motion we use this idea of structural outcome as a means of explaining 'later in an individual's history'. We assert that the structural outcome of a state of affairs or series of such states is determined by qualitative aspects of those states, not by their temporal order, and thus that it is conceivable this outcome be earlier than the original state or series of states. So far we have merely reformulated the possibility of time travel as earlier described. The reformulation is, however, also a refinement, for an individual's history is such that events which are not immediately due to external influences are the structural outcome of other experiences, and that it is this structural relationship (which is sometimes also causal) which orders events as earlier or later in the individual's history. Consequently, since we asserted that structural outcomes need not be later in time, we assert here that as a result historically later events need not be later in time. Now our analogy from the conditions for motion can be constructed as follows:

(i) If an object temporally moves from time A to time B, then there is, for every time between A and B, a moment of the object's history when it is at that time.

(ii) If an object temporally moves from time A to time B, then the further from time A the object is, the later in its history it is there.

The claim for full temporal motion by analogy with spatial motion is then made by adding to these conditions that it is possible that time B be earlier than time A.

Except that I have quarrelled with the interpretation of endurance as causation, this way of introducing motion through time is essentially the same as that of David Lewis, as will emerge from the discussion in the next section. I have however avoided an initial characterisation of the connectedness of the history of an individual in terms of causation because I think it is important to maintain

backward causation as a consequence of time travel or motion rather than as part of its definition. I think this because although all the cases of time travel which interest us, in particular those consisting of human action, do involve backwards causation (so far as objective time is concerned), nevertheless we ought to leave it as possible that just as uncaused spatial motion can occur in the manner I have explained, so uncaused temporal motion can occur. Furthermore, if we are to assert that time travel is a plausible extension by analogy of ordinary travel, then we must use accepted theories as to the structure of the world in order to show this. If these can accomodate time travel, then they must be able to accomodate backward causation. Certainly if a theory of the world structure allows backward causation it has opened the doorwide to the admission of time travel, but the most interesting thing, surely, is why it should do so. One may look for justification of backward causation without the intermediary step of time travel but this is one of the most compelling reasons for entertaining the idea, and historically one of the most important. But if time travel is to play this role in a theory of the world structure it cannot without question begging assume backward causation.

An immediate consequence of this is that in finding a criterion for the tying together of the stages of a time traveller's life into a unified whole we cannot rely on causal threads, since if we do we are begging the question.

THE PERSONAL IDENTITY OF A TIME TRAVELLER.

David Lewis, whose introduction of time travel I have said closely parallels my own, in the article I discussed briefly in Chapter One, devotes his energies to defending the consistency of backward causation. In this respect his paper is excellent. However he uses causation in order to define the identity of a time traveller, and evidently sees the idea of time travel as a consequence of that of backward causation. But this is, I think, putting the cart before the horse. The plausibility of time travel should follow from the extension of ordinarily accepted features of space and time, not depend on the plausibility of backward causation. However before we move onto

this matter, I shall let Lewis describe how he handles the identity through his history of a time traveller.

Instead of an operational definition, we need a functional definition of personal time: it is that which occupies a certain role in the pattern of events that comprise the time traveler's life. If you take the stages of a common person, they manifest certain regularities with respect to external time. Properties change continuously as you go along, for the most part, and in familiar ways. First come infantile stages. Last come senile ones. Memories accumulate. Food digests. Hair grows. Wristwatch hands move. If you take the stages of a time traveler instead, they do not manifest the common regularities with respect to external time. But there is one way to assign coordinates to the time traveler's stages, and one way only (apart from the arbitrary choice of a zero point), so that the regularities that hold with respect to this assignment match those that commonly hold with respect to external time. With respect to the correct assignment properties change continuously as you go along, for the most part, and in familiar ways. First come infantile stages. Last come senile ones. Memories accumulate. Food digests. Hair grows. Wristwatch hands move. The assignment of coordinates that yields this match is the time traveler's personal time. It isn't really time, but it plays the role in his life that time plays in the life of a common person. It's enough like time so that we can - with due caution - transplant our temporal vocabulary to it in discussing his affairs. We can say without contradiction, as the time traveler prepares to set out, 'Soon he will be in the past'. We mean that a stage of him is slightly later in his personal time, but much earlier in external time, than the stage of him that is present as we say the sentence. (1)

Lewis' procedure is certainly the first step necessary in the development of the idea of personal time, for it enables the construction of what looks like an ordinary personal history. But as we observed earlier the mere collection of such a series of events is not sufficient, there must also be adequate grounds for believing the collection to be the history of the same individual. Not only must the collection of events show the regularities of an ordinary history, but the events making it up must show the same relationships as the events of an ordinary history would. Lewis recognises the necessity of this, and gives the following answer to the question of why the events form the life of one person:

I answer that what unites the stages (or segments) of a time traveler is the same sort of mental, or mostly mental, continuity and connectedness that unites anyone else. The only difference is that whereas a common person is connected

(1) David Lewis, *op.cit.* p.146.

and continuous with respect to external time, the time traveler is connected and continuous only with respect to his own personal time. Taking the stages in order, mental (and bodily) change is mostly gradual rather than sudden, and at no point is there sudden change in too many different respects all at once. (We can include position in external time among the respects we keep track of, if we like. It may change discontinuously with respect to personal time if not too much else changes discontinuously along with it.) Moreover, there's not too much change altogether. Plenty of traits and traces last a lifetime. Finally, the connectedness and the continuity are not accidental. They are explicable; and further, they are explained by the fact that the properties of each stage depend causally on those of the stages just before in personal time, the dependence being such as tends to keep things the same. (1)

As Lewis says the connectedness and continuity of the sequence of events which make up the life of the time traveller must not be accidental, but must rather be explicable. Consequently regularities that for an ordinary person would be causally connected must by similarly connected for the time traveller. Such causal continuity is, Lewis asserts, a necessary condition of the unity of the traveller's history, for if it were not, counterfeit time travel would result. Lewis postulates a demon who creates Fred ex nihilo in the prime of life. Fred thereafter lives normally and dies. Later the demon either discovers that, or engineers things so that Sam, who has been born naturally, reaches a moment in the prime of his life when he is qualitatively identical in every respect to Fred at the moment of his creation. At this moment the demon annihilates Sam. Sam and Fred have the qualitative continuity required by Lewis (and by me), but they do not have the kind of causal relatedness required to make them identical. Lewis says, 'Either way, Fred's last stages do not depend causally for their properties on Sam's last stages. So the case of Fred and Sam is rightly disqualified as a case of personal identity and as a case of time travel'.(2)

I find I must disagree with Lewis here on two counts. Firstly, Lewis' demon example does not show what he thinks, and secondly, what Lewis imagines to be causal connection in this passage is not in fact so.

(1) op cit p.143

(2) op cit p.143

In order to show the failing of Lewis' example let us remember that we (and Lewis) have already postulated that the external order of events is not a relevant consideration concerning the order of events in personal time. We can, therefore dispense with Fred being earlier in time than Sam and make him later, with no difference in principle to the example. We can then tell the story as follows. Sam, an up to now normal human being, is destroyed at a moment in the midst of his life by a demon. This demon later creates Fred, an exact replica of Sam, perhaps in a fit of remorse brought on by a reprimand from the Godhead for interfering in His handiwork. Is Fred identical with Sam? There are strong grounds for saying so, since Sam would be effectively reincarnated even though Lewis' criterion of causal continuity is not met because Fred's early stages are not causally dependent on Sam's later stages.

At least, there is no such dependence in the story as Lewis tells it or in my rewrite. There is, however, an essential asymmetry between the two stories, because there is implicitly a difference in the information available to the demon. The natural assumption in my story is that the demon creates Fred on the basis of the information he has available about Sam. On the contrary, the natural assumption in Lewis' story is that since the demon created Fred before Sam, he did not have the information available about Sam that would be necessary for his creation of Fred to count as a recreation of Sam. Suppose we grant to the demon complete foreknowledge, then the asymmetry of information disappears.

The real lesson of Lewis' demon story is, then, that the demon's creation of Fred cannot count as a recreation of Sam unless the demon has, at the time of his creation of Fred, the knowledge of exactly how Sam was at the time of his destruction. Now Lewis' point about causal connectedness reemerges if we suppose that all information is gained as the result of a causal process, because this supposition eliminates genuine foreknowledge. (Foreknowledge becomes a particular case of reverse causation, if it can occur at all.) Even accepting this supposition, Lewis' conclusion of causal continuity is considerably weakened, for Sam and Fred in my story are not connected causally as adjacent stages of an ordinary man's life are, and yet

the connection is sufficient for them to be one and the same person. Interestingly, Lewis' demonic creation, when developed as in this discussion is equivalent to the matter transmitter from which my development of time travel began. Finally, let us note that if we do not suppose that information must always be gained as the result of a causal process then Lewis' conclusion collapses utterly.

My second point of disagreement with Lewis was with his assertion that the explanation of the connectedness of stages in the time traveller's life must be causal in nature. Lewis asserts this on the grounds that the corresponding connectedness of stages in an ordinary life is causal in nature. I disagree with this, for as I have explained in an earlier chapter I do not believe that the endurance of an object is a causal process except in the trivial sense that it is a continuous process. (I am of course, always here using cause in the sense of efficient cause.) Certainly an object which exists now exists because it has existed up to now, but that prior existence, although it is the 'because' of its existence now, is not the efficient cause of that existence. A cause is an interaction between things which alters the course of events from what would otherwise have occurred. Thus, for example, in classical dynamics, the causes of motion are the impacts of bodies one upon another, and the continuance of that motion requires no further cause. That the motion continues is not the cause of the further continuance of the motion. Equally a thing does not cause its own continued existence, it simply continues to exist. If we were to use causation here, we would have to say that the continued existence of a thing is the result of its previous interaction with itself. This is patent nonsense. There is no such interaction.

My disagreement with Lewis, therefore, is that when he says, '...the properties of each stage depend causally on those of the stages just before in personal time, the dependence being such as tends to keep things the same' he is thereby implying that each stage remains the same because of some internal interaction in previous stages.(1) This may be true, as for example a state of health is maintained by the interaction of a poison and an antidote, but it need not be true, for

(1) c.f. previous quote.

inert bodies, which undergo no such interactions, or absolutely simple and undifferentiated particles, such as electrons, can likewise endure. Admittedly, if we interpret causation here as simple continuity, then Lewis' condition of dependence on earlier stages holds, but Lewis, as the section quoted earlier shows, wants causation to mean more than this.

COUNTERFACTUALS AND CAUSATION.

In fact it turns out that what Lewis means by causation is counterfactual dependence, and certainly the stages of a man's life are related in this fashion, and it is true that if a man had not existed up to now he would not now exist. But such an idea of causation is a very weak one, and though applicable to full-blooded causation, is far more general than it. Consider an example.

It is autumn, a leaf falls from a tree next to a stone. As time goes by the leaf changes while the stone remains the same. The change in the leaf is a causal process - the gradual interaction of chemicals in the process of decay, the drying out, which is an interaction of the leaf with its environment. These things are the causes of the changes in the leaf. Now consider the stone. It does not change, but we might reason as follows: change can occur at different rates, sometimes faster, sometimes slower, and so we can conjecture that no change at all is the limit of slower and slower changes, so that a 'zero rate' of change is of the same kind as any other rate of change. No change is then an infinitely slow change, but nevertheless change of a kind (that which we call remaining the same). We can then if we wish arrange rates of change so that decays are negative rates, and growths positive. The stone thus, paradoxically, changes and we must consider what the causes of this change (the remaining-the-same change) are, just as we did for the leaf. And just as the change in the stone is, we found, essentially, the same kind the same as the change in the leaf, so also it must be a causal process.

Once we have assimilated the state of no change as a kind of change the rates we assign to changes become arbitrary. Instead of giving the stone a zero rate of change we can assign it some other rate and adjust the rates of other changes accordingly.

This line of reasoning is, however, drastically in error, for a state of no change need not be, and indeed is not, a state of change. A state of no change certainly is the limit of slower and slower rates of change, but this does not imply that a state of no change is itself a rate of change any more than the fact that a number is the limit of a sequence of rational numbers implies that that number is itself a rational number. The limit of a sequence may well be of a different kind to the members of the sequence. There are other examples than numeric ones. It is by no means certain that the creature which represents the limit of human evolution will itself be a man, although all the generations up to that point have been generations of men. Or, when a man has reached the limit of his capacity he has likely found something that he cannot do, not something that he can. Or, the limits of language are what it cannot say, not what it can. Clearly, then, it is not necessary that the limit of a sequence be of the same kind as the members of the sequence.

Having established this we must now enquire whether the limit of a sequence of slower and slower rates of change is in fact itself of the same kind as other rates of change. I say no. My reasons for this are two. Firstly, I have argued on independent grounds that the persistence of objects is not a causal process, whereas the hypothesis at issue implies that it is. Secondly, if it were a causal process it would have to be of a completely different kind from other causal processes, because the sort of relationship there is this between the states of a thing which does not change are not the same as that between the states of a thing which does. Suppose for example that I try to smash a tough macadamia nut. All my efforts are in vain, the nut remains exactly as it was. What has happened is that none of my efforts have been sufficient cause for the nut to break. The survival of the nut and my failure to break it are both results of my activity, and I may well want to know the cause of my failure and the survival of the nut. I would conclude perhaps that the cause was that the shell of the nut was too strong. I would certainly not conclude that the survival of the nut was the cause of the survival of the nut. The nut simply survived, and my failure to break it was certainly not the cause of its survival.

For these reasons I conclude, as I have before, that cause is essentially an interactive notion, and where there is no interaction, such as in simple persistence, there is no cause. There may indeed be a cause for the lack of such an interaction, but this is not a cause of the persistence of a thing. Consequently I do not believe that causation and counterfactual dependence amount to the same thing, but rather that causation is a special case of counterfactual dependence.

PERSONAL IDENTITY AND THE TIME TRAVELLER AGAIN.

To return now to the case of the time traveller and the question of his personal identity. I have given my reasons for believing that Lewis' causal condition for personal identity do not hold, and I shall now give reasons why I do not think that a counterfactual condition holds either. Let us consider Fred and Sam again. The counterfactual condition for Fred being Sam's later self is that Fred would not be what he is if Sam had not been what he was. This condition is only adequate if overdetermination is not possible.

Overdetermination of an event or state of affairs is the condition where several causes are at work any of which is sufficient to bring about that event. If that is so, then a counterfactual analysis of any one of those causal relationships will be false, for the event would still occur even if one or more (though not all) of the causes did not occur.

Let us redraw a Fred and Sam picture. Suppose that a demon tailor Sam during his life till at a given moment Sam is exactly in every detail as the demon wishes him to be. The demon then destroys him and later creates Fred the replica. As we decided earlier, we can legitimately call Fred the recreation of Sam and the same person. Now consider this. The demon knows exactly what Sam is to be, for he engineers things so. Thus even if he had not engineered things so, it could well be that he would later create Fred as if he had, according to the model in his mind. Thus Fred would still be what he is even if Sam has been what he was. Nevertheless, as I have said, Fred is legitimately the same person as Sam, because in fact he is a recreation.

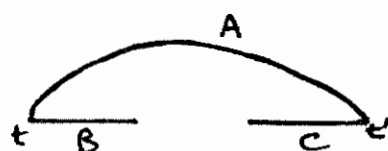
If I have got this story right, Lewis' original story is constructed simply by making the creation of Fred earlier than the destruction of Sam. As I have told it, the story involves an overdetermination of the creation of Fred, for either the final state of Sam or the demon's model of Sam would be sufficient for Fred to be as he is. Thus Fred is the continuation of Sam even though the counterfactual dependence criterion fails. Now Lewis' story, where Fred is earlier than Sam, is the same in this respect. Fred would be as he is whether or not Sam were the same or different. Why should the objective temporal order matter when we have postulated that it does not?

The obvious answer is of course that Fred's existence should depend only on Sam's existence and not on anything else. But if this is so, what evidence could there possibly be for it? If Sam disappears and Fred appears whether earlier or later in time and there is no continuity between these two events or causal or informational chains connecting them, on what grounds can we say that the beginning of Fred's existence depends on the end of Sam's? There are only two that I can see, and they are interdependent. The first is that the beginning of Fred's existence should be identical with the limit of the sequence of the closing moments of Sam's existence. In the terminology I have used, Fred should be the structural outcome of Sam. This is a strong form of the continuity or regularity criterion. The second is that we could bring about such discontinuities as between Fred and Sam as we willed, perhaps also controlling the temporal length of the discontinuities and certainly controlling the time of disappearance. Let me explain.

If we are to infer causal connectedness in another way than by continuity, then we must do so according to some law. But what law? Here structural similarity between the individual at the end point of one segment and some other individual at the beginning of another segment was, we determined, not sufficient, we must have some law to the effect that variations in the state of the individual at the end of one segment would if they occurred correlate with variations in the other, as if the two were one and the same individual. But, unless we can make things undergo such a transition, and so test for cause and effect we cannot from this correlation of variations determine which is cause

and which is effect. Thus in order to make the necessary causal connections on which time travel is based we must already have grounds for ordering historical segments so that they constitute time travel. That is, time travel can be used as a means for introducing disjoint and reverse causation, but not vice-versa.

Note that the same problem does not arise where the criterion of continuity is applied. For imagine an event at a time t from which emanate two continuous sequences of events A and B . The sequence B later terminates, and later again a sequence C begins and continues until A and C converge to a single event and time t' . A , B and C are related in such a way that a continuity of events is maintained: C up to t' , A from t' to t and lastly B from t form a continuous sequence. Thus continuity is as the diagram indicates. We can now



distinguish between the event at t being the causal ancestor of the event at t' and the converse state of affairs. For if the sequence A is broken it makes a difference whether it is connected to t or to t' . Suppose that the sequence A is interfered with at some point A , then the trace of this will be continuous either to t to t' . If the latter, then the causal connection in A is from t to t' , whereas if the former the connection is from t' to t .

Thus when it comes down to it the criterion for the identity of an object through temporal discontinuities is either simply that of a strict continuity of events in the object's personal time, or it depends on the prior justification of time travel. Consequently I cannot agree with Lewis' introduction of time travel by way of backward causation or counterfactual conditionals. The explication of time travel must antecede these.

CONCLUSION.

I have spent some pages trying to explain why it is that I have avoided bringing causation into by initial description of time travel. I do not intend to avoid the topic altogether, I think it is a most critical one, and the final chapter will be devoted to it. My aim has been, rather, to try and plumb the foundations of the plausibility of time travel and discover the ultimate principles upon which it rests, because the idea of time travel is amazingly hard to eradicate. Consequently the emphasis has been in this chapter on the development of time travel by analogy with ordinary travel, and I have tried to show what is not and what ought not to be involved in the analogies I have drawn. It remains now to pull the threads together and prepare the way for the next chapter, for this one has been quite a sprawling one.

It has emerged from the discussion of this chapter that continuity is one of the most important criteria for establishing identity, and that if it is abandoned, as it can be for time travel, then great difficulties emerge in establishing identity. Thus one important strand is that of temporal motion, for it is this which supplies the analogue for time travel of ordinary spatio-temporal continuity.

It has emerged also that there are great difficulties in defining personal time, that is an individual's history without such continuity. Nevertheless, such personal time or individual history is a normal starting point in descriptions of time travel. Heinlein uses it for example, and it is a favourite of philosophers like Lewis. It is almost as if there is some ground for believing a personal history to be an ultimate touchstone of the way the world is. I shall explore this more in later chapters.

Indeed the idea of time travel as I have introduced it, with its tolerance of discontinuities, seems eminently suited to such a reliance on a personal history. I do not believe this is any accident, as I hope I will later be able to prove.

In the next chapter I will discuss what I have foreshadowed earlier in this chapter would be needed, namely the establishment of the

plausibility of time travel in accepted views of the world and the nature of time. That chapter will therefore be a more direct continuation of Chapter One than this chapter has been with its emphasis on analogy. I hope, however, that this chapter has achieved its purpose of showing that ultimately the mere conjecture of time travel is a matter of analogy and does not depend on any particular world view.

As a result of the discussions of Chapter Three I shall go on to search out the epistemological bases for the world theories on which time travel is founded, again with a view to discovering why it is that time travel remains plausible.

CHAPTER THREE.
THE METAPHYSICS OF TIME TRAVEL.

I have shown how we can go about defining time travel by analogy with spatial travel, while avoiding the pitfalls of the most straightforward analogies. In this chapter I intend to show how the various descriptions of time travel presented in Chapter One are related. The issues here are metaphysical ones, but I shall only present them fairly sketchily, for my ultimate purpose is not with the metaphysics, but with the epistemology behind them.

We found in the last chapter that ultimately the difficulty in preparing an analogy upon which to base time travel was that it was extremely difficult to formulate a criterion of identity through time which had the necessary flexibility to permit time travel and which nevertheless does not presuppose it. Let me recapitulate.

We had a collection of disjoint histories each of which was a connected sequence of events occurring to an apparently normal individual. There is a way of putting these histories together so that events concerning immediately the various individuals form a connected and continuous sequence as if they were the entire history of a single individual. How can we decide that they in fact do so? One way would be to demand similar connectedness and continuity not only for the individual but also for his total environment. This condition we, with Lewis, deliberately suspended for time travel (though such continuity is necessary for temporal motion). An alternative to demanding continuity is to demand causal connectedness, since if an event in one segment of an individual's history is the cause of some event in another, there is thereby sufficient ground for us to order them sequentially. I had several quarrels with the threefold identification Lewis makes conflating identity through time, causal connectedness, and counterfactual dependence. These quarrels are not relevant here, but my final point is, namely that concerning the evidence for such causal connectedness.

The result of the discussion was that to establish identity through time travel either one must demand environmental continuity

for the series of events which it is claimed constitute time travel, or one must have prior justification for time travel. The primary purpose of this chapter is to show how such justifications are made. I shall not attempt to argue correctly in detail, but rather merely to show the general outlines of such arguments.

AN OBSERVATION ON EPISTEMOLOGY.

Before I go on to these matters, however, I wish to make one observation. The crucial question of the last chapter was the formulation of a criterion of personal identity which could accommodate time travel. The resolution of the matter turned on the notion of an individual history, which defined a personal time. The notion in turn required the relevant connection, namely causal, between pieces of the history to make it of one individual. The determination of events as so connected emerged as problematic except if an objective continuity of events were supposed. But I must observe here that the problem can be avoided entirely by adopting a subjective epistemology, that is, by referring all metaphysical concepts, including those of causation and identity, back to the evidence of human experience. For if the final nature of things is to be found not only in how we come to know them but more narrowly, in how we experience them, then nothing can gainsay the evidence of our experience. The body of experience then becomes that to which the structure of the world must conform. The issue of time travel then becomes whether the purported bodies of experience which time travel allows are internally consistent as bodies of experience; that is, whether the nature of human experience is such as to preclude time travel type experience.

Using human experience in this manner as an epistemological and metaphysical ultimate is, one might think, straightforwardly empiricism in the tradition of Locke. But the matter is not so simple, for the phrase 'human experience' is ambiguous, and can refer either to what they experience or to how they experience it. The first interpretation is that proper to empiricism, and the latter to rationalism. Empiricism tends to deal with the objects of experience, rationalism with the subject and modes of experience.

This well known division leads to curious circumstances. Bergson, for example, calls himself an empiricist because he investigates what human experiences are. By this he means that what humans seem to themselves to experience is in fact what they experience. Bergson thus seems to fit the form of empiricism, namely the study of the objects of human experience, but his method is alien to normal empiricism. For where Bergson is holistic, looking to the report of the experience for its nature as a whole, the empiricists are analytic, looking to the elements of the experience and their relationship to see how

the experience is constituted. This methodological difference is ultimately an epistemological one, for it is a difference as to the nature of evidence and the acquiring of knowledge. The empiricist proper cannot rest with the way things seem to be, he must construct this from the way things are; for him knowledge is acquired piecemeal and the pieces put together. The Bergsonian empiricist on the other hand (just like the phenomenologist, another claimant to the title Empiricist) accepts as raw data the way things seem to be and constructs his 'objective' world - his world of objects - to suit.

This difference in epistemological method, especially the difference over what constitutes raw data, leads to the possibility of different approaches to the question of time travel. For if a person's reports, memories and so on represent the ultimate evidence as to the nature of things, then the problem we have been discussing of personal identity through time disappears, for this notion becomes merely a construct which we use in order to partially represent our experience. If on the other hand a person's experiences are only evidence in a derivative and distorted sense, requiring to be analysed to discover the hard facts, then the question of identity through time must be referred to an external standard, in other words to the way the world works.

The essential objectivity of empiricism and its relation to things external is obscured, unfortunately, by the tradition that the only things we can be aware of are sense impressions or sense data. While this tradition affects the ontology of empiricism, it has no

effect on its methodology and epistemology, which remains objective in character. Sense data are, as G.E. Moore showed, no more private or personal than the apparent objects of the external world are supposed to be.

The consequences of the division of method within empiricism are important for time travel, as will emerge in the course of this work. To return now to the subject at hand, of the metaphysical bases of time travel, let us begin with the theory of Dunne and Wells.

TIME TRAVEL AS A FORM OF MOTION.

When Wells and Dunne described time as a form of motion as well as a dimension of extension they were working within a well established tradition which goes back to Newton. This tradition is that time can be equally conceived either as analogous to the path a moving point traces out or as analogous to an infinite extended line. The difference between the two was practically speaking a matter of indifference to Newton and the scientists, because either achieved its purpose, which I shall come to in a moment. When the two concepts of time were synthesised, as for example by Locke, the groundwork was laid for Dunne and Wells. (1)

The purpose of the two conceptions of time was, to Newton and the mathematicians and natural philosophers of similar mind, to emphasize the continuity of time, that time forms a geometrical continuum rather than an arithmetical sequence. If time consisted of a series of jumps, so that from any state of affairs there was a next state of affairs, it would be impossible to use the method of vanishing increments, that is infinitesimals, in order to calculate the behaviour of moving bodies. One intuitively clear way of demonstrating that time is a continuum is to imagine a moving body and the path it traces out. Evidently the body is at each point on the path at a definite time, and at each point in time it is at some definite place on the path. Thus there are exactly as many points on the path as there are in the length of time the body takes to move along it, and thus time is

(1) These matters will be dealt with more fully in the next two chapters.

a continuum. Another way of going about the demonstration that time is a continuum is to begin with the observation that time cannot be an arithmetic sequence because between any two times however close there is evidently another time, and consequently an infinite number of time between those two times. Thus time has at least the structure of a rational continuum. But any two points of such a continuum are separated by a definite length of time which evidently can be subdivided in any proportion as lengths can be divided, namely as a spatial distance can be divided, and the point of subdivision is itself a point of time. Thus time is a real continuum. In this mode of reasoning there is no reference to motion.

The combination of the two images of time as generated by motion and as an extended dimension is in itself innocuous, but becomes difficult when, as it universally was, it is coupled with the idea of the uniqueness of the present moment. For how can one reconcile the two propositions that time is an extended dimension and that only the present exists? Locke's solution is that time is 'fleeting extension', a dimension whose parts exist successively and do not coexist.⁽¹⁾ But then there are problems as to what successively can mean, if it does not imply that one time succeeds another as present, which means that times which do not coexist nevertheless exist.

From this state of affairs, which had laid quiescent after Locke, it was but a step to the conclusion the the present itself moves through time. However, although this was a common way of talking in the nineteenth century, as the sources Dunne quotes show ⁽²⁾ and the age old image of the flow of time assisted matters, nevertheless, the implications of this way of talk were not fully realised until they were presented jokingly by Wells and seriously by Dunne.

If we contemplate the flow or motion or passage of time we find that it has two aspects. Firstly it means that time is divided into past, present and future, and secondly it means that a moment of time which is present will become past and a moment which is future will become present.

(1) This matter will be dealt with more in Chapter Five.

(2) See Chapter One.

This very formulation of passage is fraught with difficulties, as the argument of McTaggart shows, since it implies that any moment of time is past, is present and is future all at once, a contradiction which can only be avoided by saying that each qualification applies at successive times. But this means that passage enters into the very description of passage.

A correlative difficulty is found in the idea of the motion of the present, which is generated from passage by rendering it somewhat differently. Since the moments of time constitute a dimension of time and moments are successively present (that is, they pass) there must be a means of measuring this succession, and this can only be another dimension of time. But a dimension is only temporal if it involves succession (as for Locke). Thus again passage enters into the very description of passage. This is how Dunne argues. The parallel between time as like the path of a moving object and time as like the path of the passing present is obvious.

McTaggart's and Dunne's reactions to these very similar difficulties were opposite, McTaggart using his to prove the unreality of time and Dunne welcoming his as an explanation of precognition. The reason the one could regard his difficulty as a vicious one and the other not lay in their different attitudes to time as a dimension of extension. For McTaggart time as extension was derived from time as passage, so that passage is necessary for the very explanation of time. For Dunne, however, the extensional and successive aspects are independent features of time, so that the idea of time is not vitiated by the circularity in the description of passage.

McTaggart's circularity leads, then to a vicious regress because passage is supposed to explain time and there is no way of describing passage except in terms of passage. Dunne's circularity does not lead to such problems for his regress is not inevitable and does not explain time. It is not inevitable because of the independence of extensional and successive time. The second dimension of extensional time, needed to describe succession in the first, does not itself have to involve succession, since extension and succession are independent. Dunne himself did not realise that his regress is not

necessary (though Heiland realises it(1)), but this consequence follows from the conception of the present as moving through time.

The fully fledged idea of the present as moving through time is a development of the Newtonian tradition of time. One identifies time as extension and time as succession as distinct, and then asserts that time as extension is spatial since all of its parts exist together as one dimension. Then the succession of the present is the successive occupation by the present of different times, which are equivalent to places. But we have in this the definition of motion, so that the present moves through time. This motion implies a time which is its measure, but it does not imply a further succession through this time. The reason is that the measure of succession is, if succession is motion, a measure of the rate of motion of the present, in other words, a measure of how long it takes to move from one point to the next. But how long it takes is merely a duration and, from the above, does not imply a succession. The argument here can be put in a somewhat different form.

Passage is the succession of the present through time, or of time through the present moment. It allows of only one present, which undergoes changes, or to be accurate, is the location of change. The present, then, is an enduring thing in the way that ordinary objects are. The combination of the doctrine of the present as an enduring thing with the idea of time as equivalent to a spatial dimension produces the passage model of time. For the present has to endure through an extension (namely time), but how can it do so? To endure is ex hypothesi not to be extended, but to be identically the same thing over time. But to be identically the same thing through an extension is to move through it. Therefore passage is the motion of the present through time, and not merely analogous to motion. But time is itself the measure of motion, and so unless this aspect of time is distinct from its extensional aspect, a second dimension of extensional time has been discovered. If all the features of our ordinary time carry over to this new time, and not just the extensional ones, then a regress is created.

Motion through time, then, requires several things, which I

(1) see Chapter One.

shall list:

1. That the moments of time all exist and form a dimension equivalent to a spatial dimension.
 2. That the present is a single thing equivalent to a spatial object.
 3. That the moments of time are successively present.
 4. That therefore there is a second dimension of time as in 1.
- Motion through the first time dimension can then be represented just as can spatial motion, by a two dimensional graph. We can in a similar manner to the way of deriving two dimensions of time derive as many as we wish. (1)

Evidently much needs clearing up, such as the nature of a dimension, the features of a spatial dimension, the correctness of understanding the present as a pseudo-object, the meaning of succession and so on.

Now that we have motion of the present through time it is not too difficult to derive time travel. We need to assert two things: that the motion of the present is not constrained by logical necessity, and that the present is composed of the myriad of individuals' presents. That the first is needed is immediately evident, but that the second is needed is not quite so clear, but emerges as necessary when we consider that if the present moved however it would through time, we would nevertheless be unaware of that fact, since we would move as it moved, being restricted to the present.

The most obvious difficulty which any such theory of time which treats the present as being a kind of object, a thing which can have motion, is just what this might mean. What, for example, is the relation between the present and the moment of time which is present? Furthermore, what is the relationship between the present and the objects which are present? Since these questions are crucial to the viability of the view of time under discussion, let us discuss them.

(1) c.f. Weiland, op.cit., p. 160

THE PRESENT AS A MOVING OBJECT.

Just what is 'the present' that is supposed to move? If it really does move then it must be the sort of thing that can move, that is a physical entity - except of course if like God the present moves in mysterious ways. Now there are two sorts of physical motion, that of concrete objects and that of things which, though real, are not concrete. Thus when I move my centre of gravity moves, and vice versa. I am concrete, but my centre of gravity is not, and like my soul it can on occasion leave my body. Just as there are such real but phantom objects there are real but phantom motions. The stars traverse the sky in a single night. If this were a motion of concrete objects, the stars, it would contradict the law that nothing can travel faster than light, since the most distant stars would have vast speeds. Nevertheless, such motion is real enough, and since it cannot be attributed to its apparent source, it is known as apparent motion. Given all this, then, what sort of thing is the present, and what sort of motion has it?

The best answer to give in defence of the motion of the present would seem to be that the present is a phantom in the sense described but its motion is real. To begin with the present cannot be an object, for if it were the problem arises of just what it could be, since all ordinary objects have a temporal extension, whereas the present does not.

Furthermore, the present encompasses all existing things, but cannot be identified with them, any more than an individual's present moment can be identified with the individual, since the individual, as I have said, has temporal extension, whereas the present does not. Nor can we identify the present with the moment of time that is present, since the present must remain one and the same thing if it is to move, and moments of time are distinct a priori. The present, then, is not a kind of concrete object, for there is nothing concrete with which we can identify it.

The way out of this Wells and Dunne adopt is to identify the present with consciousness, since what is present to me and what I am conscious of are one and the same thing. The conscious self,

having no spatial or temporal dimension and yet being an object seems an ideal candidate for motion through time. Not so, however, for it is itself a phantom in the sense I have introduced, since consciousness exists only in relation to that which is conscious. Furthermore, if the conscious self has no dimension, then either it is not spatial or temporal at all and consequently not the sort of thing which can move, or it has no dimension in the sense of being a spatio-temporal point, that is, it has no extension. In this latter case we cannot identify consciousness with a temporal location, since then it could not move, and so we must identify it with a temporal point which can move, namely the present. Consequently, treatment of the nature of the present cannot be avoided by the use of consciousness.

The ghostliness of the present can readily be seen if we picture it as the universe moving through a spatialised time. For suppose that the universal present were to traverse a stretch of time, then reverse direction over that time, afterwards covering it again. The events of that stretch of time would appear first in the normal order, then in reverse order, and then in normal order again. From the viewpoint of the universal present, that is by its own time, all these events would occur thrice, but from the temporal perspective of any object or event within the spatialised time no such repeated occurrence would be evident. This state of surroundings; if a snapshot were taken of it, it would show both the object and its surroundings. If a 'snapshot' were taken of the moving present, at some instant of its motion, what would it show? It would have to show both the present and its temporal surroundings, if the motion of the present is to be anything like ordinary motion, but nothing seems to distinguish the present from its temporal surroundings, because nothing distinguishes the present from the events that happen then, or from the time at which the present is. The present cannot be identified either as an event or as an object, and hence cannot be part of the snapshot. We must conclude, as we have before, that the present, if it is anything, is a phantom object, not a concrete object.

Nevertheless allowing the present to be a phantom has its problems, since we must specify what it is. To do so we must be able to describe what a phantom is. As I said above it is something that

exists and has physical properties but is not concrete. This idea of concreteness is a difficult one to work with, but we can introduce it effectively as follows. The salient property of phantom objects such as I have described is that they can occupy the same place as other objects - my centre of gravity can be within my body, for example. This property is sufficient to distinguish phantoms from concrete objects, since the former can occupy the same place as other objects, but the latter cannot. There undoubtedly are such phantom objects, many of them, of varying degrees of usefulness, but their status is strange, since we can create them simply by specification for example the midpoint of the straight line connecting Canberra and Sydney. A universal feature of examples like this is that such objects cannot be specified except in relation to concrete objects. Is this true of all phantom objects? I believe so, although an affirmative answer does not follow simply from the definition of a phantom as an object which exists, has physical properties, and can occupy the same place as other objects. Consider, however, some other candidate for phantomhood, ghosts and spooks, might have been phantoms in our sense, but they are not, because either they are concrete, however tenuous they might be, or they are not physical. Things such as 'astral' bodies, can be accepted as phantoms, for they are projections of the body, not independently specified. Phantom objects, then, if they are physical, are distinguished from concrete objects primarily by this one feature, that they can exist where other bodies are located, they can interpenetrate, whereas concrete bodies cannot.

Given that the present is a phantom, and that phantoms must be defined in relation to concrete objects, how can we go about defining the present? We must do so in relation to some concrete object, but what? The obvious candidates are the whole universe and any individual object, since the objective is to establish time travel, a requirement of which must be that individual and universal times may differ radically. Let us consider the individual candidate.

Bearing in mind the identifications of the present which we found to be untenable, we have to discover a relation which will define the present. A likely relation, and one which we have not considered yet, since we have been considering the present as an object, is that of temporal perspective, so that we define the present as the centre of an individual's temporal perspective. Now this is the common

definition of the present, and avoids all the problems we have been discussing. Then, just as a motion of an individual's centre of spatial perspective implies a motion of the individual, so does a motion of the individual's centre of perspective. Consequently, motion of the present so defined implies time travel in the fully fledged sense.

The difficulty here is that since the present is a phantom its motion is a derivative one from that of a concrete individual. That is, the phantom (such as a centre of gravity) moves when and because the concrete object moves, and not vice-versa. As a result, the motion of the present through time as if it were an object is only intelligible if the motion of an object through time is already intelligible.

The end result of the above argument is that time travel, in the sense of concrete objects travelling through time, cannot be derived from the motion of the present without circularity, since this motion presupposes the motion of concrete objects through time. Nevertheless the idea of the temporal motion of the present is a valuable one, for it remains true that if the passage of the present genuinely is a form of motion, then time travel is a possibility.

Given that we cannot use the present directly as a means for justifying the idea of time travel, what options do we have? The use of the dimensionless entity 'the conscious self', which Wells and Dunne both employ, is out as a means of justifying the motion of the present since, as I have explained, it leads to a circularity. The only possibility seems to be to find a new approach to the question of whether an object can move through time, an approach which does not require the motion of the present either as a starting point or as a middle point.

There are independent reasons for believing this to be necessary, reasons which have nothing to do with time travel or the present as a moving object, but rather to do with a general critique of the concept of time.

THE FISSION OF TIME.

When I introduced the idea of the motion of the present earlier this chapter I spoke of the uneasy union of time as extension and time as succession in the philosophical tradition of Newton. Locke is an excellent example. I spoke also of how this union lay quiescent and unquestioned, part of the common wisdom which is excellently summarised by Kant:

We represent the time-sequence by a line progressing to infinity, in which the manifold constitutes a series of one dimension only; and we reason from the properties of this line to all the properties of time, with this one exception, that while the parts of the line are simultaneous the parts of time are always successive.(1)

I spoke further of how this conception of time was adequate to the philosophical concerns of the age, which were to do with the description, explanation and understanding of continuous change, because it ensured that time itself was continuous.

Towards the end of the nineteenth century the synthesis began to break down. One minor development was that with which I have been concerned, the drawing out from the synthesis of the Newtonian tradition of the idea of the present as moving through time. Another more important development was that of Idealism, in the tradition of which McTaggart attempted to show the unreality of time. Another important development was undoubtedly that of Relativity theory, which proved that time and space need not, and are not, related in the way the Newtonian tradition demands. The last important development was the invention in mathematical logic of a sound foundation for the notion of a mathematical variable, which showed that the variable need not be explained in terms of succession. The first two of these developments primarily concern time as succession, but this is secondary to the third and fourth, which are concerned primarily with the extensional, measuring aspect of time, but which nevertheless have profound implications for succession.

The result of these different developments was a split between time as succession and time as extension which led to opposing

(1) Immanuel Kant's Critique of Pure Reason, trans. by N. Kemp Smith, Macmillan, London, 1933, p.77

theories of time, one of which accepts temporal succession as fundamentally real and the other of which accepts temporal extension as fundamentally real. In what follows I shall attempt to give a brief indication of how this state of affairs came about. I shall explore in the next chapter the opposing creeds and their backgrounds.

TIME AND CONTINUITY.

In the development of the physical sciences after they had been given their definitive frame of reference by Newton, the primary tools of investigation were observation and experiment rendered into laws by the infinitesimal calculi. Consequently, nature was described in terms of continuous laws. The conception of the succession of time in such a frame is of a continuous flow rather than of discrete moment following discrete moment, but succession in any form finds no expression in the laws of continuous change. This is because distinctions of past, present and future are irrelevant to specifications of continuity, only the order of moments of time and the mathematical type of their series matters.

The irrelevance of succession to laws of continuous change has had an important impact on the theory of time in the modern philosophy of science. It has led, for example, to the question of whether time has an intrinsic direction (1). While succession is fundamental, time has a guaranteed direction, for it is the order in which events and times succeed one another. The state of affairs in which the sciences found themselves with respect to succession was a fortunate one, for it meant that when the idea of succession was shown to be a contradictory one it could be thrown out as excess baggage. Up until then succession could remain, although it had no functional use in the Newtonian world scheme.

The only use of any kind that the flow of time and succession had for this scheme was that it bolstered the view of a universal simultaneity, that is the idea that every place in the universe shares a single time, so that for a given moment at some place in the universe there is everywhere else a unique moment which is simultaneous with that given moment. Such a view has intuitive appeal through the image of the

(1) c.f. Williams, op. cit. p. 462 for a typical line on this.

flow of time as like the flow of sand through an hourglass, so that the universe is in like manner seen as flowing through the present.

This Newtonian view of time was, early in the twentieth century, under threat from many sides. There was the relatively unimportant paradoxes generated by showing the flow of time to be a form of motion. These were relatively unimportant because as I have explained they do not affect the structure of Newtonian time, since they affect neither the doctrine of time as continuous extension nor the succession upon which universal simultaneity is based. There was the development of relativity theory which showed that universal simultaneity was by no means necessary, and furthermore that the events of the universe perhaps could not be placed in a single temporal order. There were the criticisms of time by McTaggart, which undermined the explanatory force of succession as the generator of time (which is what the tradition we are discussing believed of succession). I shall return to McTaggart's argument later in this chapter, because it has the advantage of clearly relating opposing theories of time. Finally, the modern theory of the variable completed the undermining of succession as the generator of time, by showing finally and absolutely that succession is not required for the expression of continuous functional relationships such as those of physical law.

These topics will be treated at greater length in the next chapter, I am here more interested in their results. It is perhaps suprising that the physical sciences which have been based on the Newtonian theory of the structure of space and time should have survived the destruction of this theory with so little disturbance. The relative calm of the transition is, I think, attributable to the purpose of the theory and its main feature, which have never come under serious attack. The purpose was, as I have said, to make space and time continuous, so that the mathematical theories of continuity could be brought to bear on them. This feature of continuity, which makes the universe amenable to analytic treatment, has carried over wholesale into relativity theory. Anything more is superstructure and can be dispensed with if there is reason to do so. Consequently we find that when the metaphysical foundations of the Newtonian concept of time are shaken by the criticism of succession this blow has very little effect.

THE END OF SUCCESSION.

For the Newtonian tradition time is generated by motion or succession. Locke and Kant say so. ^{? or don} the parts of time do not coexist but are successive. But this leads to paradox if it is to mean as it is intended to that it is by the fact of succession that the parts of time come to form an extended dimension. The idea that succession, that is change, is the foundation of the extension of time, that is the sequence of events, is a natural one, but paradoxical. The paradox is due to McTaggart who also believes that succession is fundamental. He states: '...it is because the distinctions of past, present and future seem to me to be essential for time, that I regard time as unreal.'⁽¹⁾ It is the language of past, present and future which is the language of succession. I shall now show how the paradox arises, using a reconstructed form of McTaggart's argument.

Firstly we have the principle that if there were no succession there would be no duration, that is, temporal extension. Secondly we characterize succession. Put crudely the idea of succession is that the parts of time exist one after the other, that they come into existence and then cease to exist. But let us characterise succession a little more carefully. The idea begins from the perception that some events are past, some present, and some future, with only those which are present existing now. But this perception does not deliver us the full idea of succession, for which we need to be able to express how what is past, present and future changes from time to time. We can express this in either of two ways:

1. Any event which is now present has been future and will be past.
2. Any event which is present at time x is, at any earlier time y , in the future and, at some later time z in the past.

Now, given that the extended temporal series is generated from succession, as we have assumed, then 2. which refers to the ordering of such a series, ultimately has to be explained in terms of succession, so that it gets us no further forward and 1. is the only genuine possibility as an expression of succession.

(1) J.M.E. McTaggart, The Nature of Existence, Cambridge 1927 Vol.11, Ch XXIII, p.10.

What has happened in 1. is that we are using further characterisations of past, present and future in order to introduce succession, applying them, instead of directly to an event, to the presentness of an event, the futureness of an event and the pastness of an event. Each of these could be past, present or future.

The paradox of succession is built on this groundwork. As McTaggart says 'Past, present and future are incompatible determinations. Every event must be one or the other, but no event can be more than one'.⁽¹⁾ But as we know, every event has all of these incompatible determinations. Not, to be sure, simultaneously, rather, successively. By the characterisation of succession we have given above, this means that the futureness of an event, the presentness of an event and the pastness of an event are determined as past, present or future. But again, past, present and future are incompatible determinations which all apply to each of these second order events. How is this contradiction to be resolved? Continued qualification of the determinations as applying successively will not help because the contradiction will reappear at each stage. Nor, if there is no fault in the argument or its premises, can a resolution be found, and consequently, by the principle of reductio ad absurdum, there can be no such thing as succession.

McTaggart's argument is, I believe correct, and shows that the standard combination of succession and extension in the Newtonian tradition cannot be maintained. The two crucial premises of the argument are that from which it begins, that the extensional order of time is generated from or can be reduced to succession, and that every event has all three determinations of past, present and future. If the first is denied, then succession can be successfully treated by reference to extensional time, and the regress does not arise. If the second is denied the regress arises, but it involves no contradictions, and the effect is to make impossible any reference to events except present events. These two premises are, the crucial ones, I believe, for several reasons.

(1) op.cit. p.20

First, it is the combination of these two which generates the idea of temporal motion. For temporal motion requires on the one hand that succession is a necessary part of time, and on the other that the moments of time have an equal ontological status, that is, coexist. But this latter requirement is implicit in saying that every event has all three determinations of past, present and future, for this implies that it is possible to refer to events indifferently whether or not they are present, and whatever belongs to the same class of reference coexists.

Second, the denial that succession is necessary for change, which is the result of the modern interpretation of the variable, is intimately connected with replacing the variable by a class of entities of the same ontological and referential status.

Third, it appears that at any attempt to reduce durational extension to succession must face the difficulty that the foundation of the idea of succession cannot be temporal in character because it cannot involve any reference other than to the present. I discuss this matter at some length in a different connexion in Chapter Five.

THE SURVIVAL OF TIME TRAVEL.

With the complete discrediting of the notion of succession as it was standardly understood, one would think that time travel should have become entirely defunct also, since it was derived fundamentally from the notion of succession. Strangely, however, it has survived, and has found a niche in each of the two opposing modern theories of time.

On the one hand, time travel has found a place with theorists of the 'manifold' or 'block' universe, that is, with theorists who have inherited the Newtonian universe stripped of succession. Time travel functions there in two ways. It is used by some, such as Williams, to demonstrate the similarity of space and time.⁽¹⁾ It is used by others,

(1) Williams, *op cit.* (see Chapter One)

such as Gödel, to show the flexibility of relativity theory and to further discredit the idea of a single universal time.

On the other hand, time travel has found a place with theorists who reject the 'block' universe and centre their theories on succession. There time travel is used primarily to investigate the nature of the past or of human action. There is a greater tendency among such theorists to suppose that time travel is a touchstone for inconsistency than there is amongst their opposite numbers, but not all believe so, as Heiland evidences.

I believe that both camps have deep seated principles which make the idea of time travel a very tenacious one. As I remarked at the beginning of this chapter, the treatment of time travel is intimately connected with two different epistemological standpoints connected with the nature of evidence and human experience. This intimate connection is I believe, not restricted to time travel, but extends to the treatment of all aspects of time.

In order to demonstrate how deep seated these epistemological standpoints are, the next chapter begins a discussion of theories of time which is unconnected with time travel, and which culminates in Chapter Five with a detailed discussion of the epistemological issues. The final chapter returns the discussion to time travel and shows something of the implications of these issues.

SECTION TWO.

GENERAL PHILOSOPHIES OF TIME.

CHAPTER FOUR.

THE BLOCK UNIVERSE AND THE EVOLVING PRESENT.

The theory of time I have been calling 'block' acquired that name as a term of derision from William James, for whom it indicated that time was a dimension of space. James, following the lead of Bergson, thought this absurd, and designated the universe envisaged as so four dimensional the 'block' universe, and the spatial time involved as 'cinematographic'. The point of calling spatial time cinematographic is that for such a time events are a sequence of instantaneous events in a line, like the frames of a movie film along the film. The analogy is for James and Bergson a good one, though I believe it defective.

I have chosen to discuss this theory of time first of all from the point of view of its enemies, because that way some salient points stand clear. It turns out from reading Bergson that the attack which uses such graphic names is against anyone who believes that when he is measuring or quantifying time he is dealing with a real thing. While a denial of this would come as a surprise to most of us, and seems contrary to common sense, for most of us also the issue is unimportant, and so long as we can continue to measure and quantify time as we do, we do not care. Practitioners of the sciences share this majority view, but the theoreticians of the sciences do not. They regard extended, measureable time as real. Bergson, then, is attacking a feature common to all the metaphysics of modern physics. Thus when the block universe is shorn of its derisory aspects it simply refers to that structure and connection of space and time as advocated by the philosophers of science. These philosophers of course have their scare words to throw against the Bergsonian ranks, accusing them, half accurately, of believing in the passage of time. It will be useful, I think, to begin this chapter with a discussion of Bergson himself.

HENRI BERGSON

Bergson's philosophy of time was based on two fundamental premises, that any numerical quantity must be spatial in character, and that no moment of time persists. Working from the basis of these two propositions he

denied reality to the time of the scientists, and constructed a strange doctrine to avoid its unreality. He construed the time of science as that defined by Locke, infinite duration infinitely divisible. This time has a character analogous to that of space; duration is the idea of temporal distance, it is represented by a geometrical line, and moments of time function for time as places do for space. Time and space are distinguished by Locke in one important respect. He says:

Duration, and time which is a part of it, is the idea we have of perishing distance, of which no two parts exist together, but follow one another in succession; as expansion is the idea of lasting distance, all whose parts exist together, and are not capable of succession. (1)

Bergson purports to find this characterisation of time as suffering from an internal contradiction.

The thesis which Bergson uses to show this contradiction is that the idea of quantity is necessarily spatial in character, from which it follows that duration, being a quantity, is spatial in character; that is, its parts coexist rather than succeed one another. Bergson justifies his thesis in psychological terms, appealing on the one hand to the learning of number and quantity concepts, and on the other to the visualisation of time, but it is quite clear that this justification need not be interpreted in psychological terms. We read such representative passages as:

It is certainly possible to perceive in time, and in time only, a succession which is nothing but a succession, but not an addition, that is, a succession which culminates in a sum. For though we reach a sum by taking into account a succession of different terms, yet it is necessary that each of these terms should remain when we pass on to the following ... And where could it wait if we do not localise it in space? (2)

This problem, despite its new dress, is a very old one, and is the one familiar in Augustine of how we can have a measure of something, such as time, whose parts do not coexist. Bergson's solution also is that of Augustine, albeit less tentatively expressed:

... when we add to the present moment those which have preceded it, as is the case when we are adding up units, we are not dealing with these moments themselves, but with the lasting traces which they seem to have left in space on their passage through it. (3)

(1) An Essay Concerning Human Understanding, Bk.11, Ch.15, Para.12.

(2) Time and Free Will, translated by F.L. Pogson, George Allen, 1912, p.78-9.

(3) *ibid.*, p.79.

In other words we do not measure time, but only present representations of it, and therefore, according to Bergson, quantities of time are strictly speaking quantities of memory, as Augustine concluded somewhat dubiously. Bergson's conclusion, like Augustine's, seems paradoxical, since it appears to deny, for example, that clocks measure time, and indeed Bergson does deny just this, although he does not deny the usefulness of clocks. Rather he says that clocks never measure time, but only indicate one time which by a mental construction we interpret as one of a coexisting series, whereas this series does not coexist for the clock, only the time it indicates exists.

Because he finds quantified time so abhorrent, Bergson looks for a way in which time can be understood unquantified. He asserts that our fundamental temporal experience is qualitative, and does not permit of division into distinct pieces, that is, of quantification in his sense; for him the essence of time is lost by representing it as quantified. He does not deny the reality of time, if time is understood correctly. Bergson's position is encapsulated in his discussion of an oscillating clock:

... within our ego, there is succession without mutual externality; outside the ego, in pure space, mutual externality without succession; mutual externality, since the present oscillation is radically different from the previous oscillation, which no longer exists; but no succession, since succession exists solely for a conscious spectator who keeps the past in his mind and sets the two oscillations or their symbols side by side in an auxiliary space. (1)

The conclusion is that the time of the mathematicians and scientists, of time as measureable and quantifiable, is a time devoid of succession, and therefore a time whose parts can, contrary to Locke's opinion, coexist.

Such a conclusion does not worry the modern philosophy of science one bit, one of its major enterprises has been the elimination of tenses, the means by which we express succession. Bertrand Russell describes how this elimination can be carried through, and Quine; many philosophers, notably D.C. Williams, have attacked the idea of passage, that is, succession, as incoherent. The elimination of

(1) Op. cit. pp108-9.

succession is no worry in itself, ^U what is worrisome is the further charge, ^X levelled by Bergson and many others, that without succession there is no change, nor indeed any endurance. Bergson's own argument for this is simple. On the one hand he points out the abundantly evident experiential fact of the transiency of things, and on the other he claims that any quantified, that is, spatialised, time falls foul of Zeno's paradoxes. Thus he claims that mathematical time does not account for an essential feature of time, namely succession, which is a given fact of life, and that if mathematical time is granted its essential feature it cannot represent motion, but only position.

^X The challenge to mathematical or physical time is a reasonable one, ^I It must give an adequate account of the experience of succession, and it must deal with Zeno's paradoxes of motion. Whether the challenge has been adequately met is a matter of current dispute.

Unfortunately the central issues have been clouded by mismatches of terminology. The issue between those of Bergsonian and those of the opposite temper has often been posed as the question 'Is time a fourth dimension?', a question which it would seem means what you wish. The issue is again raised as 'Is time spatial?', which also is calculated to be misunderstood. Such issues are derivative, evolving from the basic issues: is time measurable? and, do the parts of time coexist? Those who answer negatively are Bergsonian, those who answer affirmatively, most philosophers of science.

The Bergsonian worries about mathematical time are reflected in modern writers, a good example being G.J. Whitrow, who gives a popular exposition of his views in What is Time?. I shall present these shortly.

In Time and Free Will and Matter and Memory Bergson does not use the cinematographic analogy from which this discussion began. The analogy however forms an important part of Creative Evolution, for it exemplifies excellently Bergson's view of measurable or mathematical time. Bergson, as I have said, argued that we can only measure time by representing it as spatial, by placing its parts one by one next to one another and distinct from one another in an 'auxiliary space'. The cinema film could hardly have been a more appropriate invention, whose frames are placed next to one another and distinct from one another in a

spatial line. Further, the film, though it represents motion, is devoid of it and must be played in order to recreate motion.

In these respects the cinematographic analogy is excellent, it captures Bergson's account of how we represent time spatially. Unfortunately the analogy is as crucially defective as it is crucially accurate. The time of science is unlike a cinematic film in two fundamental respects: the analogue of frames of the film are moments of time, but whereas each frame has a spatial length, the moments of time have no temporal length, that is duration; and whereas each frame has a closest spatial neighbour, the moments of time have no nearest neighbour - between any two points of time there are other points, but the frames of the film are not like this. You soon arrive * at an adjacent pair of frames between which there is no other.

Bergson's opinion of the account of change given by mathematicians and scientists is that it is cinematographic; he believes that according to it there is a state of affairs at one instant, another state at some later instant however close, and somehow a thing must jump from one to the other. 'The movement slips through the interval, because every attempt to reconstitute change out of states implies the absurd proposition that movement is made out of immobilities'.(1) What Bergson is expressing here is the paradoxes of motion due to Zeno, as he goes on to say, but in his mode of expression there is an important though implicit doctrine about states of affairs.

When we visualise a moment of time we visualise motion so to speak frozen at that moment, like a snapshot. We say that the camera has captured a certain state. We do not for a moment suppose, however, that it has captured everything about that state. Photographs are notoriously ambiguous, and of two people leaning together, for example, it may be impossible to tell who is supporting whom. Bergson is, I think, captivated by the snapshot version of states. It would be impossible for him to admit, for example, states of motion. If we think for a moment beyond the idea of an instantaneous state as 'frozen', we see that we ascribe statehood to all kinds of things, talking of states of disorder, states of motion, states of hysteria and so on. However, our natural inclination is to turn such expressions into a grammatical form where the filler for 'state of.....' is a substantive. Corresponding to this grammatical form is the contrast between states and processes, where for example running

(1) Quoted from Zeno's Paradoxes p. 63 extract from Creative Evolution.

and exploding are processes, and are to be contrasted with states such as readiness or bliss. Processes are, by this contrast, reported by verbal derivatives, states by adjectival derivatives. We might say therefore that states are qualifications of things, not, as processes are, changes in things. In the Continental terminology states are aspects of being, processes are aspects of becoming. Ordinarily we do not distinguish one from the other very clearly, and it is no part of science or mathematics to improve on ordinary usage in this matter. States of motion, states of change are perfectly respectable as far as science is concerned, especially since it can, when it wishes, dispense altogether with talk of states in favour of the truth of propositions. There is a genuine difficulty with the idea of a state of change or motion, in that it seems to involve the idea of actual infinitesimals, which are anathema to the rigorous mathematical physicist. I will discuss this later in connection with Bertrand Russell.

Bergson, then, contrasts states with processes. Processes take time, so no process can be instantaneous, and so nothing can be in process at a moment of time. Such is the import, I think, of Bergson's insistence that motion can only pass through the points of its course, and can never be at any of those points. The emphasis is on the 'be'. If we contrast states and processes in the above fashion it becomes a matter of definition that a process cannot be reduced to a series of states, for we can never say that at a given instant a thing is in a state of motion, for motion is a process. It is fair to summarise Bergson's complaint about mathematical time as follows. Time is a composite of instants. Things at an instant can only have proper ties of being, not becoming, because becoming takes time. All that's true at an instant is that things are in a certain state, and no collection of states can add up to a process. The sort of thing Bergson says is that at an instant a thing can only be in a position, not in motion, and that no sequence of being in a position adds up to motion. Bergson's thesis, then, is that the time of science deals in states not in processes.

This thesis is either a new assumption, because it does not follow from the rest of Bergson's account of measureable time, or is to be derived from Zeno's arguments. Bergson presents Zeno as corroborative evidence for his distinction of motion from change of position, that is, ; x

of process from a sequence of different positions, but Zeno's arguments are better taken as the reason for making the distinction, because without these arguments there is no obvious reason for thinking it contradictory to say that at an instant a thing is moving. The one potential reason for thinking so, other than these arguments, is the impossibility of an instantaneous process, the fact that processes take time, which one might, highly dubiously, express by saying that a thing cannot be in process at an instant. Bergson gave this line of thought more weight than it deserves, I think, because of his insistence that time, to be measureable, must be represented via space. Even granted this, it does not follow that the attributes which are represented are spatial in character. Bergson was confused by the distinct yet related notions of dimension and spatiality, and consequently forgot that representations are analogies, and not all the characteristics of the representation carry over to the reality. Because Bergson thought that time is represented spatially, and must be, and spatial properties are properties of being, not becoming, that the only temporal properties which can be represented in space are properties of being - in the case of motion, all that can be represented is being in a certain position at a certain time. In thinking so Bergson was just plain wrong. As Russell says of him, he was working with a philosophy of mathematics that was long out of date. I shall return to this later. *

Unfortunately there are other reasons, not related to Bergson directly, for an apparent denial of process in the scientific world view. These emerge in Whitrow's book What is Time?, to which I now turn.

G.J. WHITROW

The modern philosophy of science has been a great boon to philosophers, lending a new weight and authority to old doctrines. Despite being a mathematician, Whitrow's doctrine on time is Bergsonian. He concludes What is Time? with this summary:

... although our perception of time has many subjective and even sociological features, it is based on an objective factor that provides an external control for the timing of our physiological processes. This objective factor is what we call physical time. It is an ultimate feature of the universe and its relationships with observers, particularly fundamental observers, which cannot be reduced to anything else. But this does not mean that it exists in its own right: it is an aspect of phenomena. The essence of time is its transitional nature (1)

(1) What is Time? G.J. Whitrow, Thames & Hudson, London, 1972, p. 177

The language is new, but the message is the same, physical time is an objective feature of the world, but it is not real. Bergson would say that physical time accurately represents phenomena, but it is not real, it is only a representation. I am at this point concentrating on Whitrow's popular exposition, rather than on his more careful and sophisticated work in the philosophy of time (1), because the guiding principles of his philosophy are clearer this way than otherwise, and my aim is to discover these, not subtleties.

Concerning the relation of past and future, which Bergson labels creative evolution, so that past and future differ in ontological status, the past being created but the future uncreated, with the present being the moment of creation, Whitrow has the following to say:

Genuine precognition, in the sense of our being able, in certain circumstances, to perceive future events before they actually happen, might perhaps be possible if we inhabited a block universe in which ... physical events do not suddenly occur but are there waiting for us to experience them. This idea has already been rejected on the grounds that past, present and future are in fact objective characteristics of physical events. But the block-universe hypothesis has strange implications for mental events, such as our conscious perceptions and our decisions to perform physical actions. In a block universe ... past, present and future do not apply to physical events, and so they neither come into existence nor cease to exist - they just are. But whatever kind of universe we inhabit, mental events certainly come to be and cease to be in our personal experience. Therefore, if we inhabited a block universe, mental events would have a completely different kind of existence from physical events. This would have the most peculiar consequences for cause and effect. In purely physical causation, an effect would not actually be produced by its cause, it would merely be further on in time. But mental causation of a physical event - such as deciding to drop a stone into a pond - would mean that a cause (in this case, the decision to drop the stone) suddenly comes into being, but the effect (the splash when the stone strikes water) would not: it would just be. Such a strange difference between cause and effect would be completely incomprehensible.(2)

Though couched in more modern terms, this line is pure Bergson. I have quoted it at length because it encapsulates well the modern revamping of Bergson. The same contrast of the world of physics with the world of experience is there; the same accusation that physics and science, at least insofar as they rely on the block universe, are unable to account for the

(1) The Natural Philosophy of Time

(2) What is Time?, pp. 175-6

creative freedom of human life; and the same denial of equal status to the future and the past.

In a discussion of the implications of Relativity theory, Whitrow shows how mathematical physics tends towards a block-universe interpretation of phenomena. Unfortunately in so doing he shows how the opponents of the block universe tend to confuse the ideas of mathematical physics, even though he does not do so himself. These confusions are the same ones evident in Bergson.

As is well known, Relativity theory provided a fundamental challenge to our ideas of physical time, denying the concept of a world-wide present, and asserting that the temporal order of events could be different for different observers. It led to an acceptance of the relational theory of time as against the absolute theory of time, that is, an acceptance of the theory that instants of time are artificial constructs from time relations between events, rather than existing in their own right. Leibniz's theory of time, the relational theory, was found to be able to accommodate the empirical facts of Relativity theory better than the Newtonian theory of absolute time. This apparent victory was tempered, however, by Minkowski's development of a replacement for the idea of absolute time.

Minkowski developed a four dimensional mathematical space which ascribed to every event a unique location, and from which could be derived the temporal order of events relative to any observer. The parameters were normal, three spatial and one temporal, and each event was located by a unique quadruple of numbers representing these parameters. It was therefore again possible to regard instants as absolute, though not necessary to do so. This mathematical space, which Minkowski, called the 'World', is now commonly called 'Space-Time'. Though instants of time were in a sense reinstated, they were also in a sense banished. Space-Time allows of unequivocal dating of events, certainly, but apart from that time is converted into a spatial parameter, by the simple expedient of multiplying it by the velocity of light. The idea of temporal distance, that is, duration, which was so prominent in the Newtonian theory of time, so prominent that it was used to define time, as for example Locke used it,

is completely abandoned, even though the parameter of time is not. In the Newtonian theory of space, and time, spatial distances are incommensurable with temporal distances; a spatial length cannot be interchanged with a temporal one, that is a duration, to specify the 'distance' of one event from another. It is necessary to use two numbers, one to represent the spatial separation and another to represent the temporal separation. In Minkowski's World distance is represented by just one number, which is the square root of $\Delta x^2 + \Delta y^2 + \Delta z^2 - c^2 \Delta t^2$, where $\Delta x, \Delta y, \Delta z$, represent the spatial separation between the events along each of the axes of measurement, c the velocity of light and Δt the temporal separation. How temporal distance, duration, has disappeared can be seen by considering the case of two events occurring in the same place but not simultaneous; $\Delta x, \Delta y$ and Δz are then zero, and the Space-Time distance is the square root of $-c^2 \Delta t^2$, that is, $\sqrt{-1}ct$. This quantity is imaginary, due to the coefficient the square root of minus one, but apart from this numerical oddity the quantity ct has the physical dimension of a spatial length, because it is the product of a velocity and a time. This quantity is therefore not a duration, it is quite literally a distance, and therefore we can say that Minkowski's Space-Time replaces duration with spatial distance, and therefore spatialises time. This conclusion cannot be simply maintained because of the $\sqrt{-1}$ factor which is unique to the time component of the distance formula and thus distinguishes it from space, but nevertheless so far as distances between events in Space-Time goes there is no temporal distance between events, this is replaced by a related spatial distance. Thus time, indispensable as a parameter of measurement, is dispensed with as a metrical, that is distance, notion in favour of a spatial relative.

Whitrow believes that Minkowski's Space-Time with its partial banishment of time tends to support a 'block' view of the universe, one in which the passage of time is denied objective reality. He quotes Hermann Weyl:

The scene of action of reality is not a three-dimensional space, but rather a four-dimensional world, in which space and time are linked together indissolubly. However deep the chasm may be that separates the intuitive nature of space from that of time in our experience, nothing of this qualitative difference enters into the objective worlds which physics endeavours to crystallize out of direct experience. It is a four-dimensional continuum which is neither 'time' nor 'space'. Only the consciousness that passes on in one portion of this world experiences the detached piece which comes to meet it and passes behind it as history, that is,

as a process that is going forward in time and takes place in space. (1)

There are two closely connected theses here: that time and space are not qualitatively distinct as experience suggests; and that time does not pass except for experience. They contradict the fundamental theses of Bergson's philosophy of time, which insists on the qualitative difference of space and time and on the passage of time, founding itself on the objective truth of the experience of time. Weyl's position is an extreme one, but Minkowski's work accelerated the shift by scientists towards an acceptance of a four dimensional world view. Just what this acceptance means is a matter of interpretation, ~~It~~ ^{It} is one thing to accept ~~the world as four dimensional and quite another to accept that space and time are radically alike.~~ ^{the world as four dimensional and quite another to accept that space and time are radically alike.} We tend to conflate these two issues when dealing with space and time. ~~We~~ ^U have no corresponding difficulty ~~in imagining a four dimensional world in which the dimensions are three of space and one of mass, or temperature. Scientists have, however, generally gone further than adopting time as a fourth dimension. As Whitrow says of Einstein:~~ ^{*}

Following Minkowski's lead, Einstein came to the conclusion that the objective world of physics is essentially a four-dimensional structure, its resolution into three-dimensional space and one-dimensional time not being the same for all observers. "It appears, therefore, more natural," he wrote, "to think of physical reality as a four-dimensional existence, instead of, as hitherto, the evolution of a three dimensional existence." (2)

Einstein is here adopting a more moderate position than that of Weyl, or at least it is prima facie more moderate, because it does not assert that space and time are radically alike, only that the idea of passage is to be rejected as a feature of the world. Nevertheless Einstein is going beyond the idea of time as a fourth dimension, and claiming that its relation to space has to be interpreted in a certain way, as a dimension of existence rather than passage.

Einstein's more moderate position is perhaps the minimum that can be maintained. The reason is that while Minkowski's Space-Time gives an adequate representation of space and time, ascribing definite locations

(1) What is Time? p. 125

(2) What is Time? p. 125-6 Einstein quoted from Albert Einstein, Relativity, The Special and the General Theory, A Popular Exposition, translated by R.L. Lawson, Crown, New York 1961, p.150.

to every event in Space-Time in accordance with the demands of Special Relativity theory, there is nevertheless an essential fact about the theory that prevents the interpretation of this Space-Time as the history of a spatial world. This fact is that, according to Relativity Theory, there are circumstances under which it is impossible to determine uniquely the temporal order of events, where no observer's recording of the temporal order of the events can count as more valid than any other, and consequently there is no sense, practically speaking, in saying that they have a unique order one to another even though they have a unique order to each observer. The circumstances under which this occurs are when the events in question can not be causally related one to another because of the limitation on causal propagation imposed by the finitude of the speed of light. As a consequence, although each observer has a three dimensional space with a time in which all the events as observed stand in determinate temporal relations, the world as a whole cannot be treated as if it were such an observer. There is not, and cannot be given the finitude of the speed of light, a universe-wide present moment; that is, the concept of simultaneity applicable to an observer at a point of space cannot be extended to whole world. Given this, Einstein's conclusion as quoted by Whitrow follows easily, for the whole world can be regarded as a single being which evolves through time only if the concept of distant events being simultaneous is always and everywhere maintainable so that the idea of a world-wide simultaneity can apply. Thus for Einstein to reject the idea of a cosmic evolution is for him to be as moderate as possible given the correctness of Relativity theory. He does not here as Weyl does dismiss the passage of time as an aspect of consciousness, though he is not precluded from doing so, nor does he argue for a radical similarity of space and time, though again he is not precluded from doing so. Putting Einstein's point very imprecisely, we might say that all our little evolutions do not add up to one big evolution.

Whether or not the concept of passage has to be abandoned entirely given the truth of Relativity theory is a matter requiring decision. The concept of the passage of time at a point of space is not obviously untenable, but passage has to be untenable for any object with spatial extension, for then the same considerations apply as apply for the world as a whole. The guiding principle in this decision must be whether we think that time can pass for the parts but not for the whole.

If we think not, then we will dismiss passage as only an aspect of consciousness, as Weyl does. But must we think not? Many theologians have thought that passage is a real feature of the perspective on the world of created beings, but not a feature of the divine perspective. If time passes only from the perspective of a spatial point, is that sufficient to show that passage is unreal, only a feature of consciousness? Whitrow reinstates the objectivity of passage by pointing out that by the definition of simultaneity in Relativity theory, no problems can arise with the simultaneity of events that occur at the same place, but whether this is sufficient for passage is another matter. However we decide this question of local passage, the physicist will make one demand of it, that he be able to refer to all events at a given place as equally real at least from the perspective of his four dimensional Space-Time, for Space-Time, being without passage on the large scale, is nevertheless not insensitive to the occurrence of events, or more accurately perhaps, it requires their existence. Whether or not this requirement suffices to eliminate the idea of passage is a question beyond Relativity theory, applying equally to all physical theories which require such reference. Einstein obviously thought that it was not this requirement which banishes passage, but rather features special to Relativity theory.

In this short discussion of the remark Whitrow quotes from Einstein, it has become quite clear that the considerations which motivate the mathematical physicists, and the significance of their positions regarding the nature of time, do not mesh straight forwardly with the Bergsonian line of Whitrow. It is difficult, for example, to ^{xx}straightforwardly accuse mathematical physics of spatialising time. Their position is too subtle for that. The closest one can get is Whitrow's comment on Space-Time, that 'the guiding concept is evidently more spatial than temporal'(1). The anti-scientific world view has had to adjust its accusations to compensate; nevertheless the fundamental complaint is the old one, that in formulating its world view science has at its very root missed important features of the real world, especially temporality and change.

(1) What is Time? p. 125

THE BLOCK UNIVERSE

Those I have characterised as belonging to the scientific camp are far from united in their world view, they are equalled in their division of opinion only by those I have characterised as Bergsonian. Nevertheless, each camp has essential characteristics.

The scientific camp believes that the scientific method is the way to all true knowledge, except for that knowledge which belongs to the methodology of the sciences. Concepts and theories which are found not to be compatible with findings of science are to be reconstructed until they are. Extreme forms of this position are the physicalism of Carnap and the linguistic reduction of Ayer, but there are many more moderate, such as Russell and Schlick. Such a position does not deny truth to the non-scientific, it says rather that the final arbiter of truth is the scientific method. A pre-scientific and a scientific theory are on the same footing, they must stand the test of the method, and if they do not, so much the worse for them. As a consequence our ordinary ways of speaking are very often regarded as shoddy or careless ellipses for an accurate artificial language constructed to meet the rigours of the scientific method. Quine is perhaps the most brazen advocate of the virtues of artificial or what he calls 'canonical' language, but the attitude is shared by all.

In the opposite camp, which I have called Bergsonian, the followers believe in variants on the falsely modest 'ordinary language' method, which aims to avoid the starting systems of the other camp and found truth on what we ordinarily say, on the common sense view of the world. Although by talking of ordinary language and common sense such philosophers seem to be taking a pragmatic line, this is far from the truth, and tends to downgrade the common sense foundations of the empirical sciences. The method of the Bergsonian camp has not been given a general descriptive name as the scientific method has, but such an underlying method is certainly there. In earlier times it would have been appropriate to call this method psychological, for that is certainly Bergson's beginning point, but such a name is inappropriate now, since psychology has aspired to the status of a natural science. The philosophers who follow this unnamed method believe that truth is ultimately to be founded on the conditions of and for human experience

and action. The method is no more (or less) epistemological than the scientific method, for both aim to explain the ultimate foundations of human knowledge, nor is it more subjective than the scientific method, for it claims that the human condition is the objective basis of human knowledge, as does the scientific method. I intend to call this method humanistic, even though that is something of a misnomer, because it insists on seeing the world as man-centred, and its structure as the structure of human life. I shall not go into this deeply as yet, since my immediate concern is with the block universe, but a few words are in order.

The constant complaint of those who are influenced by Bergson, and many others as well, is that knowledge gained by the scientific method simply leaves out or cannot express human experience. The future, which is humanly unknowable and unpenetrable, is treated by science indifferently with other times. Perceived qualities, which are humanly immediately known become hypothetical constructions in science, where it deigns to attend to them. Human action, which is free or otherwise, purposeful or otherwise, is treated by science indifferently with the motion and structure of material bodies. Even when science seems to become more human, say taking sense data as fundamental, it treats only of the sensations and connections among those sensations, not of the man or other being who senses. The man-centred view, which objects to science in the above respects, is thus closely allied to phenomenology, which insists that the senser and the sensation (sensee?) come together indivisibly. Fortunately, however, the view does not have to commit itself to the phenomenological method, for it can instead believe that what we ordinarily say about things, as enshrined in the language, is at heart correct. Ordinary language and thought holds the place for this view that a collection of data does for the scientific. The fundamental clue as to its method of arriving at truth can be found in its attitude to concepts or theories it finds abhorrent; that where a concept or theory is not compatible with the known conditions of human life, it must be revised until it is. For example, science must be revised, so that it does not treat the future indifferently with the past, because human life is not like that. Talking of the conditions of human life in this fashion is very like talking of a form of life in the Wittgensteinian sense. Indeed the believers in ordinary language would go along with Wittgenstein's attitude, as reported by Pears, 'Language is a part

of human life and it should be examined in that setting with all its complexities of form and function'(1).

When it comes down to it, the later Wittgenstein and Bergson share a similar anti-scientific attitude. They cannot deny the practical power of science, but they can sharply divide off philosophy from science and reprimand science for forgetting its station as servant. Pears expresses the later philosophy of Wittgenstein as having this temper:

The transcendental treatment of religion and morality has gone, and its place has been taken by a kind of linguistic naturalism; there are these forms of human life and thought, and, since they have no independent basis outside themselves, a request for their justification can be met only by a careful description of the language in which they find expression, and of its place in our lives. If this were all, the solution (ie the justification of morality) would be a familiar one. But set in the context of his later philosophy, it has effect: for he treats scientific argument and even logic in the same levelling way. (2)

Bergson would heartily agree with Wittgenstein's diminution of the sciences, and the characterisation of philosophy as a special kind of activity; for both writers the appeal is ultimately, as with the phenomenologists, to human nature. A corollary of the levelling of science and logic to just two among many forms of life is the relativisation of truth to forms of life, but with the interrelationship of forms of life as various expressions of human nature, which takes the viciousness out of the relativity of truth, a substitute for absolute truth is found. For Bergson the substitute for truth is the reality of human experience, he allows truth to the mathematical and scientific ideas of time, for example, just insofar as they represent a systematisation of human experience. The believer in science will not accept the 'just insofar' here; science certainly is a systematisation of human experience of the world, but it aims to be more, to be a systematisation of the way the world is. Against this Bergson and Wittgenstein agree; man is the measure of all things, and therefore human life and the human world is what it seems to be, and the method of finding truth is by accurately describing the way things seem to be. For Wittgenstein this is a question of human language, for Bergson one of human psychology, but the method of discovering truth is fundamentally the same, and I shall call it 'humanistic'. Enough said on it for now, Let us return to the block universe. *

(1) Wittgenstein, David Pears, Fontana Modern Masters, London, 1971, p. 15.

(2) Pears, p. 35

As I have described the matter earlier in this chapter, the term 'block' is applied to that conception of the universe employed by scientists and mathematicians. This conception is supposed by its opponents to be unsound for a variety of related reasons which I have presented, and consists of the accusations that according to it:

1. Different times coexist
2. Time is just another dimension of space
3. Time is composed of instants
4. Tenses do not describe real features of the world.

In contrast to these the opponents of the block universe hold that:

- 1! Only the present exists
- 2! Time is radically different from space
- 3! Time is composed of durations, not instants
- 4! Dates and chronologies do not describe real features of the world.

These two sets of theses determine two world pictures. The second set is a fairly reasonable representation of that point of view which pictures the world as a three dimensional object evolving in time. The first set, however, is unacceptable to those who believe in the block universe (1), however much it may indicate their opponents analysis of what is wrong with it. The first three propositions of this set together constitute the Bergsonian or similiar characterisations of the block universe.

Richard Gale in The Philosophy of Time expresses the opposing positions rather differently, and more neutrally, in order to show how each can deal with McTaggart's paradox. Using McTaggart's terminology of 'A-series' for the series of events as past, present and future, and 'B-series' for the series of events as before and after, Gale gives four tenets which together constitute what he calls the B-Theory of Time. These are:

- (1) The A-series is reducible to the B-series since A-determinations can be analysed in terms of B-relations between events;
- (2) Temporal becoming is psychological since A-determinations involve a B-relation to an observer;
- (3) The B-series is objective, all events being equally real; and
- (4) Change is analyzable solely in terms of B-relations between qualitatively different states of a single thing. (2)

- (1) one reason is that it prejudges the issue of the relationality of time.
- (2) Richard M. Gale, The Philosophy of Time, MacMillan, London, 1968, p. 70

The corresponding tenets held by the opposition he describes as:

- (1) The B-series is reducible to the A-series since B-relations can be analysed in terms of A-determinations;
- (2) Temporal becoming is intrinsic to all events;
- (3) There are important ontological differences between the past and the future; and
- (4) Change requires the A-series. (1)

Although the mode of expression is very different in Gale's lists the overall positions determined by them are obviously closely related to those I have described, the main difference being a shift to talk of 'reduction' and 'analysis', and more of an emphasis on temporal expressions, where in contrast Bergson is more openly metaphysical in his argument. It is clear, however, that throughout there are two major determining factors of the block universe, one concerned with the elimination of temporal passage, and the other concerned with the nature of the spatio-temporal continuum.

Perhaps the most lucid advocate of the elimination of passage is Donald C. Williams, whose paper, The Myth of Passage(2) has become central. In that paper he argues that the universe of space and time is at least a four dimensional manifold, and that any idea of passage over and above the temporal aspect of this manifold is superfluous at best and at worst contradictory. Passage as he conceives it is a combination of two ideas: the unique nature of the present and the extension of time. This combination can occur in many ways, but all treat the present as a continuant which lasts through time. Indeed it seems impossible to explain the special character of the present without implicit reference to other times, for if only the present is real, when one says a thing was so and so, or will be, one is strictly speaking referring to nothing at all, but obliquely to something present, perhaps to a memory or anticipation. To think of the present as enduring is to think of it lasting through time; to think of the present as the locus of change is to refer present events to events at other times, for change is change from, or change to. Williams' criticism of passage so conceived is penetrating, and I believe effective. I shall return to this later, for I wish first to examine the idea of the manifold.

To believe in the space-time manifold or continuum one does not have to believe a great deal. For Williams:

(1) op.cit p. 77 . I shall discuss McTaggart later.
 (2) Journal of Philosophy 48 (1951), p.457

...the universe consists , without residue, of the spread of events in space-time, and that if we thus accept realistically the four-dimensional fabric of juxtaposed actualities we can dispense with all those dim nonfactual categories which have so bedevilled our race... (1)

We do not, however even have to go so far as this, nor is it essential to Williams' paper that he does. He is arguing rather that, whatever else there is, there is at least this four dimensional fabric of events. Bertrand Russell and Willard Van Orman Quine take similar lines. Ultimately, the conception of the manifold or continuum is mathematical in character, and develops by dropping from the idea of a spatial continuum anything that identifies it as peculiarly spatial. The bare minimum that is left is found to be extendable to time, thus forming a four dimensional continuum which underlies spatial and temporal characteristics. This 'bare minimum' will be the next topic for discussion.

The opponents of the manifold have two strings to their bow. I said above that the block universe has two major characteristics: it has no place for passage, and it is a four dimensional continuum of space and time. Corresponding to these are the two aspects of the attack on the block universe: a defense of passage, and a critique of the continuum. Since what we are at present concerned with is the block universe, it is only the critique that concerns us. Up till now, however, we have been setting up straw men. It is time the advocates of the block universe spoke for themselves.

THE SPACE-TIME MANIFOLD

The conception of a space-time manifold does not require mathematics, though it gains purity and precision from mathematics, and is a very old idea. However until the concept of temporal extension or distance was well developed the manifold tended to be connected with a rather different idea, that of a god's eye view, of the 'eternal present'. The idea of the manifold proper is well articulated in John Locke, under the influence of Newton and his mentor Barrow, who concludes his chapter

(1) op. cit. p. 458

'Of Duration and Expansion Considered Together':

... expansion and duration do mutually embrace and comprehend each other; every part of space being in every part of duration, and every part of duration in every part of expansion. Such a combination of distinct ideas is, I suppose, scarce to be found in all that great variety we do or can conceive, and may afford matter for further speculation. (1)

Indeed it has. Not that Locke, any more than Newton or Barrow, abandoned the idea of passage or succession; for him 'Duration, and time which is a part of it, is the idea we have of perishing distance, of which no two parts exist together, but follow each other in succession...' (2). Locke's hint at the manifold was taken up much later by Samuel Alexander, who denied that time and space were distinct ideas and asserted that they are both derivative ideas from the primitive Space-Time (3), but even for him the successive nature of time was intrinsic.

The manifold can only be said to be fully conceived when the idea of succession as perishing distance is dropped from it, as Williams argues forcefully, but nevertheless it has underlaid most thinking in science. Kant's position is typical:

We represent the time-sequence by a line progressing to infinity, in which the manifold constitutes a series of one dimension only; and we reason from the properties of this line to all the properties of time, with this one exception, that while the parts of the line are simultaneous the parts of time are always successive. (4)

From the earliest period the quantification of time was needed for the statement of physical law, this analogy of the spatial line was used in time's representation. The concept of acceleration, that is of changing rates of speed as measurable meant that units of time had to be representable in such a way that variation within the unit could also be represented. The first method of representation to hand was geometry, and indeed Galileo used this in his computations for artillery problems, even inventing the first ancestor of the slide rule for such computation (5). Geometrical representation was enriched by Descartes with the combination of algebra and geometry in coordinate geometry, which reinforced both the value of algebra and the spatial representation of time. Leibniz and Newton completed the task of rendering algebra suitable to the expression of both

(1) Essay BkII, Ch.15, Para. 12, p.121.

(2) *ibid* II-15-12, p. 120

(3) cf. Samuel Alexander, Space, Time and Deity.

(4) Immanuel Kant, Critique of Pure Reason, trans. N.Kemp Smith, Papermac, MacMillan, London, 1933, p.77.

(5) cf. Stillman Drake, Galileo and the First Mechanical Computing Device, Scientific American, April, 1976, p.104.

motion and geometrical relationships. In this developed algebra, the differential and integral calculi, temporal and spatial variables are treated indifferently; though the calculi do not in any respect identify them as one and the same, the calculi nevertheless do not register any of their differences. Once this stage has been reached the concept of succession as 'perishing distance' is entirely superfluous to representations of time, which is represented just as spatial dimensions are, by the set of real numbers. The mathematician and the physicist thus in a sense spatialize time, in that the representation of time is no longer from arithmetical but from geometrical sources; it is no longer an arithmetic but a geometric continuum. Consequently, though none of Locke, Newton, Leibniz, or Kant deny the successiveness of temporal instants, the concept of succession in so far as it requires the perpetual perishing of times is subsidiary.

There was no motive to alter this analysis of time until there was seen to be an intolerable tension between the ideas of temporal duration and temporal succession. Even so the manifold was the predominate aspect of their theory of time; that is, they believed that time and space can and should be represented by a continuum of four dimensions, each dimension of the continuum having the number of points of the real line. There is of course a gulf between the representation of time in this fashion and its actually being a dimension of a continuum, but the foundation is laid for the later completion of the theory of the manifold.

This completion is described by Bertrand Russell in his Principles of Mathematics, where he suggests a method for eliminating tenses from references to time. He analyses temporality as the relations of a given term to various times:

...change is due, ultimately, to the fact that many terms have relations to some parts of time which they do not have to others. But every term is eternal, timeless, and immutable; the relations it may have to parts of time are equally immutable. It is merely the fact that different terms are related to different times that makes the difference between what exists at one time and what exists at another. And though a term may cease to exist, it cannot cease to be; it is still an entity, which can be counted as one, and concerning which some propositions are true and others false.(1)

(1) Bertrand Russell, The Principles of Mathematics, George Allen & Unwin, London, 1937, p. 471.

For Russell, then, Locke's idea of 'perishing distance', the idea of temporal succession, is entirely wrong; to cease to exist is not to cease to be, so King Wenceslas is still an object, though he does not bear certain relations to the present and so does not now exist. Being is a timeless concept; though coming to be and ceasing to be are temporal, they apply only in relation to specified times. This is the general manoeuvre for the elimination of tenses. Where Russell here makes tenses relative to times, other writers make them relative to events, normally the utterance which is now spoken. The difference is for our present purposes marginal, occurring because time was for the Russell of the 'Principles' absolute, so that instants are entities, whereas for other writers, particularly after Einstein, time is relative so that instants amount only to relations between events.

A similar position is taken by Quine, who more explicitly treats time as spacelike:

Tense...is to give way to such temporal qualifiers as 'now', 'then', 'before t', 'at t', 'after t', and to these only as needed. These qualifiers may be systematized along economical lines, as follows.

Each specific time or epoch, of say an hour's duration, may be taken as an hour-thick slice of the four-dimensional material world, exhaustive spatially and perpendicular to the time axis. (Whether something is an epoch in this sense will depend on point of view, according to relativity theory, but its existence as an object will not.) We are to think of t as an epoch of any desired duration and any desired position along the time axis. Then, where x is a spatiotemporal object, we can construe 'x at t' as naming the common part of x and t. (1)

We can treat the indicator words 'now' and 'then' on a par with 'I' and 'you', as singular terms. Just as the temporary and shifting objects of reference of 'I' and 'you' are people, those of 'now' and 'then' are times or epochs. 'I now' and 'I then' mean 'I at now', 'I at then'; the custom just happens to be to omit the 'at' here...(2)

In a footnote Quine supplements his position:

... Strawson argues against viewing 'now' as a singular term. His argument is that 'now' sets no temporal boundaries. One possible answer might be to defend vagueness; another would be to construe the temporal boundaries as those of the shortest utterance of sentential form containing the utterance of 'now' in question. The latter answer is in our present spirit of artificial regimentation...(3)

(1) Willard Van Orman Quine, Word and Object, MIT & Wiley, 1960, p. 172.

(2) *ibid* p. 173.

(3) *ibid* p. 173.

Quine treats time as much more spacelike than was envisaged by Locke, Newton or Kant. Not only is time to be represented as spacelike, but a moment is to be a hyperplane at right angles to the time axis. This really spatializes time, for perpendicularity is a geometrical characteristic of spatial dimensions; nor can the accusation of spatialization be avoided (Quine welcomes it) if such talk of perpendicularity is to be taken seriously; for consider the analogous case of the variation of time with temperature - there is no point in considering time and temperature as at right angles to one another, which would suggest that time and temperature are commensurable, that is, that the same measure could apply to both; similarly the perpendicularity of spatial dimensions to time only makes sense if the same measure can apply to both, so that a measure of time can be equivalent to a measure of space. The conception of the space-time manifold does not need this extreme identification of time with space. Williams, though he finds the idea of the uniqueness of time with respect to space superfluous, emphasises that this is no necessary conclusion:

The theory of the manifold leaves abundant room for the sensitive observer to record any describable difference he may find, in intrinsic quality, relational texture, or absolute direction, between the temporal dimension and the spatial ones. He is welcome to mark it so on the map. The very singleness of the time dimension, over against the amalgamated three dimensions of space, may be an idiosyncrasy with momentous effects... (1)

Quine does not seem to treat the manifold thus neutrally, even though he does not explicitly draw the conclusion that time is a fourth dimension of space. He says:

Physical objects, conceived...four-dimensionally in space-time, are not to be distinguished from events or, in the concrete sense of the term, processes. Each comprises simply the content, however heterogeneous, of some portion of space-time, however disconnected and gerrymandered. What then distinguishes material substances from other physical objects is a detail: if an object is a substance, there are relatively few atoms that lie partly in it (temporally) and partly outside. (2)

Quine's position is here much like that which Williams sees as a possibility: the explanation of enduring physical objects as those which are elongated in the temporal direction, and the singularity of time as

(1) Williams, The Myth of Passage, p. 467.

(2) Quine, Word and Object, p. 171.

the world's causal graininess in that direction, much as a plain shows a preference for a certain direction because the trees are bent in that direction by prevailing winds; things just happen to be bent in the temporal direction. What distinguishes material objects from others is for Quine that their component parts (atoms) maintain constant spatial relationships one to another over a considerable period of time. But the expression of this materiality cannot be so neutral for Quine, because 'atoms' cannot be given the ordinary interpretation, but must be considered as four-dimensional entities in their own right. Material objects are therefore interpreted as four-dimensional entities whose four-dimensional parts relatively rarely intersect their four-dimensional boundaries.

Such conceptions of what distinguishes time from space seem unexceptionable on the face of it, given an original acceptance of the manifold in its neutral form as described by Williams above, for they represent sufficient conditions for identifying the time direction and enduring objects. What is exceptionable is that these conditions should also be necessary ones. Both Williams and Quine are inclined to regard the conditions as necessary and sufficient, ^{that is that what makes one} direction in the manifold temporal is the de facto causal 'graininess' in that direction, or the relative lack of intersected boundaries in that direction. Williams is more reluctant to think so, but finds the position compelling. And indeed it is, for the aspects of it which result in this conclusion implicitly presuppose the conclusion itself. *

To see the circle involved, consider the concept of four-dimensional boundaries, upon which the idea of a four dimensional entity rests. A boundary is a point which separates two parts of line, a line which separates two areas, or a surface which separates two volumes. In each case the boundary is commensurable with what it bounds. Similarly we may conceive of temporal boundaries, points such as birth and death marking off the history of a thing. Here the boundaries, birth and death, are commensurable, that is, have the same measure, as the life, and the sweep of history. When such temporal boundaries are used in conjunction with spatial ones, there is no obvious reason why the result should be a spatio-temporal boundary unless all that is meant by this is that there is a boundary in an analogous four-dimensional space. There is no guarantee that temporal duration and spatial distance will be commensurable so that

there would be sense in talking of a spatio-temporal boundary, and as I have said, it is characteristic of boundaries that they are commensurable with what they bound. In other cases we are not even inclined to make this mistake; a multidimensional plot of temperature against position does not dispose us to the conclusion that temperature and position are commensurable. Since talk of spatio-temporal boundaries presupposes the commensurability of space and time, it is small wonder that this conclusion emerges.

More obviously question-begging is the idea of Williams that 'The very concept of "things" or "individual substances" derives from a peculiar kind of coherence and elongation of clumps of events in the time direction'(1). This is supposed to be true regardless of any absolute difference between space and time, but it presupposes that there is no such difference, because the very idea of elongation in the time dimension implies a comparison of the time measure with the spatial measure, and the conclusion that the time is longer than the space; that is, it presupposes that space and time are commensurable, that there is no intrinsic difference between them. The remark I quoted by Williams here is not central to his argument, but it does I think well illustrate the wrong thinking that one can all too easily fall into when thinking of space-time.

The concept of a boundary can of course be stripped of its metrical aspects, to become a purely topological notion which would be applicable to the manifold, but there are important consequences of so doing. The most important is that if the manifold is treated topologically, no concept of spatial or temporal distance can be fundamental because, to put it imprecisely but adequately, topological properties are those which remain invariant despite the deformation of a thing, and metrical or distance properties do not. The charge of presupposing the commensurability of space and time can be avoided by restricting boundary concepts to topologically invariant properties, and the passage from Quine concerning material bodies should perhaps be so interpreted. But consider what Williams has to say:

(1) Williams, p. 468.

Living bodies in particular have a special organized trend timewise, a conatus sese conservandi, which nothing has in spatial section. Characteristic themes of causation run in the same direction, and paralleling all these, and accounting for their importance and obviousness to us, is the pattern of mental events, the stream of consciousness...(1)

Running 'in the same direction' is a metrical notion, and 'paralleling' more obviously so. These notions should be replaced by topological ones, and should not be used, as they are here, to suggest that causation is a topologically invariant relation. It is only by the assumption of topological invariance in the four-dimensional manifold that notions like 'paralleling' can be introduced with regard to time in the first place; at least, this is so if 'parallel' is intended to be univocal for space-time.

In the passage I just quoted Williams intends to be giving reasons in support of the 'hypothesis that the peculiarity of the time dimension is not... primitive but is wholly a resultant of those differences in the mere de facto run and order of the world's filling'(2). He proceeds to describe rotations of sections of the world so that:

It is conceivable, though no doubt physically impossible, that one four-dimensional area of the manifold be slewed right angles to the rest, so that the time order of that area, as composed by its interior lines of strain and structure, runs parallel with a spatial order in its environment.(3)

This assumes two things, that the relations which make 'interior lines of strain and structure' are invariant under the required rotation, and that space and time are commensurable; it assumes these things in order to support the hypothesis, that the manifold is isotropic, that is contains no preferential directions. Neither of these two assumptions is self evident, nor can either without question-begging be used to suggest that the manifold is isotropic.

If the manifold were isotropic, its laws being formulable independently of reference to direction, then there would be no relations between events which could not in principle hold between any other events in the manifold. Thus any event could be causally related in any other, any event could in principle be earlier than any other, any event could

(1) Williams, The Myth of Passage, p.468.

(2) *ibid* , p.468 .

(3) *ibid*, p. 468.

be adjacent to any other. This is only possible if all relations between events are in principle indifferent to temporal and spatial orientation. It is this possibility, together with the commensurability of time and space, with which it is related, that provides evidence for the isotropy of the manifold. Indeed the commensurability requirement is redundant, though necessary, for an aspect of spatial commensurability is the rotatability of rulers, that is, physical distance measures, so that they function equally as measures in any spatial direction.

Though it is true that the manifold shows the regularities it does regardless of whether these are de facto or necessary, the very descriptions of these regularities contain assumptions as to the nature of the manifold. In the case of Williams and Quine it is not clear what is attributed topologically to the space-time manifold and what is attributed to other factors. The conceptual foundations of the idea of the manifold need careful expression, and this will be my next task. But before I proceed to that, there is another important aspect of the manifold which I have not touched upon except briefly in relation to Bergson.

THE STATE OF CHANGE

Bertrand Russell in The Principles of Mathematics not only sets out to eliminate tense, but also denies that there can be any such thing as a state of change or a state of motion. He says:

It is to be observed that, in consequence of the denial of the infinitesimal, and in consequence of the allied purely technical view of the derivative of a function, we must entirely reject the notion of a state of motion. Motion consists merely in the occupation of different places at different times, subject to continuity... There is no transition from place to place, no consecutive moment or consecutive position, no such thing as velocity except in the sense of a real number which is the limit of a certain set of quotients. The rejection of velocity and acceleration as physical facts (i.e. as properties belonging at each instant to a moving point, and not merely real numbers expressing limits of certain ratios) involves... some difficulties in the statement of the laws of motion; but the reform introduced by Weierstrass in the infinitesimal calculus has rendered this rejection imperative.(1)

(1) Bertrand Russell, The Principles of Mathematics, p. 473.

Russell could hardly be more emphatic. In discussing Zeno he is as definite:

"If everything is in rest or in motion in a space equal to itself, and if what moves is always in the instant, the arrow in its flight is immovable." This has usually been thought so monstrous a paradox as scarcely to deserve serious discussion. To my mind, I must confess, it seems a very plain statement of a very elementary fact, and its neglect has, I think, caused the quagmire in which the philosophy of change has long been immersed. (1)

The denial of velocities and accelerations as strictly applicable at instants of time means that the laws of motion are complicated, because normally they are expressed using instants. For example, Newton's first law, that an object will move in a straight line with uniform velocity unless acted upon by a force, cannot be stated as simply as it usually is, but becomes a statement about the behaviour of a body over a stretch of time, because it is only with this that velocity (and acceleration) can be translated into sequences of positions at different instants, and all Russell will allow at instants is position.

There are two reasons for rejecting states of change and motion, though the two are closely related. The first is the same reason as that for rejecting infinitesimals. A velocity is not to be interpreted in terms of infinitesimals, but in the way mathematics has made logically sound, by the theory of limits. Infinitesimal quantities are paradoxical because although being arbitrarily close in size to zero, they are not zero, but have a kind of indefinite size. Examples of infinitesimals can be found; for example, a line segment is infinitesimal relative to the area of the square it forms a side of, but they play no part in the infinitesimal calculus after Weierstrass introduced the interpretation by the theory of limits.

The second reason for rejecting states of change lies in the theory of the variable. As Russell and Frege argued, the idea of the variable as something which changed was fraught with difficulties for mathematics. For instance, the Euclidean treatment of geometry does not require reference to time at all, but differential geometry uses, and must use, the idea of the variable. But the idea of the variable as

(1) op. cit p. 475

something which changes introduces time, an element foreign to the Euclidean treatment of geometry, and sentences result like 'As the line rotates, its point of intersection with the plane moves...'

Mathematicians have always regarded such expressions as mere ellipses, as shorthand, not involving true change at all, but until the time of Frege there was no satisfactory means of eliminating them. Frege criticized the whole idea of the variable as a thing, explaining it rather as a form of quantification over a range of values or constants. Russell's interpretation somewhat later was similar, and it was this that led him to accept the paradox of Zeno mentioned above. For the variable is nothing over and above the values or constants which form its range, so that to vary over time is to be a set of constants which exist at various times.

The connection between the two reasons for denying states of change is well described by Russell:

... Zeno's argument contains an element which is specially applicable to continua. In the case of motion, it denies that there is such a thing as a state of motion. In the general case of a continuous variable, it may be taken as denying actual infinitesimals. For infinitesimals are an attempt to extend to the values of a variable the variability which belongs to it alone. When once it is firmly realized that all the values of a variable are constants, it becomes easy to see, by taking any two such values, that their difference is always finite, and hence that there are no infinitesimal differences.' (1)

Russell's diagnosis of the cause of the Eleatic problem follows:

This static theory of the variable is due to the mathematicians, and its absence in Zeno's day led him to suppose that continuous change was impossible without a state of change, which involves infinitesimals and the contradiction of a body's being where it is not. (2)

As we saw earlier, Bergson's position on the matter is similar to Zeno's, except that he embraced the other horn of the dilemma, and instead of denying change he denied the quantifiability of time, and affirmed change and motion.

It is the analysis of the variable, then, which leads Russell to deny states of change and motion, though, as he claims, this does not

(1) Russell, Principles of Mathematics, p.351

(2) *ibid* p.351-2.

imply that there is no change, or that change cannot be continuous. Nevertheless the idea of something changing while remaining the same, which had for so long underlain the concept of change, has to be abandoned along with states of change, or rather modified into an almost unrecognisable form. For the relation between a variable and its values is not one of successive assumption of the values, but rather as Russell none too happily puts it, one of 'indefinite' reference to the members of the class of values which constitute the variable's range. The notion of indefinite reference is indeed not a happy one, and in the work of Frege the variable is replaced entirely by the range of values, so that the variable has an expository and shorthand usage only. Thus identity over time, which was always a presupposition of change, is replaced in a similar manner to the identity of a variable over its range, with the class membership of the values of the range. Identity over time is no longer strict identity, the object which endures becomes a class whose elements do not endure and are quite distinct one from another, and the endurance of the object is expressed by giving the membership of the class. This result does not follow so long as the variable is allowed some status as an entity which 'can be counted as one, and concerning which some propositions are true and others false'(1). The phantom presence of the variable in the Principles was ultimately eliminated in an amendment to Principia Mathematica(2). The idea of identity through time thus fully disposed of as true identity, the character relating the elements of the class which is now the object is given a name, 'gen-identity' or variants on this. Objects cannot be variables, but the various momentary stages of thing all are the one object; this identity is not to be taken, therefore, as asserting that all the momentary stages are identical, but as asserting that they belong to the one object, just as all his body cells belong to the one man even though they are not identical one with another; this relation of belonging is one form of class membership, the man is identified with the class of his momentary stages, as he is with the class of his bodily parts. There remains nothing which is identical over time, if this is to mean that things existing at different times are themselves identical. Momentary stages of an object exist only at moments, the class of momentary stages does not exist at any moment, though it exists.

(1) Russell, p.471, quoted earlier.

(2) With the recognition that there is no need of the distinction between real and apparent variables.

In this conception of identity we have the virtual completion of the modern conception of the manifold, or 'block' universe. It consists of what there is at times and places as organised into a spatio-temporal whole. The spatio-temporal whole consists of points, that is spatial points at an instant, what there is at those points, and what is true of those things. The whole further consists of all the things that we normally suppose it to consist of, but these things are all events, in the sense of taking up a spread of the spatio temporal whole. There is no place for passage.

Note that this theory of the manifold is as applicable to a perceptual field as to the physical world. The system of spatio-temporal points remains, as do spreads of it, but the items which exist at the points will be of a different kind, although on the large scale the perceptual field will consist of all those things we normally suppose the world to consist of. The glaring difference, however, is that passage is an evident feature of the perceptual manifold. However, as Bergson admits, the manifold is an excellent representation of the history of a perceptual field.

In the next section I shall attempt to uncover something of the conceptual foundations of the manifold as exercised of passage by a rather different approach from that I have used up to now. My beginning point is the denial of states of change, and I use this in order to show changes that occur as a result in the conception of the manifold in order to expose the roots of the idea. In the coming section I assume that the space-time manifold is a topological structure, not a metrical one, as I argued against Williams earlier in this chapter.

THE NATURE OF THE MANIFOLD.

The criticism of states of motion has, I have said, the important corollary that there can be no such thing as a state of change of any kind. Of course, if when we speak of a state of change we mean that a thing is undergoing a process of change over a period of time, then states of change do exist. The accepted meaning of states of change, however, allows that something might be in a state of change

at a given instant, so that not only does the thing change over a period of time, but at any instant it is changing. But whatever the kind of change, the thing changing goes through all the determinate characteristics between those at the beginning and end of the change. Should we thus say that at an instant when the object is changing it has an indeterminate characteristic? We cannot, because if the change were to end at that instant, as it could, the object would have a determinate, not an indeterminate characteristic. Consequently we have the contradiction, as for the special case of motion, that an object which at a given instant is changing, also at that same instant is not changing because it is determinate. This paradox is the same as that of motion, and the argument proceeds mutatis mutandis.

A consequence of the banishment of instantaneous motion and change is not so commonly recognised. It is the schizophrenia of the concept of an event. The dictionary definition of 'event' is 'fact of a thing's happening,...thing that happens.'(1). These two apparently equivalent descriptions conceal a considerable difference. In English we have both a simple and a continuous present, which for the most part we can use interchangeably, so that 'he walks' and 'he is walking' amount to the same thing. But there is a considerable difference between the two, as is shown by the difference for adjectival predicates between 'It is red' and 'It is being red'. Though such examples show the difference clearly, it holds for all verbs. Consider the difference between 'If it works, sell it' and 'If it is working, sell it'. The second implies the first, but not vice versa, yet either could be the rendering of 'In the event of its working, sell it'. The same ambiguity can be seen in other examples, such as 'In the event of his dying, inform the nurse'. Of course such ambiguities do not often occur in practice, since the meaning is clear from the context, but the fact that they can exist leaves the way for two differing interpretations of the doctrine that the world is the totality of events. Furthermore, the denial of states of change turns these differing interpretations into mutually opposing ones.

If we adopt the interpretation of event as implying a process or activity which is going on at the time of the event, then we must deny that there can be instantaneous events, since there can be nothing

(1) Concise Oxford

going on in an instant. Consequently, if something is the case right up to an instant, and afterwards is not, there is no event at that instant. There can, however, be events which go on over a period of time, because this can be interpreted as meaning that different things are the case at different instants.

If against this interpretation we assert that an event can be instantaneous, we cannot understand it as necessarily implying that something is going on. We must rather interpret it as a state of affairs, as not necessarily implying anything other than what is true at the instant. Now what is true at the instant is of two kinds: what is true then without reference to any other time, and what is true at the instant in virtue of what is true at other times. Thus, for example, that something has been true or is going to be true is true at the instant but does not imply any process in the instant, since it only indicates a present state of affairs which exists because other states of affairs have been or will be such and such. As a result, we can interpret something being the case up to an instant and thereafter not as an instantaneous event, since it means that at that instant something has been the case and is not going to be the case. Having thus characterised instantaneous events, we have further to characterize extended events. Now, given that all events are of the same kind, whether instantaneous or not, we cannot, assuming instantaneous events, interpret extended events as implying processes, since for the reasons given in the last paragraph this would lead to the contradiction that there both are and are not instantaneous events. This leaves us with two possibilities. Either we interpret all events as states of affairs, or we adopt an interpretation whereby an event is neutral between state and process. In the former case no process or change can be an event, because an extended event is then an extended state of affairs which as I have explained, involves only the way things are. Nevertheless, it remains possible to give some account of change, since the state of affairs can include that something has been otherwise or is going to be otherwise, and so we can say that an event is a state of affairs which exists at one time or over a time, but not at others. The problem with this is that most of those things we call events are not states of affairs, but changes or processes, and mere states of affairs do not allow of the internal differentiation necessary to characterise

these. The second possibility mentioned above, of the neutral interpretation of event does not further the analysis of the idea of an event at all.

The result of all this is that it is impossible to regard the notion of event as univocal, because processes and changes on the one hand and instantaneous events on the other cannot be reconciled under a single characterisation of events. This result follows directly from the denial of states of changes and not, as is more usual, indirectly from the difference between events and intersections of events, once it has been established that events must be extended.

To come now to the subject of this section, namely the nature of the manifold, the difference between the two kinds of events we have been discussing has important ramifications. Williams, whom I quoted earlier, says '... the universe consists...of the spread of events in space-time...' In this simple definition it is not clear what kind of event Williams has in mind, or whether he allows both kinds. Other writers, such as Quine definitely opt for events as processes. Quine says, as I also quoted earlier, 'Physical objects, conceived... four dimensionally in space-time, are not to be distinguished from events or, in the concrete sense of the term, processes'. The relatively simple picture of the manifold as so described is deceptive.

The universe as the spread of events coincides in extent with a locational framework: each point of which requires four coordinates for its specification. It is internally structured by the identification of portions of it as parts of the same or distinct events, according to principles of location, classification by properties, continuity and causal connection (which is intended to identify a series of coordinates in the locational framework as temporal).

As the universe is so described, we do not have enough information to determine what in it corresponds to a point of the locational framework. Is it an event? This is the answer that would naturally be given in Relativity theory. The manifold is very ably described by Einstein in a popular exposition:

The reader may think that such a description of the world would be quite inadequate. What does it mean to assign to an event the particular co-ordinates x_1, x_2, x_3, x_4 , if in themselves these co-ordinates have no significance? More careful consideration shows, however, that this anxiety is unfounded. Let us consider, for instance, a material point with any kind of motion. If this point had only a momentary existence without duration, then it would be described in space-time by a single system of values x_1, x_2, x_3, x_4 . Thus its permanent existence must be characterised by an infinitely large number of such systems of values, the co-ordinate values of which are so close together as to give continuity; corresponding to the material point, we thus have a (uni-dimensional) line in the four-dimensional continuum. In the same way, any such lines in our continuum correspond to many points in motion. The only statements having regard to these points which can claim a physical existence are in reality the statements about their encounters. In our mathematical treatment, such an encounter is expressed in the fact that the two lines which represent the motions of the points in question have a particular system of co-ordinate values, x_1, x_2, x_3, x_4 , in common. (1)

So far, Einstein's description is neutral, but he sums up as follows:

Every physical description resolves itself into a number of statements, each of which refers to the space-time coincidence of two events A and B. In terms of Gaussian co-ordinates, every such statement is expressed by the agreement of their four co-ordinates x_1, x_2, x_3, x_4 . (2)

The natural interpretation of this passage is that events correspond to points of space-time, and indeed relativity theory is usually worked out in terms of point-events. There is, however, another interpretation, due to the ambiguity of sense of 'location' or 'place', whereby it can mean either a point or an area. This allows that an event can correspond to a volume in the universal locational framework rather than to a point.

It is here that the problems begin, for, as I have shown, instantaneous (and therefore point) events and extended (and therefore volume) events cannot consistently be treated as of the same kind. If, in order to preserve events as changes or processes, we identify events with volumes, which is the normal procedure in modern theories, then points correspond to components of events which are not themselves

(1) Albert Einstein, Relativity, The Special and General Theory, trans. by R.W. Lawson, Crown, New York, 1961, p.94-5

(2) *ibid* p.95

events but rather the limit of smaller and smaller events. These components we may class as point-events, but they are of a radically different kind to volume events, since a finite class of point events, unlike volume events cannot form a volume event. If instead of identifying events with volumes we identify them with points, then we face a corresponding problem, since we cannot then treat a class of events as itself being an event.

The consequences can be seen by a consideration of causality and identity through time. Causation is standardly understood as a relation between two events, or as the relation pertaining when an event is the result of a process (which is itself an event). But if this is the case, then, assuming that events are space-time volumes, a causal relation cannot exist between so called point-events, since these are, strictly, not events. As a result, the identity of a thing through time cannot be considered as a form of causation, since identity through time means that the thing is the same thing at each point of a period of time, and point events cannot be causally connected. Nor can persistence through time be recovered by regarding it as a relation between volume-events, because the persistence of a thing within any volume-event then remains to be defined.

Causation is equally problematic if we regard it as a relation between two point events, for a point event A is connected to a point event B by a continuous sequence of point events, a sequence which is dense in the mathematical sense, that is, between any two point events there is another point event. Postulating identity through time as causal connection between A and B then suffers from the problem, familiar in the philosophy of action, that there is an infinite regress of causes. For, if there were a finite string of point events between A and B, then the identity of the object between any two of those events remains to be explained.

One way to avoid such problems would be to abandon altogether causation as an explanation for identity through time, characterizing this instead as simply belonging to an event. This means not only that, as in the last section, the identity through time of an object is to be understood as a form of class membership, but also that it is to be

understood solely as this, there is no reason for the various elements to cohere as a class. Such a move raises a further difficult problem, however. In the original conception of the manifold, it is imagined that there are means of identifying events as being parts of the same or distinct events. But if the characterisation of identity through time is 'belonging to the same event' this presupposes either that what collections of events themselves form events is otherwise determined, or that this is arbitrary. There is more to the matter than this, for if it is to some extent arbitrary what events we choose as enduring objects, then it is also to some extent arbitrary what events are causally connected. For consider a group of events which can be resolved into the histories of objects in different ways. Evidently the tracing of causal chains through this group will depend on which events form the histories of what objects, so that if this latter is to some extent arbitrary, the former will be too. Such arbitrariness of identity and causation is an allowed possibility according to Relativity theory.(1)

Another way to avoid the problems about causation as a relation between events would be to interpret causation differently, and perhaps define the relation of cause to effect as that of a process to the state of affairs which is the result of that process. As we found earlier a state of affairs can be instantaneous or it can last for some time, so that effects need not be limited to point events. The relation would be that the effect is that, state of affairs which is the limit culmination of a series of events. Corresponding to this would be a continuous series of point events which compose the series of events and whose limit is the point event which borders both the series and the state of affairs. Causation by this definition becomes, as a result, a special form of continuity, which returns us to the same problem as before as to what determines continuity.

If it is arbitrary how a group of events are organised causally and by the identity of objects through time, what conditions are placed on the possible objects and their histories? The answer can be given by reference to our original description of the means available to characterise the structure of the manifold. The first is that the events which form the life of any object ought to be spatio-temporally continuous. The second is that there should be a continuity

(1) Hans Reichenbach, The Philosophy of Space and Time, Para. 43

not only by location but by form. That is, if we choose a series of point events in the manifold to determine the temporal direction, the corresponding spatial cross sections at various times should show a persistent similarity of form. The third is that the spatial object should remain of the same kind throughout its history, that is, that its classification should be permanent. These second and third principles are evidently principles of continuity of a kind, but different from the basic principle of spatio temporal continuity. The differences may be seen by considering that a series of events may be spatio temporally continuous, with all their component events forming continuous series, and yet all the component parts of the supposed object radically changing their position from time to time. Thus the need for the second principle. Then again, even though both these principles be met, this is not enough, for even so an object may change in kind, and therefore cease to continue. Consider for example a piece of wood which has been burned to form charcoal. It has the relevant continuity in space and time and form but is not the same object, because it has changed in kind.

Such Platonic principles as these, which are necessary to a general theory of the manifold, have tended to be ignored by most theorists, largely I think because they are unnecessary when the world is supposed to be atomistic, for in principle atoms are internally undifferentiated and unchanging through time except in their external relations to other atoms, so that it is unnecessary to add principles of continuity of form and classification, since these are assumed as a basic part of atomism.

Though such Platonic considerations as these can reduce the arbitrariness of choice of structure in the manifold, the lesson of its possibility must be learned. That is, the fundamental structure of the manifold is that of the continuity of series of point events. This continuity is of two kinds: spatio-temporal and parametric. Parameters are the measures of qualities true at spatio-temporal points, that is of point-events. Where such criteria of continuity do not give unambiguous results, the possibility arises of there being different equally good structures for the space-time universe. Such additional

features as causation or identity through time have a place, but not a fundamental one, since they have a degree of arbitrariness dependent on the arbitrariness of the results of the continuity criteria.

CONCLUSION.

In this chapter I have tried to trace the development of the theory of time as part of the space-time manifold in the light of opposition to it from writers who consider that time is in character essentially as it is humanly experienced. I chose as representative of such writers Bergson and Whitrow. My aim was in the first place to show the grounds upon which the opposition was based, and secondly to show what is involved, and what is not involved, in the elemental notion of the manifold.

The manifold, it emerged, is essentially a topological notion, and it was only on unnecessary and unwarrantable metrical assumptions implying that interchangeability of spatial and temporal measures that anyone would be tempted to regard time as a spatial dimension. The manifold is indifferent to the characters of space or time. This is not to say that the spatio-temporal universe does not have distinguishable spatial and temporal features, or that space and time are not distinct, but merely that the manifold does not take these features into account a priori.

Given that the space-time manifold is such a Protean thing the criticisms that its opponents level at it on mathematical grounds fail for lack of mathematical generality. Equally the defence of passage by these opponents of the manifold fails when ever it is based on the grounds that it is necessary for motion, because this defence ultimately rests on the discredited notion of states of motion. The opponents of the manifold cannot take on the mathematical philosophers on their own ground.

But they do not need to. One thing that has emerged from the discussion is that the spatio-temporal manifold is arrived at by analytic procedures leading to a series of generalisations, whereas the

time of passage is arrived at by a holistic treatment of human experience. It is over this question of the proper method of enquiry that manifold theorists and their opponents should be debating. It cannot ultimately ever matter to an analyst that analysis has implications for the nature of the world or the aspect of it he studies which do not square with the evidence of human experience. For the analyst human experience or part of it must be reinterpreted to fit the analysis. For his opponents, however, human experience is the ultimate evidence for the way the world is, and an analysis is a more or less useful way of representing that experience or part of it.

I observed in chapter two that these differing methods can, and are, both interpreted as being the true empiricism. However, while the underlying structure of the analytic approach is made clear since self analysis is part of an analyst's programme, the underlying structure of the experiential approach is not clear, because it is of a holistic kind. Nevertheless, just as the analyst has the protean manifold as the schema by which to organise the evidence his method accepts, so there ought to be a schema by which the holist can organise the evidence which he accepts.

The existence of such a schema does not become clear from the controversy over the manifold, but there are some hints of it in relation to the idea of passage. So far as time is concerned this showed itself in the form that the past, present and future have a different ontological status. But this leads to problems, as the next chapter shows by way of a discussion of Augustine and Locke. This discussion is the beginning point of a treatment of the divergence between the two methods of empiricism, with an aim to discovering the holistic equivalent of the manifold.

CHAPTER FIVE.
EXPERIENCE VERSUS ANALYSIS.

The modern theory of the manifold is, as I have explained, a historical evolution having its origin ultimately in the new cosmology begun by Kepler and rendered into a world-view by Newton. The tools of the infinitesimal calculi, which were necessary for the development for the new cosmology, since they made possible a quantitative study of continuous motion, were the means by which the theory of the manifold developed from there. The modern theory of the manifold has many apparently paradoxical elements, among which three are most relevant to our present purposes. Firstly, the theory denies that time passes; secondly, it denies that there is any such thing as a state of change; and thirdly, it denies that anything remains identical through time. These results are most perplexing, for the manifold and the calculi which describe it, were first invented for the purpose of managing an accurate description of the continuous motion of bodies. Now the bodies seem to have disappeared, and their motion with them. Nor does the modern theory claim that the manifold is a useful fiction, a working hypothesis which enables us to manipulate the world and predict events, but which is not, in the strict sense, true. Instead the theory claims that the way the world seems to be, peopled with enduring and changing objects which move hither and thither as time passes, is itself a fictional construct, useful to describe the perspectival view observers have of the world, but itself not strictly true, while the manifold is strictly true.

The modern view of the world, the space-time, 'block', or manifold view, has behind it the weight of modern orthodoxy, the Authority of Science. The opposite view, that of the evolving present, has therefore captured the allegiance of the rebels, who present a more or less revamped form of Bergsonianism. How are we to decide which side is right? And is the apparent opposition genuine? I do not believe that it is, but I find my belief at the moment to be a mere suspicion, and without adequate foundation.

The way the modern exponents of the evolving present talk, such as Richard Gale and Arthur Prior, one would think that their philosophy

of time was not in exactly a similar quandry as that of the scientists. In truth they must face a similar problem, for it is not enough to present a description of time which is closer to our experience of it. The problem such a description faces can be explained as follows. Where the manifold theorists work in a young tradition having its roots in the quantitative tradition of cosmology and physics begun by the astronomers in the rennaissance of Europe, the evolution theorists work in a much older tradition based on the qualitative human experience of things temporal. There is, however, a deep problem in this qualitative tradition, as to how there can be any quantitative measures of time whatsoever, since on a strictly experiential description time is unreal. The classic formulation of this problem is that of St. Augustine, but essentially the same argument recurs in Bergson and Bradley, for example. I shall introduce the problem by first presenting a discussion of St. Augustine's dilemma concerning time.

ST. AUGUSTINE

The much quoted phrase from the Confessions of St. Augustine: 'What then is time? If no one asks me, I know: if I wish to explain it to one that asketh, I know not.' (1) has often been used as an introduction to modern analyses of time, especially in the empirical tradition. Augustine's perplexity, it is thought, is natural but misconceived, and by a proper recasting his puzzlement will disappear, being due to unwarranted suppositions concerning the logical grammar of the question 'What is Time?'. A typical example of the criticism levelled at Augustine is the following from Richard Gale in answer to Augustine's question:

The answer proposed by Wittgenstein is that Augustine has lost his way in language. There are many surface grammatical analogies between temporal expressions and expressions that refer to physical objects and processes. Augustine's 'mental discomforts' come from riding these analogies too hard by expecting temporal expressions to behave in the same way - have the same 'grammar' or use - as these other expressions. When the conformity of temporal language to other types of language breaks down - when it is discovered that we cannot

(1) The quotes from St. Augustine are from E.B. Pusey's translation reprinted in Richard Gale's The Philosophy of Time.

meaningfully say and ask the same things about time that we can about trains, rivers and the wind - Augustine begins to feel that time is a very queer sort of thing.(1)

The talk of logical grammar or use is new, but the old accusation is there - Gale is accusing Augustine of substantialising time. This approach is usual in the empirical tradition; Locke says concerning Augustine on the supposed ineffability of time:

Duration, time, and eternity are, not without reason, thought to have something very abstruse in their nature. But however remote these may seem from our comprehension, yet if we trace them right to their originals, we shall find that the idea of eternity itself is derived from the same common original with the rest of our ideas.(2)

Such usage of Augustine tends to misrepresent his enterprise, and his difficulty with time, transplanting it into more modern contexts.

A fairer precis of Augustine on time is to be found in Russell's History of Western Philosophy (3), where Russell brings out the problem as one of the relation between God, time and eternity in the light of Platonic theology and philosophy. Augustine poses the problem thus:

...What was God doing before He made heaven and earth?
..For if (they say) He were unemployed and wrought not, why does He not also henceforth, and for ever, as He did heretofore? For did any new motion arise in God, and a new will to make a creature, which He had never before made, how then would that be a true eternity, where there ariseth a will, which was not? (4)

It may seem that Augustine's reasoning concerning time is irrelevant to modern philosophies of time if it has to be interpreted in such a theological context, but not so. How, then, is Augustine's treatment relevant? The answer, briefly, is that his analysis of eternity is still significant.

The problem with creation is one that only arises from a combination of Jewish scripture with Greek, especially Platonic, philosophy. For in the Platonic tradition, if a thing is eternal, it is changeless, but if changeless is to be interpreted as 'the same at all times' then the act of creation is incompatible with the eternity of God, since before that act God was different, that is, he had not

(1) c.f. Wittgenstein, Philosophical Investigations, Para. 89-90;

Richard Gale, The Philosophy of Time, Intro. p.6.

(2) Locke, Essay Concerning Human Understanding, Bk.11, Ch.XIV, Para.2.

(3) Bk. 2, Part 1, Ch.4, Sect.1.

(4) Confessions, Bk.XI, Sect.X., Gale, p 38

then acted. In order to reconcile the act of creation with the changlessness of God, Augustine says that this act is not temporal. This commits him to a description of the eternal different from the ordinary. 'Eternal' was normally interpreted as 'perpetually existing', and if God's eternity is understood in this fashion, that is as omnitemporal, so that God is in time, then His act of creation is also temporal. Thus, if Creation is atemporal, as Augustine asserts, God's eternity must be also. Since it is wrong to speak of the time at which Creation occurred, it is also wrong to speak of the time before Creation.

Augustine expresses eternity in the following way:

Thy years neither come nor go; whereas ours both come and go, that they all may come. Thy years stand together, because they do stand; nor are departing thrust out by coming years, for they pass not away; but ours shall all be, when they shall no more be. Thy years are one day; and Thy day is not daily, but To-day...(1)

The gist of this quotation is quite clear - that which is temporal to us is not temporal to God but simply present. Thus God's understanding of what is to us temporal cannot involve any reference to its temporality, that is passage. Now this is a point of contact with modern philosophies of time: passage is in some such philosophies eliminated, or, better, recast into a purely perspectival form with no ontological force; it seems that Augustine is in a parallel fashion eliminating passage, at least insofar as God is concerned. That there is a parallel here of course needs justification, the modern atemporal truth, conceived as like mathematical truth, is not obviously like the Divine eternal truth, since Divine truths are true temporally, but mathematical truths are not; so, for example, God knows today what happens, but temporal qualifications are not appropriate of mathematics.(2)

One might think that Augustine would rest satisfied with his distinction between time and eternity, but he does not. Instead he goes on to inquire into the nature of time as contrasted to eternity. The problem he sets himself has its modern counterparts, since it appears to be an epistemological one of how we can know time. But why does he

(1) Confessions, Gale, p.40.

(2) Geach on Aquinas in Three Philosophers, p.124 makes the same point.

bother with this at all? Remembering the reconciliation Augustine is working of Platonic doctrine with Christian scripture, we recall also the intimate connection between the known and the real in Platonic doctrine. Augustine's famous dilemma about the nature of time is not a new factor, it arises from his very enterprise. Indeed if we take it as being new the immediate context of its introduction becomes curious:

At no time then hadst Thou not made anything, because time itself Thou madest. And no times are coeternal with Thee, because Thou abidest; but if they abode, they should not be times. For what is time? Who can readily and briefly explain this? (1)

So begins Augustine's lament, and its position is as if it had explanatory force for the assertion that no times are coeternal with God.

We can paraphrase the reasoning here. God the eternal has created time. But some things, for example his own son, He has created as eternal(2). Augustine shows that this cannot be true of time, since time passes. What follows seems an expansion and explanation. What else could it be in the context? And the argument leads up to Augustine's final conclusion in answer to the problem posed by creation: 'Let them see therefore, that time cannot be without created being...'(3)

What, then, is it that Augustine is trying to do? Remembering the platonic tradition where the eternal is the real Augustine has to show how time is not real even though it seems to be, for if it were real it would be eternal. Thus Augustine has two tasks: to show that what is cannot be temporal, that is cannot pass; and to account for the apparent reality of time. These tasks are closely connected with knowledge, for the real has to be intellectually comprehensible, as is the Platonic requirement. From the connection of reality and knowledge comes the Augustinian paradox of time. We cannot know time, because it passes, but we know it very well.

We now see that the error Augustine is often modernly accused of, namely substantializing time, he did not commit.(4) The problem is not to do with a definition of the thing time, but with the status of time, that is of the past, present and future, both ontologically and epistemologically. Given that time is not proper to the Godhead, that is

(1) Gale, p.40

(2) 'Thy Today, is Eternity; therefore didst thou beget the Coeternal...' Gale, p.40

(3) Gale, p.53

(4) for example, Gale, introduction to Philosophy of Time, p.3-5

the real, then if it is proper to anything it is proper to the created world. But we know that time is proper to the created world because, after all, we know time. Thus Augustine's problem is to give an account of our knowledge of time which does not imply that time is real, that is proper to the Godhead.

Augustine's solution is to show that passage, which is the essence of time, can never be directly known. If we know any time we know only the present, which does not pass - it cannot because it is an indivisible instant. Our knowledge of the past and future is indirect, the former coming from memory and the latter from expectation. But both memory and expectation are present, and so strictly speaking we do not know the passage of time.

The nub of Augustine's problem, therefore, is the explanation of how we can know something which we manifestly do know. The past and the future (that is thing past and things future), ~~which~~ can never be present to the mind's contemplation, and therefore cannot be known or be real. What it is we actually know when we say we know such things is memories and anticipations, which can be present to the mind.

EMPIRICISM

Now, although the reasoning which led Augustine to this result, namely an application of the Platonic principle that only that which can be comprehended by the intellect can be real, is very different from the reasoning of empiricists which leads to a similar result, nevertheless the Augustinian argument is equally effective there.

Let us begin with the principle, apparently opposed to the Platonic doctrine of the sovereignty of the intellect, that only those statements which are in principle decideable by sensible observation can be true. This is the principle which underlies the enterprise of trying to build all knowledge on the foundation of sensible information. One of the results of applying the principle rigorously is, as Hume demonstrated, the undermining of the representative theory of perception, for if we apply the principle to the apparent piece of

knowledge that corresponding to all sensible qualities is an object from which the qualities originate, we discover that all we can know is the sensible qualities and in no way the object behind them. If we apply the same principle to our apparent knowledge of time an equally disconcerting result emerges. For if we examine our own ideas and sense impressions carefully, we discover that there are none of them which are not present, and since all our knowledge is confined to these ideas and impressions, it follows that the past or future objects on which we apparently fixed our attention, cannot be known, and the only things which can be known are memories and anticipations, which supposedly correspond to actually past or future objects or events. This result, the same as that of St. Augustine, can be seen to follow by a critical examination of Locke's teaching on time.

JOHN LOCKE

John Locke was a man of eminent common sense, who never took his doctrines further than reasonableness demanded. Nevertheless his writing has an underlying thrust, which is the explanation of metaphysical ideas in terms of psychological ones, either by the structure of the human mind, or by the history of how the mind comes to have the structure it does. Such an enterprise as the elimination of the metaphysical in terms of the psychological requires, however, a principle that common sense would not perhaps entirely admit. This principle is the close delimitation of the kinds of material upon which the mind can work, and in addition of the possible operations of the human mind. Locke did not follow the principle very carefully, though he was committed to it, and as a result much of his philosophy was seriously undermined by David Hume. Taking the same principle rigorously leads also to a demolition of Locke's theory of the origin of time, or rather to a reconstruction of it in terms surprisingly like those St. Augustine uses.

Locke's definition of time is as follows:

Time is duration set out by measures - Having thus got the idea of duration, the next thing natural for the mind to do, is to get some measure of this common duration, whereby it might judge of its different lengths, and consider the distinct order wherein several things exist... This consideration

of duration, as set out by certain periods, and marked by certain measures or epochs, is that, I think, which most properly we call time. (1)

At first sight this definition is that of the modern manifold theorist, but once we include the definition of duration, this appearance vanishes:

Duration is fleeting extension: There is another sort of distance or length, the idea whereof we get not from the permanent parts of space, but from the fleeting and perpetually perishing parts of succession. This we call duration, the simple modes whereof are any different lengths of it whereof we have distinct ideas, as hours, days, years, etc., time and eternity. (2)

It would seem, therefore, that favouritism is now bestowed upon the opponents of the manifold view, those who espouse the evolutionary theory of time, since duration is reduced to succession, but this is tempered by the reduction of succession and duration both to the train of ideas:

It is evident to any one who will but observe what passes in his own mind, that there is a train of ideas which constantly succeed one another in his understanding as long as he is awake. Reflection on these appearances of several ideas one after another in our minds, is that which furnishes us with the idea of succession; and the distance between any parts of that succession, or between the appearance of any two ideas in our minds, is that which we call duration. (3)

Locke evidently did not regard either the idea of succession or duration as fundamental, but rather the train of ideas, from which the ideas of succession and duration are derived, for if he did not, then there would be no need of reflection on the train of ideas in order to generate the idea of succession and therefore duration, but rather the idea of succession would be part and parcel of the train of ideas.

Locke's analysis of the idea of time is therefore founded on the train of ideas. But the train of ideas can not be what we might suppose from Locke's talk of it. For Locke talks of the train of ideas in temporal terms. When he says 'Reflection on these appearances of several ideas one after the other' this seems to presuppose an awareness of ideas as earlier than the present. But such an awareness

(1) An Essay Concerning Human Understanding, Bk.2, Ch.14, Para.17

(2) ibid Para.1

(3) ibid Para.3.

just is an awareness of succession, and therefore reflection is not needed to produce the idea. Thus, however sound Locke's psychology of learning may be, he cannot, it would seem, use it as a basis for a definition of time.

Nevertheless, Locke wants to define time by the psychological origins of the idea of it, via duration and succession, but can he do so? He says that the origin of the idea of succession is reflection on the succession of ideas. Therefore, in order to develop the idea of succession, we must be aware of the succession of ideas. At the very least this means that we must be aware of some ideas as being present to the understanding, and others not, for if we were not aware of ideas not present to the understanding we could have no awareness of the train of ideas, but only of the presence of ideas. It seems that awareness of the train of ideas, that is the succession of ideas, must involve the awareness of ideas not present to the understanding. But what is this awareness? It seems a contradiction to be aware of an idea not present to the understanding, because for an idea to be present to understanding just is for the person understanding to be aware of that idea, and so it would seem that we are required to be aware of ideas that we are not aware of, which is paradoxical.

Some one might object at this point that this paradox, that we can be aware of ideas we are not aware of, trades on quantificational ambiguity. For to be aware of an idea one is not aware of can be read with different scopes for the quantifier:

1. There is at least one idea x , such that A is aware of x and x is not present to A 's understanding (that is A is not aware of x).
2. A is aware that there is at least one idea such that he is not aware of it (it is ^{not} present to his understanding).

This second interpretation certainly avoids the paradox, but it leaves the problem of what account to give of the succession of ideas, for unless we have already some notion of succession, we can give no sense to saying that an idea we are aware of succeeds one which we are not aware of. Indeed, it seems a contravention of the basic empirical tenet that all knowledge is relationships between ideas to suggest that we can order ideas that we are not aware of. Ideas that we are not aware of must have some indicator in our awareness. That there are

in fact such indicators can be seen by an example of the mental history of an idea. Firstly one is aware of an impression, and then one remembers it, and then later one remembers having remembered it. Thus, one can be aware of having forgotten something which previously one knew. If there were not an indicator of some sort or other in one's awareness which showed that there was here an idea one was not aware of, it would be impossible for ideas one was not aware of to play a part in one's mental life. But for one to be aware of the succession of ideas as coming into being and perishing, it is necessary that one be aware that here there are ideas which one is not aware of. And so, if we are to be aware of the succession of ideas, there must be a characteristic belonging to ideas which are present to our understanding which serves as an indicator for ideas which are not present to our understanding.

It is not difficult to see the necessary characteristic. To be aware of the train of ideas is to be aware of some ideas as present, and others as having been present to the understanding. But to be aware of tensed reference in this fashion is already to be aware of time, or at least, to already have an idea of succession, so this characteristic would commit us to circularity. Consequently it must be modified. The modification is the introduction of memory, so that to be aware of the train of ideas is redefined as being aware of some ideas (as present to the understanding), and to be aware of the memory of other ideas (as present to the understanding). By this definition, the train of ideas requires nothing beyond the presence of ideas to the understanding, these ideas including memories (and, presumably, anticipations as well).

When the train of ideas is so reconstituted so as to refer not to what we would naturally suppose it to be, the temporal sequence of ideas, but rather to the collection of ideas which are present to the understanding, perhaps together with an awareness that there are or at least may be ideas which are not so present, then it becomes possible to derive what time is, that is a definition of time, from the psychology of learning temporal concepts without falling into circularity.

The reinterpretation we have been forced to make of Locke's succession of ideas, from which the idea of time emerges, is, curiously, that which Augustine was forced to, albeit that the rationale comes from different philosophical traditions. Locke's claim to have solved

Augustine's problems of time, which he makes at the beginning of the chapter from which I have quoted(1), is thus seen to be quite overoptimistic. But there is a more important result than this, for such a coincidence between different traditions ought to make us look for a common element or structural relationship between the two traditions. There is indeed such a connection.

THE CRITERIA OF EXPERIENCE AND MEASUREMENT.

Locke, as we saw, thought that the essence of time was measurable duration, but he tried to found this idea of time upon the succession of ideas, which attempt was, again as we saw, unsuccessful. But the association of time primarily with measurable duration, duration as set out by measures, was a very important shift in the concept of time, for up until the development of clocks which reliably measured periods of time, the flow or passage of time had always been supposed its dominant characteristic, and this flow is a qualitative phenomenon, not quantitative. The importance of this shift in emphasis in the concept of time was not immediately apparent to Locke, or to Newton, from whom he derived it.

The important aspect of the new theory of time was, for the writers of that time, the establishment of the infinite straight line as the correct metaphor for time. For only if some such figure is correct for time can geometry be applied to time, since geometry requires the real continuum. The need to justify the application of geometry to time arises from the infinitesimal calculi, which give accurate motions for terrestrial and planetary objects, but which require the treatment of time as a geometric continuum. Such a treatment is contrary, however to the ancient tradition of succession, that each moment is followed by a next moment. This tradition makes of time an arithmetical sequence, not a continuum, and if it is true, then the method of increments, that is infinitesimals cannot be applied to it, for between two instants there are no increments. And given the unquestioned dominance of Euclidean geometry, the natural replacement for this tradition of time is that of the real line. Newton's mentor Isaac Barrow thought

(1) op. cit. Para. 2, Ch. XIV, Bk. 11.

that the line could be either straight or circular, seeing as circular motion had the endorsement of the ancients, but Newton and all other later writers rejected the circular, on the grounds that periodic motion might complete a cycle but does not exhaust time. These two aspects of the new concept of time, that it was infinitely divisible as the real continuum, and that time is not circular, were well represented in the image of a point moving in a straight line, the line being identified with time and the point with the present.

The resulting conception of the universe as a kind of spatial and temporal box within which events occur was a powerful support for the new mathematical tools. It was achieved essentially by an extension of Euclidean geometry to four dimensions. However, with the gradual recognition that Euclidean geometry does not necessarily truly represent the shape of the physical world, a new basis of the theory of the structure of time began to emerge, and that is measurement. With the development of relativity theory scientists have commonly accepted that only the results of measurement can enable us to determine the structure of time, that its structure is derived from the results we actually get with our clocks and rulers. The metaphysical argument of Newton and Locke has given way to instrumentalism.

Time, as Locke defined it, was duration as set out by measures. He, along with Newton, believed that time is ontologically prior to its measures, prior to the cycles and periods of stars, planets or clocks, so that time would exist even if none of these did. The features of time were however, derived analogically from those of clocks and rulers, even though the arguments in support of this absolute time were metaphysical, and thus time was, effectively, considered as necessarily measured. The assimilation of the measurement of time to the essence of time, though not complete, since absolute time was a metaphysical, not a physical notion, was a necessary prelude to the later more modern development where the essence of time just is its measurement. For the motivating principle of the Newtonian theory of time is that time really is as it is set out by measures, and the difference between Newtonian and relativistic teaching on time is that for the former the inevitable conclusion is that time forms a Euclidean line, whereas for the latter this conclusion is not inevitable. For both the fundamental principle is

the same - that time really is as it is set out by measures.

Now it is not at all obvious that this principle can conflict with the principle that time really is as it is given in human experience, for after all, measurement is given by observation, which is a form of human experience; but nevertheless this conflict does exist.

The two principles concerning time are special cases of more general principles, each being a variant on empiricism. Consider the basic doctrine of empiricism, that only those statements are true that are supported by the evidence, especially the evidence of the senses. This is a common sense doctrine supposedly, and as such it has two aspects, both common sense, that the direct evidence of one's senses cannot be contraverted, and that what we understand on the evidence of our senses may well be mistaken - the evidence of ones senses certainly is evidence, but what it is evidence of may not be entirely certain. This doctrine of empiricism seems innocent and unambiguous, but it is not, for it is satisfied by at least two different schools, that of phenomenology and that of phenomenalism. Both phenomenology and phenomenalism begin with the evidence of the way things seem to be, the apparent evidence of the senses. But from there they diverge. For the phenomenologist asserts that my report of my sensory experience cannot be mistaken, that my sensory experience is what it seems to me to be. The phenomenalist, on the other hand, is sceptical about my report of my impressions; for him my report, and the corresponding sensory experience, are composites constructed from the myriad simple sensory impressions I receive, and cannot be mistaken about, which are processed into complex impressions by my mind. Concerning the differences between phenomenologist and phenomenalist here, the original empirical doctrine is silent. For what is the direct evidence of one's senses? If I mistakenly believe that I see the number 47 on a bus, what is it that is incontrovertible about my experience here? Certainly that I seemed to see the number 47, but this use of 'seem' is a mere prevarication. Did I see the number 47, or did I not? If I did not, what did I see? To the first question the phenomenologist would answer that I did see the number 47, the phenomenalist that I did not, but that I had certain impressions which I construed as the number 47. These different answers to what I saw

imply a profoundly different attitude as to what in any case of empirical investigation is to count as evidence.

Before we proceed, note that this divergence between phenomenology and phenomenism is independent of the further ontological question as to what there really is. Most phenomenists believe that what there really is is fields of sense impressions from which all our ordinary objects and concepts are constructed. Such a phenomenist ontology is a result of Berkley and Hume's destructive criticism of the empiricists' program. We can in the first place accept the divergence between phenomenology and phenomenism as a dispute about the nature of sensory evidence without yet being necessarily involved in ontological questions (though these must ultimately be faced).

To return to the matter in hand, we were faced with fundamentally different attitudes as to what in any case of empirical investigation is to count as evidence. The phenomenologist's technique known in their jargon as 'bracketting off' is equivalent to accepting as incontrovertible a subject's description of his experience; this acceptance is to be contrasted with the procedure of the phenomenist, where the subject's description is regarded as requiring analysis to discover the truly incontrovertible experience. As a consequence, the phenomenologist's world is a human-centred one, where all experiences are interpreted in terms of what they mean to the human, whereas the phenomenist's world is a phenomenon-centred one, where all experiences are interpreted in terms of how they are constructed from the phenomena.

This general divergence of approach subsumes the divergence I mentioned above concerning time, that the principle that time is as it is set out in measures diverges from the principle that time is as it is given in human experience. For the former principle is equivalent to saying the structure of time is the structure given by an analysis of the behaviour of clocks (whether natural or artificial), which is a special case of the phenomenist's approach; and in contrast to this the latter principle is equivalent to saying that the way human's experience time is the way time really is, which is a special case of the phenomenologist's approach.

Though I have for the purposes of exposition labelled the two camps 'phenomenologists' and 'phenomenalists' these tags are too narrow to comprehend all those who belong to one camp or the other, and I shall from now on designate them by the principal emphasis of their approach, on the one hand we have the school of analysis, and on the other the school of experience, both of which a common origin in empiricism. Because the difference between the two schools is one concerning the nature of evidence, many futile debates are wages between them, those concerning the nature of time and of space being among them.

LOCKE AGAIN

Having established this difference of approach let us return to John Locke, who has established, so he thinks, the psychological origins of time in the succession of ideas. He then turns to the definitions for time as duration set out by measures, for which he invokes the revolutions of the sun and moon, or any periodic change such as the seasons. We are now in a position to see that in turning from the one to the other Locke has shifted his ground. For, in his analysis of the psychological origin of time he generates duration from the introspection of succession and succession from the introspection of the train of ideas. This is an introspective investigation into qualitative aspects of human experience. The limits of this investigation I have already shown, in that the train of ideas cannot be as Locke describes it, the actual succession of ideas in the mind, for we cannot be aware of that for the same reasons St. Augustine gives, and it must be instead a present collection of ideas in the mind, if we are to stick steadfastly to the rule that we can only be aware of what is present to our minds. But the qualitative exploration of the human experience of time is precisely the sort of thing I have characterised as belonging to the experiential rather than the analytic school. And indeed that turns out to be the case. For Locke says:

Let a cannon-bullet pass through a room, and in its way take with it any limb or fleshy parts of a man, it is as clear as any demonstration can be that it must strike successively the two sides of the room; it is also evident that it must touch one part of the flesh first, and another after, and so in succession: and yet I believe nobody who ever felt the pain of such a shot or heard the blow against

the two distant walls, could perceive any succession either in the pain or sound of so swift a stroke. Such a part of duration as this, wherein we perceive no succession, is that which we may call an instant, and is that which takes up the time of only one idea in our minds without the succession of another, wherein therefore we perceive no succession at all.(1)

Before we analyse this passage, let us remember that we are not criticizing Locke directly, for he was not a consistent psychological reductionist but also a realist, as the correspondence theory of perception indicates. Now, to begin, we must suppose that Locke is aiming to explain the significance of time, and not just to give an account of the psychology of learning. Supposing this, we must conclude that the significance of time is to be explained in terms of the psychological experience of events. And this implies that the structure of time is a construct from those events. But if we are to take this seriously, it cannot be possible for those events which we perceive in an instant, as Locke describes it, to be in fact successive. Not only is the train of ideas 'the measure ... of all other successions'(2), but if we are to look to it for the ultimate explanation of time, the only genuine simultaneity and succession can be that of our ideas. And so it would seem that the succession Locke describes, of the cannon-ball breaking through one wall, striking and penetrating a man and departing through the opposite wall, is at best a theoretical construct, and not real, the reality being given by the experience of the man. Clearly this is not what Locke intended, but it follows from grounding the nature of time in human psychology.

Locke has, I believe, two contradictory intentions in this passage. The first to found all of our ideas of time on the train of ideas, and second to support the reality of time as discovered by the arts of measurement. Thus in the passage quoted he plainly believes that the described circumstances imply a real succession, for he says '... the sense of succession is lost, even in cases where it is evident that there is a real succession'. But the real succession is not discoverable in the succession of ideas, though the physical circumstances of the passage of the bullet enable us to infer that there must have been such a succession. At this point Locke clearly puts his trust not in the

(1) Locke, Essay Concerning Human Understanding, Bk.11, Ch.14, Para.10,

(2) ibid . Para.12.

psychology of events but in the art of their measurement as the true indicator of reality, for it by such art we discover the real succession.

In Locke's case the resolution of these contradictory intentions is that he was investigating the psychological correlatives of real processes, not attempting to reduce the one to the other. However he himself invites the reduction of the real to the psychological, for he says without qualification:

Since the mind, in all its thoughts and reasonings, hath no other immediate object but its own ideas, which it alone does or can contemplate, it is evident that our knowledge is only conversant about them.(1)

It is this doctrine that, as rigorously pursued by Hume, transforms much good psychology into suspect metaphysics.

As in Locke's example, the criteria of human experience and the art of measurement often give contradictory results, conflicting not only as to the simultaneity of events, but also as to their rate of occurrence and even as to their order. It therefore makes a great deal of difference which one accepts as the court of last appeal. The way in which the difference shows most clearly is ontological, for ontology is that derivative field of epistemology where theories of knowledge are translated into theories of reality. Even over such an apparently tangible thing as reality, the arguments are pretty abstruse. For very few arguments concern what there actually is in the world, primarily they concern the relative statuses of existing things. For example in the case of Locke's cannon-ball, those that cleave to the experiential criterion will say that the experiential instant is the ultimately real, whilst those that adhere to the analytic criterion of knowledge will say that the measured (inferred) sequence of events is the ultimately real. Each will say that the other's ultimate reality is a theoretical construction.

Is there any way to resolve such a dispute? Probably never conclusively: but, as I said, ontology is a derivative field from

(1) Locke, op cit Bk.IV Ch.1 Para.1.

epistemology, and it may well be possible to limit ontologies to those permitted by a correct theory of knowledge. Though it is not my purpose in this work to defend the final truth of any particular ontology or epistemology, I am concerned about what ontologies are possible, and in particular I am concerned that the analytic claim to the method of discovering the real to be consistent, so that real succession and experiential succession both be consistent ideas. In the next section I treat of this matter.

OUR KNOWLEDGE OF TIME.

I have shown that if we take Locke's doctrine that our knowledge of time is from our trains of ideas, then we can have no knowledge of what is not present, and thus our knowledge of other times consists in memories and anticipations. This correction of Locke's theory of time is strikingly similar to Augustine's solution of his problem with time. I remarked earlier that there is a strong connection between the two cases. It is that which I wish now to discuss. The connection is important because it turns out that in it lies a basic threat to the reality of time. For it seems to follow from the principle that what is real is possible to know that only the present can be real, so that the reduction of time to psychology is not only a consequence of Locke's position but necessary. In order to show how let us return to St. Augustine.

Augustine, as I have explained, was faced with the problem of reconciling the Platonic doctrine of reality as both what is changeless and what is knowable with the apparent fact that we know changes, events which pass in time. He manages to reconcile these by asserting that what we know when we think we know time is our memories and anticipations. He says of past events:

It is not them themselves, which now are not, that I measure, but something in my memory, which there remains fixed.(1)

This develops into:

(1) Gale, *op cit*, p.50

It is not then future time, that is long, for as yet it is not: but a "long future", is "a long expectation of the future", nor is it time past, which now is not, that is long; but a long past is "a long memory of the past." (1)

Augustine's position is quite categorical. In this context he says:

It is in thee, my mind, that I measure times. Interrupt me not, that is, interrupt not thyself with the tumults of thy impressions. In thee I measure time; the impression, which things as they pass by cause in thee, remains even when they are gone; this it is which, still present, I measure, not the things which pass by to make this impression. This I measure, when I measure times. Either then this is time, or I do not measure times. (2)

Now Augustine does not say that all knowledge must be restricted to the present, only that human knowledge, being restricted to the present, cannot be knowledge of anything else. God, from the point of view of eternity, can know everything that we can only remember or anticipate.

Augustine's analysis of passage is thus strikingly similar to that of any analytic philosopher in the tradition of Bertrand Russell. In this tradition human time, relative to a person at a given moment, is the organisation of his memories, perceptions and anticipations. Objective passage then consists primarily in the fact that what is at one time the content of a perception may at a later time be the content of a memory, and that what is the content of an anticipation may at a later time be the content of a perception. Such objective passage has a subjective correlate in that a person has not only memories, perceptions and anticipations, but also memories, perceptions and anticipations of these, and so on in a regress. All the types of these experiences serve to order those experiences, and such ordering is the subjective passage of time.

Now objective time is alien to Augustine, if only because for him time belongs essentially to created being and not to the real, that is a God. But subjective passage is evidently just what Augustine meant by time, or else he would not have said, in the above quote, of the impression left in this mind by passing things 'Either then this is time, or I do not measure time.' That passage

(1) Gale, op cit, p.51.

(2) op cit, p.50-1.

is subjective follows, though Augustine expresses the matter somewhat differently, saying that time is a property of created being, because on the one hand we are aware of it and on the other knowledge of passage implies knowledge both of what was and what is, so that, since this knowledge can only be of memories and perceptions, and is therefore subjective, passage must be also.

Curiously, though Augustine's eternity and the modern time of science are not alike (for one thing Augustine thought that the measurability of time was entirely a property of the mind and not of reality), nevertheless the two show remarkable resemblances. First, both concepts allow that it is in principle possible for humans to know other times than the present: Augustine's does so because humans can attain the point of view of eternity, thus transcending the human condition; and the modern time of science does so because the limits of human experience are for it a mere matter of fact, not necessary, since an observer can in principle be anywhere at any time. Second, both eternity and objective time involve the implication that they are real, as opposed to subjective time or passage.

These similarities are not coincidental. They follow from a common belief, indeed a common sense belief, that knowledge and reality are intimately connected because what is real is possible to know. This belief is absolutely fundamental to any system of philosophy which intends that the world should be intelligible, for this just means that there is nothing true or real which is in principle beyond the possibility of human knowledge. In the modern age this rule of intelligibility is more familiar in its Empiricist form as the doctrine that whatever is impossible to know is not real. This form is exactly equivalent to the other, being merely its logical transposition.

This simple observation of equivalence promises to do untold damage, for it apparently leads to the necessity of Augustine, and consequently all Platonists, along with all realists including scientists, rejecting the reality of any world other than that of the human condition, that is, sensation. Hume's argument against Locke's representative theory of perception applies to them all.

As we have seen in this chapter, Locke cannot maintain objective time, either as extension or as succession, because he founds all possible knowledge to the actual psychology of the human mind. The thesis which necessitates this foundation, and consequently the elimination of objective time, is fundamental. I quoted it earlier:

Since the mind, in all its thoughts and reasonings, hath no other immediate object than its own ideas, which it alone does or can contemplate, it is evident that our knowledge is only conversant about them.

This doctrine of Locke's was tempered by his distinction of mediate and immediate knowledge, mediate knowledge being knowledge via ideas, but whose objects are not ideas. This is Locke's theory of representative perception. He meant by this that the real object is represented in my mind by an idea, either a sensation or some other idea. Mediate knowledge was, then, the type of knowledge of the external world, and when mediate knowledge as of the external world was eliminated by Hume using the principle we have referred to that the real is possible to know, the reduction of the real to the psychological was complete.

Two alternatives seem open to the realist. Either he must defend mediate knowledge or he must assert that immediate knowledge is not necessarily of mental objects. This second line has been taken, and is the basis of neutral monism as developed by Russell and others from the analysis of sensation by Moore, but it has the uncomfortable consequence that the external world it is designed to guarantee is nevertheless an artificial construction from the not necessarily mental objects. It would seem preferable to defend mediate knowledge. Another line on immediate knowledge is the Platonic, where a faculty of intellectual perception is supposed, whose objects are not mental. The trouble with such a characterisation of immediate knowledge is that it must explain how I can know which objects of thought are mental and which are not. (Neutral monism avoids this by saying that all objects of thought are not mental, or equally mental and not.)

THE ARGUMENT AGAINST THE EXTERNAL WORLD.

Can Hume's destructive criticism be avoided? Let us examine a reconstruction of Hume's criticism of mediate knowledge in order to

see. We begin with the common sense (and Platonic) principle we referred to:

If x is real then it is possible to know x .

This is a principle we apply to objects (that is, things which can be real), and transposes as:

R. If it is not possible to know x , then x is not real.

Now, according to Locke's distinction of immediate and mediate knowledge, 'I know x ' is to be construed either as 'I am aware of an idea x ' or as 'I am aware of an idea y and I know that y is an idea of x '. Thus, 'I am aware of x ' is never true if x is not an idea. As a result of the distinction the principle R has two forms, of which the interesting one is:

R'. If it is not possible to be aware of an idea y , and to know that y is an idea of x , then x is not real.

The antecedent of R' is true if it is not possible to know that y is an idea of x . Now the interesting case is where x is not an idea, for is it then possible that I should know that y is an idea of x , and yet not be aware of x ? Certainly it would seem so, but I must at least know that x exists. Here we ask the same question again. Can I know that x exists without being aware of x ? I can but only if I am aware of some z which I know is conclusive evidence for the existence of x ; and I can know this only if I have some idea of x , so that I can decide on the evidence. This brings us full circle, for we must ask again how I can know that this idea is of x , without being aware of x . The circle so established is vicious, for it must be broken if mediate knowledge is to be possible. The conclusion has to be that only immediate knowledge is possible. Combine this with Locke's doctrine that the only immediate objects of knowledge are ideas, and it follows from principle R that nothing that is not an idea can be real.

If this argument were correct, it would be necessary to abandon analysis as a means of discovering what is real from experience, if this is taken to mean that things may be other than they seem to be. The only form of error that is then possible is of the agreement or disagreement of ideas. Historically, forms of analysis have survived imprisonment within the dungeon of perception, but only by a certain artifice. The theories of sensationalism, such as those of Hume, the Mills and Ayer, all postulate ersatz objects in the form of elemental impressions or primitive, 'raw' sense data. These data have the

characteristics of physical atoms, they are indivisible, independent of other data, and exist as what they are independently of the operations of the mind. It is these features of sense data that leave the way open for neutral monism. Analysis then becomes the business of reducing all ideas to their psychological atoms. But this sort of analysis is quite unlike that which is sceptical about the evidence of the senses, regarding the senses as always possibly in error.

Sensationalism is a bad base for scientific analysis, because it cannot allow that the objects of science actually exist. Consequently, there ought, for the purposes of science, to be a way of avoiding the conflation of the real with the mental. Equally, anyone who wants to maintain the manifold or 'block' universe as being real, or the extension of time as being real, must find a way of avoiding the reduction of reality to perception, for as my discussion of Locke and Augustine on time shows, given Hume's argument, it is not possible to perceive either the extension or the succession of time.

The key to the reduction in question, and therefore to its refutation, lies in the analysis of knowing that something is an idea of something else. According to Locke, this is a relation, that of representation. Being a relation I judge to be true by showing that it holds between its terms, but I can only do this if I am aware of its terms. So, if I know that a memory represents a perception, then I am aware both of the memory and the perception. This seems innocuous until we realise that to be aware of the perception does not here mean to remember it, but means to be aware of the original perception, with the result that it is not the case that we know that our memories represent perceptions, because when we remember we are not aware of the original perception.

Memory thus conceived becomes problematic. Since a perception cannot, given the above, be characterised as such by reference to the original perception, then a memory must be qualitatively different from a perception. This is the line that Hume takes, for he defines memory as less vivacious perception, where Locke merely remarks on the tendency of memories to fade.(1) But what then if one remembers a memory?

(1) D. Hume, A Treatise of Human Nature, Vol.1, Part 1, Section 3.
J. Locke, Essay, Book II, Chapter X.

One must then have a less vivacious perception of one's memory and the circumstances of one's remembering. But the memory is itself less vivacious perception, so that when one remembers a memory the vivaciousness of the original perception is twice diminished. Now, given that perceptions cannot be classified into their types by their reference, all faculties of the mind must be distinguished by the quality of the perception. Hume thus characterised imagination as very dull perception.(1) But the result of this is that, since the vivaciousness of a memory diminishes, it becomes imagination. This ought not only to be true of distant memories, of which it is somewhat plausible, but also of the termini of some sequences of 'a memory of a memory of a memory etc.', since the original perception will be diminished in vivacity a great number of times, so that the termini of these complex perceptions are not memories as we would suppose, but imaginations. But surely it is logically necessary that the termini be memories.

Another problem with this kind of interpretation of forms of perception is the explanation of the familiar phenomena of something slipping one's mind or being on the tip of one's tongue. One knows that one has the idea, but one does not know what it is. But on Hume's theory, and a consistent working out of Locke's, this is impossible, because to have an idea is to know what it is. Memories one is not aware of are consequently a contradiction in terms.

Now the natural interpretation of ideas slipping one's mind or being on the tip of one's tongue is that there is an idea to which one can refer which is not immediately before one's mind. Nor is the reference in such cases a form of representation of the elusive idea, because if it were, the idea one does have in one's mind which refers to the elusive idea, could stand in for it. The phenomena of forgetfulness of which we are conscious seem to indicate that it is possible to know that an idea exists without being aware of that idea.

We find in these phenomena, then, the point at which we ought to attack Hume's argument in order to defend mediate knowledge. We have to show that it is possible to refer to something without being aware of it. What this amounts to, in terms of the argument as I presented it, is that we must show that 'I know that y is an idea of x' does not

(1) D.Hume, A Treatise of Human Nature, Vol.1, Part.1, Section 3.

imply that I am aware of x. Our test here reduces, as in the argument, to showing that I can know that x exists without being aware of x. We can put the matter more precisely.

For me to have knowledge of the external world, it is sufficient that I know that my ideas refer to objects or aspects of this world. Thus in order to know that when I am aware of x I am aware of something other than the idea of x, it is sufficient that I am aware of an idea x, and that there is something to which x refers. Thus, can I have knowledge of the external world if I can know that there is something to which x refers, and that this is not an idea. If, however, I can only have this existential knowledge by being aware of that to which x refers, then mediate knowledge, except between ideas of which I am aware, is impossible.

The front line of the defence of reference to the external world has two parts. First is the defence of the thesis that knowledge of reference existing is possible without knowledge of the object of reference, and second is defence of the thesis that it is possible to know that such reference is not to ideas. The defence of both is relatively simple, for we are not attempting to demonstrate that the theses must be true, only that they can be.

To defend the first we assert that it is part of the character of all ideas to refer. We do not discover that they refer by discovering what they refer to. Rather, by knowing that they refer we sometimes discover what they refer to. Reference, we might say, is a quality of ideas much like their vivacity. That is, it is given for every idea that there is something to which it refers.

Given that this is so, we defend the second thesis as follows. We can classify ideas according to the sort of thing to which they refer (though we can always make mistakes.) We will end up with two classes, those which refer to other ideas and those which do not. This latter class, given that we can only be immediately aware of ideas, will be referential but we will not be aware of the objects to which they refer. This class we take as for the greater part referring to the external world. Thus it is possible, though not necessary that there be an

external world, since this class could in fact be null, though it need not be. (All our ideas might refer to other ideas). This defence is only the first line, however, because we have not yet shown how it can be possible to know that an existential statement is true without being aware of the object in virtue of which it is true, for after all, the mere existence of a reference does not guarantee that there is a thing which is referred to, as the possibility of referring to non-existent things shows. Consequently, if the only way that it is possible to know there is something which is referred to is to be aware of that thing, then there cannot be an external world. Consequently, the defence of the external^{world} turns on the question of the possible grounds for the truth of general propositions, and requires that existential conclusions be reachable on other than particular grounds.

Applying this evidential criterion rigorously eliminates, according to Hume, not only the external world but also the experiencing subject, since all I am aware of is ideas, and I am not an idea.

The question of the grounds for an existential proposition is closely related to that of those for a universal one, since the latter implies existential propositions. According to the empiricists all such propositions are inductive generalisations from particular evidence, but if this is so, then some empiricist tenets become ill-founded, for example, the doctrine that all ideas are perceived is not inductively established. Further, the rule that what cannot be known is not real is a universal proposition, but is not inductively established, and if it were it could not be known to be true.

Without going outside the realm of ideas we can consider the matter as follows. I said that it is a plain fact that I can know I have forgotten something. Evidently this does not mean I am aware of what I have forgotten, for if I were I would not have forgotten it. What it means is that I know that there is something which I have forgotten. Should we say that, this implies I do not know that I have forgotten something, that this is only at best a strong belief, on the grounds that not being aware of what I have forgotten I have no evidence that I have forgotten anything? Paralleling this we would have to say that we cannot know that an idea is a memory, since we are

not aware of what it refers to, and can only have a strong belief about this.

The detailed resolution of the matter is beyond the scope of this short discussion, but let me indicate the direction in which the escape of the realist lies. He shows that the denial of the external world ultimately rests on the proposition that no existential statement can be known to be true unless the object to which the statement refers is brought to the awareness. He points out that this is a universal statement, and that on the same grounds that it is asserted to be true, it must be inductive in character, or else existential consequences follow from it which render it false by its own rule. He points out further that the universal rule eliminates much of the internal as well as the whole of the external world. In particular it eliminates time, which is supposed to be guaranteed by psychological life. And he shows that there are prima facie examples of mental life which contravene the rule.

A further point can be made. Much of the thrust of empiricism is the explanation of how, psychologically, we come to know or believe what we know or believe. We have some explanation of how we come to believe in the external world, but only by the device of observing the coherence of our ideas over a period of time. But time, as we have shown, must be a belief derived from memory and anticipation. These in turn must be beliefs derived from the intensity of perceptions. But why should less intense perceptions ever be regarded as representative impressions, unless we already have an idea of time?

THE EPISTEMOLOGICAL BASIS OF TIME THEORIES.

In this present chapter I have attempted to subject the theory of passage to the same sort of critical analysis that I subjected the theory of the manifold to in the last chapter. My purpose has been similar. The concept of passage, like that of the manifold, has a pure form, a most general one, and the aim of my critical analysis has been to discover it. I believe that it has done so, and that the most general form of the concept of passage is essentially the thesis that anything which is not present does not exist. I have shown the

consequences this has for the concepts of past and future: that past and future have to be explained as present mental states, and cannot refer to other presents so that what characterises memories is not that they refer to other times, but that they are qualitatively different from other mental states.

My second purpose in this chapter has been to investigate the epistemological bases of the two opposing theories. As I have said throughout this work, the opposition between the two theories is based on a difference concerning the nature of evidence. This difference I believe I have now demonstrated.

Both parties admit the general principle that if a thing is real then it is possible to know it, but they differ over what it is possible to know. As my discussion of Hume's critique of Locke showed, the crux of the matter lies in the possibility of knowing that something exists of which one is not immediately aware. This is an issue about what the necessary evidence is for the truth of an existential statement. On the one hand there are those who believe that a necessary condition of knowing that an existential statement is true is knowing that the corresponding particular statement is true. On the other hand there are those who do not believe this. The difference here is given bite by Hume's argument, a bite which is sharpened by showing that affirming this principle leads to a disintegration of mental time.

Of immediate concern for my purposes in this work is the consequences of this epistemological disagreement for the fundamental nature of time. We found in the last chapter that the manifold is the fundamental expression of the nature of time for those who believe in the extent of time. We have found in this chapter that for passage theorists the fundamental nature of time is given by the classification of present perceptions and ideas according to whether they are qualitatively impressions, memories, or anticipations. Having got this far we are in a position, as I foreshadowed at the end of chapter three, to return to the issue of time travel.

TIME TRAVEL.

The last two chapters have been undertaken in order to attempt to answer one question: Why does the idea of time travel remain plausible even when its paradoxical consequences are realised? For surely it is not enough that theoretical structures can be erected which permit time travel, or that internally consistent stories can be told of a time travellers adventures. There ought also to be good reasons for believing that such structures or stories are permitted by the methods from which our fundamental theories of time are developed. If time travel were a mere superstructure or fanciful addition to a theory of time, as it is to the Newtonian view of time, it could be of no deep or enduring interest. It must strike to the very heart of our concept of time, and find its home there.

Now much of what I have said in this work is based on the assertion that we have two distinct and opposing concepts of time, and consequently I have developed both concepts to see if time travel can come to rest in both. If it can, then I believe that we can demonstrate a deficiency in the epistemological foundations of both concepts. That demonstration is the purpose of the next and last chapter, where it emerges from the more general issue of causation I shall conclude this chapter with a brief description of how time travel finds its place within each of the concepts of time.

Time travel finds its place within the manifold theory of time essentially in the way that Gödel describes. The manifold is devoid of any structure except that minimally placed on it by two conditions, the first being that it should be continuous and the second being that in every local area, that is in every 'infinitesimal' portion, it should be as it is found to be by our local investigations. The significance of Gödel's model of time travel is that it shows that the manifold is sufficiently tolerant to allow of a structure which permits time travel. A similar case is described by Hans Reichenbach as following from the principle that time order is just and only causal order, but it is not necessary to introduce such a reduction in order to get time travel, and Gödel does not. The essential point is that the manifold is such that it cannot be told a priori what the shape of the continuous curves will be which describe the structure of

space-time. Consequently it is possible to describe a structure of the manifold where the curve or curves representing the time line are closed, or where they have loops and so on. The only criteria that have to be met are those of continuity, local normality, and logical consistency.

Within the theory of passage time travel finds its place in an altogether different fashion, and much in the manner of the novelists, such as Heinlein. Heinlein describes the experiences of a man who undergoes certain adventures which are such that some events which he perceives he also remembers, at the same time, while others which he anticipates he also at the same time **perceives**. The passage concept of time allows such combinations because time for it is entirely the organisation of present ideas into those which are qualitatively memories, those which are qualitatively impressions, and those which are qualitatively anticipations. Since memories and anticipations have no reference to actual past or actual future, there is no logical reason why the content of a memory should not be the content of an impression, that one and the same idea should be qualitatively both memory and impression. Indeed this sometimes occurs, as the feeling of *deja vu* proves.

It is often claimed that the manifold eliminates genuine causation, whereas passage nurtures it, but this is not the case, for causation is no more necessary to passage than it is to the manifold. There are no causal relationships between present ideas, and no causal relationships can be known to hold between the objects of memories and present impressions because knowing this would imply knowing the object of a memory, which is, as we have seen, impossible given a passage theory. Causation is out for exactly the reasons Hume gives.

Despite this, causation is the topic of the next and last chapter for two reasons. Firstly because it is desirable to show just what effect the theory of causation and related asymmetries in time in fact do have for time travel, and secondly because a particular correlative of causation, namely the transmission of information, leads to an epistemological problem for time travel, and thus for time in general.

SECTION THREE.

THE HUMAN CONDITION.

CHAPTER SIX.
TIME TRAVEL AND CAUSATION.

It is easy to point to features of the world which, if regarded as strictly and universally true, would render time travel impossible. But, as my discussions of the last two chapters have shown, time travel is a natural possibility on the two most general conceptions of time, that which lies behind the analytic, scientific group of world views, and that which lies behind the human, experience centred group of world views. These two conceptions of time are natural opposites, as I have explained last chapter, and yet they both in their most general form allow time travel. We must conclude that time travel is a metaphysically consistent idea.

In Chapter Three I developed the analogy on the basis of which any metaphysical presentation of time travel would be entitled to be called time travel. This analogy involved the existence of two 'time' scales, where it was possible for the order of events as measured according to a person's history to differ from the order of events as measured objectively. We find now that as a result of the alienation of the concepts of time as extent and as passage there is only the history as giving the order of events, or only the objective measure. But the analogy of time travel survives because either the objective measure is reconstructed in terms of individual histories or vice-versa. Because of this practical symmetry, despite the ontological and epistemological differences between the two versions of time and time travel, I have in the following discussion of causation not brought in the differences.

A theory of time which, unlike those I have been discussing, begins with a definition of time as causal order, rather than introducing causal order into a more primitive conception of time can fundamentally eliminate time travel on the grounds that causation is a transitive asymmetric relation, from which it follows that nothing later in a causal sequence can cause anything earlier. I am not interested in such a theory because it seems to me quite arbitrary to define the causal relation in this manner, placing it in a

conceptual vacuum and deriving the nature of time from it. My interest in causation is in the further constraints it puts on time travel over and above those either of continuity in the manifold or of consistency of experience for an individual.

There is, however an aspect of the theory of time, intimately bound up with causation, which I have not treated at all, and that is the philosophy of human action. This places a further constraint on the nature of time over and above those I have discussed so far, either in metaphysics or in epistemology. This constraint can be stated quite simply as the principle that the nature of time must be such as permits human action to have the character it in fact has. Whether this in fact a further constraint is a different matter. I do not believe that it narrows the possibilities for the structure of time at all.

The essential thesis which is supposed to generate the constraint is that for human action the past and the future are asymmetrical, because so far as human action is concerned, the past is beyond the possibility of our influence, whereas the future is open to it. This asymmetry is often summed up by saying that it is impossible to change the past. Paralleling this asymmetry of action is an opposite one of knowledge, for the future is beyond the possibility of our knowledge, whereas the past is open to it. These two asymmetries are generally combined into a single metaphysical system where statements concerning the future are not yet true, and statements concerning the past are necessarily true.

In this chapter, then, I shall deal first of all with these matters, and conclude with the epistemological problems which I have remarked on. I shall introduce my discussion of the human condition as it affects the nature of time with a brief discussion of the type of causal paradox which is the basic objection to time travel by those who base their metaphysics on the human condition.

CAUSAL PARADOXES.

Superficial criticism of stories which attempt a fictional description of time travel is to accuse them of inconsistencies and lapses of detail, for it is no easy matter to present a complete account of what the experiences of a time traveller might be like. A useful start on the groundrules that must be followed in such a description of time travel has been made by Jonathon Harrison in his article 'Dr. Who and the Philosophers'(1). The first thing to answer, of course, is that for the traveller ordinary physical processes are possible, that his bodily processes are not disrupted but continue regularly, that he can breathe, that he can see and sense in the normal way. For, let us admit hypothetically that physical processes might go backward in time, then for a person to work backwards in time, all those processes which sustain his life must work in step with him. In the stories there is usually a capsule or vehicle with respect to which all physical processes are normal, and this artifice obscures an important feature of time travel which would be apparent if there were no such vehicle. That is, the time traveller must take his local environment with him. The fiction of the vehicle obscures the significance of this requirement, for though we often travel in closed vehicles, it is a matter of practical convenience that we travel thus in a sealed container taking our environment with us. Except for our physical limitations, we can, anywhere we travel, live off the land, at least in principle. Even in space it is not out of the question that the materials necessary to sustain us be gathered from those encountered along the way. But in time travel no such interaction is possible due to the differing causal sense of the environment and the time capsule.

Imagine such an interaction to be possible. Then consider something, say a bird, which is taken into the time capsule. It maintains the same causal sense as exists outside the capsule, and so, relative to that it is, like T.H. White's Merlin, growing younger. But what happens as the point of the laying of the egg is reached? Does the mother bird materialize? Does the egg vanish? And the bird radiates

(1) in The Aristotelian Society, Supplementary Volume XLV, 1971, p.1-24.

heat, what happens to that, is the bird, relative to the time capsule, a heat-sink, a refrigerator? The conceptual problems in supposing such a piecemeal interaction to be possible for time travel are insurmountable. We must admit the rule that everything in the immediate environment behaves according to the same physical laws. Such a law does not rule out all forms of interaction between the regions with different temporal senses; there is no need to assume that the time capsule is totally outside the physical world, completely isolated from it. For one can imagine a boundary, either immediate or gradual, upon crossing which an object reverses its temporal sense, so that, for example, a bird in the outside environment which flies into the space of the capsule could, from the point of view of that environment disappear, but from its point of view continue flying normally, although it now shares the temporal, causal sense of the capsule. In this way problems with the detail of physical processes are completely avoided, for the two causal spheres never interpenetrate.

Not all causal problems are eliminated however, for all the traditional causal problems remain. For example, if a man were to enter the zone of influence of the time capsule, and remain there a short length of time, and then emerge, he would, ex hypothesi, emerge earlier than when he entered, and, by the assumption we made that locally speaking all physical laws were normal, he would then be able, it would seem, to prevent himself from entering the capsule.

All such dilemmas of undoing or changing the past are well answered by the retort that the time travellers' capabilities are in no way impaired, either overtly or mysteriously, nothing prevents them from trying to change the past, but the simple fact is that they do not succeed. The misconstruals of the notion of possibility involved in the paradoxes of changing the past are well dealt with in Paul Thom's article 'Time-Travel and Non-Fatal Suicide'(1) and also P. Horwich's article 'On Some Alleged Paradoxes of Time Travel'(2).

(1) Philosophical Studies 27, March 75, pp211-6

(2) Journal of Philosophy (72) 14, pp432-444

The problem brought to light by the paradox of changing the past is best understood by a comparison of an ordinary case with a time travel one. Imagine that I am about to enter a car when a man grapples with me and prevents me from so doing. It is then true that I will not drive off in that car. For the time travel correlative, imagine that I am about to enter a time-capsule, when a man grapples with me and prevents me from so doing. It is then true that I will not travel in the time capsule. The paradox arises from the apparent fact that the circumstance of me being prevented from time-travelling might arise precisely because I do time-travel. The problem is usually posed in the form: if I time travel to a point before the time of my departure, what is to prevent me from stopping that departure. The existence of the temporal loop makes the problem a dizzying one, but it is solved by bearing in mind that any sequence of events must be logically self-consistent. Consider the case of me trying to enter an ordinary car, and a man trying to stop me. If he does not succeed, I enter the car; if he does succeed, I do not. Equally if I succeed in entering the time-capsule, I have not succeeded in stopping myself, and there is nothing paradoxical in this. There is only something odd in assuming that I do succeed. But are we at liberty to assume this? No. For if I do not enter the time-capsule, there can have been no time travelling to try to prevent me. This circumstance, although unlike the corresponding case of ordinary travel, is self-consistent. Given that these conditionals are self consistent, to ask what it is that prevents me from stopping myself entering the time capsule is parallel to asking the similar question of what it is that prevents a man from stopping me enter my car, when in fact he does not succeed. There is nothing that prevented him, nor was there anything that prevented me. The difference between the two cases is that the man who fails to stop me entering my car can coherently entertain the possibility of his success, whereas, in contemplating my attempt to stop myself entering the time capsule, I cannot coherently contemplate my success, for that would be logically impossible. But nothing mysterious, such as the force of logic, prevents my success, I simply know that I will not succeed.

The circumstance of my abortive attempt to prevent my time travel is thus analogous to similar cases of inevitable events that are going to occur. Suppose that I know for certain that a dam will

break. I nevertheless may attempt to prevent it breaking, but I know that I will fail, and I cannot coherently contemplate the success of my attempt, if it is true that I know the dam will break, rather than just that this event is highly probable, for the truths of the two are logically incompatible. My foreknowledge in a sense 'dooms' my attempts to failure, but it does not prevent me from trying.

The novelty of time travel is that it allows past conditions to depend on future ones, whereas this never occurs ordinarily. In working out the ramifications of time travel, it is therefore easy to mistake the character of features of the past and future, since otherwise past and future never have to be intertwined. Now, while we have shown that the supposed paradox of changing the past is only a paradox if contradictory assumptions are made, and that there is no reason to assume these in the case of the past any more than for the parallel case in the future, we have not attempted an analysis of what 'changing the past' is supposed to mean. Once we have done so, the logical difficulty involved with time travel disappears entirely, I think, though further more serious problems remain.

CHANGING THE PAST.

The genesis of the supposed paradox we have been discussing is the symmetry of past and future which time travel implies. For while every individual retains a simply ordered personal history, so far as his immediate surroundings are concerned, this no longer corresponds to a simple objective time order, and the individual can be indifferent to objective past and future. A consequence of this symmetry is that every feature which is supposedly unique to the future must now be also applicable to the past. Part and parcel of the advocacy of time travel is the assertion that this consequence is true, or at least, is logically possible. The opponents of time travel must therefore, if they choose it as the field of battle, show that assuming it leads to contradiction. As I have presented it, the assumption that we can change the past as we can change the future does not lead to contradiction. Now the doctrine that we can change the future but not the past is the key asymmetry between the two for

those that divide past and future this way, so the mere demonstration of a logical consistency in the supposed paradox of time travel does not suffice to dispose of this asymmetry. Not only must we show that the supposed paradox is nothing such, but we must also offer a positive account of just how and why there is no asymmetry between changing the future and changing the past. To begin on this we must examine what we mean by changing the future.

Change, as we have known at least since Aristotle, is the change of a thing from one state to another. Besides the change there is that which undergoes the change, the initial state from which the change occurred, and the final state in which the change culminates. And all of these are real. Can we interpret changing the future in this full blooded way? No, for consider the consequences if we did. Firstly, we would have to consider the future as a thing which can undergo change. Secondly, we would have to regard the future as it would have been as being as equally real as the future as it was after we changed it. After all, in the full-blooded Aristotelean change, the initial and final states are both actual. Once this is admitted we have allowed the actual existence of alternative futures. (This is sufficient, as Meiland points out(1), to allow a toe-hold for a description of time travel in terms of dynamic temporal, a scheme based on the evolution of the present.) We cannot mean strictly what we say when we say we can change the future, for as we have seen, that is incompatible with there being only one actual future.

What we do mean by changing the future is, I think, that we can within limits shape events now so that the future, again within limits, turns out as we wish. This power we have with respect to the future we do not have with respect to the past. Now, so far as this goes, we must accept it, but only as a practical fact about the world. The advocate of time travel will have to say that it is only that, only a practical fact, and that if we had access to the past as we do to the future it would cease to be true; that is, it is perfectly coherent

(1) c.f. Chapter 1.

to assume we can shape the past as we can shape the future. This assumption seems, on first sight, to be necessarily wrong, for we can work to build the future we want, but we know the past was and therefore has to be, so we cannot build it. The reasoning here is, I believe, faulty.

When we contemplate our powers as human beings we discover that to a certain degree we are at the mercy of external forces, but that by a certain degree of forethought, understanding and technical skill we can mitigate or even nullify the meretricious effects of these forces. Such forethought requires an extrapolation, based on our understanding and observation, from the present to future events, and a calculation, again based on our understanding and observation, of how these future events may be influenced, that is what their present causes are, and to what extent it is within our capacity to influence them. Given that this is the condition of human life, it would seem that we have no knowledge of the future, and can only make sophisticated guesses at it, quite unlike the past, which we can remember. Equally, while we can influence the future, which we do not know, we cannot influence the past, which we do know. There thus seems to be deep seated connections between our knowledge of things temporal and our power over them. And, many would add, their nature.

In attempting to unravel these connections and maintain time travel, a preliminary point is in order, which I have touched on before. Time travel is in no way supposed to alter the individual's perception of his perspective in time. The time traveller still has a past and a future in exactly the same way as anyone else - a past which he remembers and a future which he does not, no apparent power over the one and some over the latter. He differs from those who do not time-travel, however, in that his own subjective time order, and so he can become involved in events which while subjectively future for him, are objectively in his past.

What does it mean to say that within limits we can influence events so that they turn out as we wish? It means, for a start, that future events have their causal origin in the present, and that the

initiation of a process now will result in a consequence which we can predict. It means further that there are some such processes which we can initiate now. But however true this may be, it does not alter a further principle, that whatever will be will be. For this principle is merely a special case of the law of the excluded middle. An event cannot both be going to occur and not going to occur. The principle is more famous however as a fatalistic one, meaning that there is no way of preventing what is going to occur from occurring, that whatever anybody does, the future will remain as it is. This fatalism has a familiar ring to it, it is the future correlative of the denial that it is possible to change the past, and as such it is very useful, for in discovering what is wrong with future-oriented fatalism we find clues for showing what is wrong with past-oriented fatalism.

FATALISM.

The fatalist argues essentially as follows. Either any given event is going to occur or it is not. If it is going to occur, nothing I can do will prevent it, and if it is not going to occur, nothing I can do will bring it about. In either case I cannot influence the course of events, and therefore nothing I can do now can influence the future. That the argument is fallacious is plain, for it is an evident fact that we can influence the future, since we do. The power of fatalism waxes and wanes as does the chaos of human life, being great in times of war or social collapse, and being small in times of peace and social order, and since it is a subtle matter to refute fatalism, the argument for it at some times has greater appeal.

The beginnings of a criticism of fatalism lie in the criticism already given of the idea of changing the future. It is a logical incoherence to interpret our power of influencing the future as changing one actual future into another, as the idea of changing the future requires. The difference this makes to the appeal of the fatalistic argument can be seen by reconstructing it in a slightly altered form. Either any given event is going to occur or it is not. If it is going to occur, then nothing I do now will bring about its non-occurrence, and if it is not going to occur, nothing I do now will bring about its

occurrence. And so on. The argument is considerably less appealing emotively when corrected in this way, and failings in the argument appear more clearly. For consider the proposition 'If x is going to occur, nothing I can now do will bring it about that it does not occur'. This proposition is by the laws of logic equivalent to its transposition 'If something I can now do will bring it about that x does not occur, then it will not occur.' But this proposition is patently false, since the mere possibility of my acting to prevent x ~~does not prevent x,~~ I must also perform the necessary action. The mere fact that I could step from the path of an oncoming car does not prevent the collision, I must actually take the step. The fault in the proposition is, then, with the modal operator 'can'. If this operator is removed, so that the proposition reads 'If something I now do will bring it about that x does not occur, then it will not occur', and it is then clearly true. If I step aside that action ensures the collision will not occur, and it does not occur. The elimination of the 'can' is however not the only means of rendering the proposition true, for we might also amend the consequent giving 'If something I can now do will bring it about that x does not occur, then it is not necessary that x will occur'. The addition of a further modal operator saves the proposition equally. Transposing these corrected propositions gives us two interpretations of the original proposition:

1. If x is going to occur, then nothing I now do will bring it about that it does not occur.

2. If x is necessarily going to occur, then nothing I can now do will bring it about that it does not occur. The other branch of the fatalistic argument must be amended similarly, and the non-modal correction reads as follows:

- 1'. If x is not going to occur, then nothing I now do will bring it about that it does occur.

But what about the modal correction? For what does 'x is not going to occur' become? We have to decide between 'x is not necessarily going to occur' and 'x is necessarily not going to occur'. But which? Let us write out both interpretations.

- 2a'. If x is not necessarily going to occur, then nothing I can now do will bring it about.

2b'. If x is necessarily not going to occur, then nothing I can now do will bring it about.

The first of these (2a') is false, as is clear from its transposition 'If there is something I can now do to bring about x, then it is necessarily going to occur'. We cannot infer the necessity of an event occurring from the possibility it might be brought about. The second (2b') is true, as can be seen from its transposition 'If there is something I can now do to bring about x, then it is not necessarily not going to occur'. That is, x is possibly going to occur. Thus this is our modal correlative of 2 above.

Now, then, does the fatalistic argument stand? Setting it out schematically we have:

0. Given any event x:

Either x is going to occur or it is not.

On the non-modal interpretation this is supplemented by:

1. If x is going to occur, then nothing I now do will bring it about that it does not occur.

1'. If x is not going to occur, then nothing I now do will bring it about that it does occur.

On the modal interpretation we have instead:

2. If x is necessarily going to occur, then nothing I can now do will bring it about that it does not occur.

2'. If x is necessarily not going to occur, then nothing I can now do will bring it about that it does occur.

And the fatalistic conclusion is drawn in two steps, from whichever argument.

3. Since 0. and 1 and 1' (or 2 and 2') are true, by the Constructive Dilemma, I can do nothing whether or not x will occur.

4. Therefore, nothing I now do can or will influence what will occur.

The argument, whether modal or not, is faulty as it stands. Let us draw the correct inferences from the non modal argument first, for that is the simpler, since the antecedents of 1 and 1' do directly relate to 0 whereas those of 2 and 2' do not, for they are not contradictories and they involve modalities overtly, whereas 0, does not. By the constructive dilemma we get from 0, 1 and 1':

5. Either nothing I now do will bring it about that x does not occur, or nothing I now do will bring it about that x does occur. Translating this by De Morgan's rule to its equivalent:

5. It is not true both that something I now do will bring it about that x does not occur, and that something I now do will bring it about that x does occur.

In other words, my present action cannot eventuate in incompatible results. This truism by no means leads to the fatalistic conclusion that I cannot influence future events, or that my present actions will not determine future ones. Unfortunately, however, neither does it lead to the affirmation of my power to influence the future, for 5 is still true if both of its components are true. Nevertheless, we cannot conclude from the argument that both are true, or must be true.

What then of the modal argument? So far as the given premises go, it does not even get off the ground. For 0 whether we interpret it as it stands or as:

0'. For any given event x: It is necessary that either x occurs or it does not.

We cannot apply the Constructive dilemma to the combination of it and 2 and 2'. Nor can we assume the distribution of the operator in 0' to give 'Either x necessarily occurs or it necessarily does not occur', for besides being false, this begs the question, assuming what the fatalistic argument is supposed to prove, for another way of writing the fatalistic conclusion that I cannot influence the future is as the thesis that whatever happens happens necessarily, so that there are no genuine present alternatives for the achievement of different future ends.

As an aside at this point I will remark that this fatalistic necessity or fate is curiously like chance. For consider a practical circumstance, such as a war, where belief in fatalism is rampant. In such circumstances inevitability is closely associated with randomness or chance. A pilot nightly traversing flak, for example, relies on luck more than skill. If he consistently avoids damage and injury, he considers himself, and others consider him, to lead a charmed life, to be fated. Luck and fate, chance and necessity coalesce. Nor is this conflation of ideas mere irrationality, for it follows from the very basis of fatalism. For if nothing makes any difference as to whether

an event will occur or not, nothing can be said to be the cause of the event, because no event could be that without which the given event would not have occurred. But an event which has no causal antecedents is precisely what we call a chance event. So fatalistic necessity reduces to chance. Consequently, fatalism should not be confused with predeterminism, the doctrine that every event has a sufficient prior cause. Events which are predeterminable are the only ones we can have influence over, so where fatalism denies our power to influence events, but leaves us free to act as we choose, predeterminism leaves us with the power to influence events but denies us, at least so its critics would have us believe, the power to act freely, since all our actions are determined by prior causes.

Returning now to the arguments for fatalism, let us look at their structure, for only thus can we see what the modal argument is supposed to be. The argument form is the Constructive Dilemma, which has the schema:

$$p \vee q$$

$$p \supset r$$

$$\underline{q \supset s}$$

$$r \vee s$$

Examining the non-modal argument first, we find that its premises have surprising simple origins. Let us represent the premises thus:

0. $(x) (FOx \vee \sim FOx)$

1. $FOx \rightarrow \sim (\exists y) (NOy. (NOy \rightarrow \sim FOx))$

1'. $\sim FOx \rightarrow \sim (\exists y) (NOy. (NOy \rightarrow FOx))$

('Ox' means 'x occurs'; 'F', 'N' and 'P' are prefixes indicating 'Future', 'Present' and 'Past' respectively; $\rightarrow$ indicates implication (if...then...))

Clearly 0 is the law of the excluded middle, but more surprisingly, 1 and 1' are akin to the law of Modus Ponens, from which they are derived as follows:

$$(p.(p \rightarrow q)) \rightarrow q$$

fa/q $(fa.(fa \rightarrow q)) \rightarrow q$

Ex. Gen. $(\exists x)(fx.(fx \rightarrow q)) \rightarrow q$

Transp. $\sim q \rightarrow \sim (\exists x)(fx.(fx \rightarrow q))$

If the same steps are allowed, then the modal premises 2 and 2' can be derived from the principle,

$$(\Diamond p.(\Box(p \rightarrow q)) \rightarrow \Diamond q) \quad (\Box \text{ necessity, } \Diamond \text{ possibility})$$

which is an unexceptionable principle of modal logic. The resulting law is, in this modal case:

$$\sim \Diamond q \rightarrow \sim (\exists x)(\Diamond fx. \Box (fx \rightarrow q))$$

Indeed the non modal argument can be strengthened by replacing $(p \rightarrow q)$ with $\Box(p \rightarrow q)$ without otherwise affecting the argument (apart from the legitimacy of quantifying into modal contexts). The premises of the modal argument for fatalism are:

$$0. (x) \Box (F0x \vee \sim F0x)$$

$$2. \Box F0x \rightarrow \sim (\exists y)(\Diamond H0y. \Box (H0y \rightarrow F0x))$$

$$2'. \Box \sim F0x \rightarrow \sim (\exists y)(\Diamond H0y. \Box (H0y \rightarrow F0x))$$

Clearly the argument cannot be carried through as a constructive dilemma. There is however a somewhat similar argument which can be carried through, which goes as follows:

$$(x)(\Box F0x \vee \sim \Box F0x)$$

$$\Box F0x \rightarrow \sim (\exists y)(H0y. (H0y \rightarrow \sim \Box F0x))$$

$$\sim \Box F0x \rightarrow \sim (\exists y)(H0y. (H0y \rightarrow \Box F0x))$$

and the interesting conclusion:

$$\Box F0x \vee \sim (\exists y)(H0y. (H0y \rightarrow \Box F0x))$$

We would, naturally enough, interpret this in the terms 'Either x will necessarily occur, or nothing which now happens will make x happen necessarily.' We are, however, wrong to do so, because as we have written it here the necessity operator has no temporal qualifier, and our rendition into English gives it one. Though the conclusion seems to deny that any presently contingent event can become determined, an eventuality we all want to believe in, in fact it does not do so, for unless we add temporal qualifiers before the necessity operator, the conclusion does not relate directly to what is now possible or now necessary, and so cannot be interpreted in terms of becoming. Insofar as we are interested in these we must amend the argument as follows:

$$(x)(N\Box F0x \vee \sim N\Box F0x)$$

$$N\Box F0x \rightarrow \sim (\exists y)(H0y. (H0y \rightarrow \sim N\Box F0x))$$

$$\sim N\Box F0x \rightarrow \sim (\exists y)(H0y. (H0y \rightarrow N\Box F0x))$$

From which we interpret the conclusion as:

'Either it is now the case that x will occur necessarily, or there is nothing which now occurs which implies that x will now occur necessarily'.

And this conclusion, with its temporal qualifications, allows that such a state of affairs might change.

As it turns out then, the foundations of the argument for fatalism are very simple, but they lead to a great number of easily misapprehended variants, and though the determinably valid arguments lend no support to fatalism, they do not exclude it either. The discussion of fatalism has been more important than this, however, for the valid arguments concerning it turn out to have quite a considerable symmetry with respect to the interchangeability of past and future. But before we go on to this, we must turn to our original purpose, which was, via a discussion of fatalism, to discover what it is that changing the future might mean.

CHANGING THE FUTURE.

In discussing fatalism, we found several possible interpretations of the idea that it is not possible to change the future, all related to mistaken arguments from variants of the principle of *modus Ponens*. The idea that we can influence the future, that when an event is not necessarily going to occur, it is quite possible that present human action will have the result that the event does not occur. Unfortunately, while the principles on which the fatalistic arguments are based were relatively easy to codify in logical symbolism, the same is not true of the doctrine that we can have power over future events. If we present this doctrine in the same shorthand, it reads:

$\sim \Box \text{Tor} \Rightarrow \Diamond (\exists y) (\text{MOY} \rightarrow \sim \text{Tor})$

and the problem with this can be seen by transposing it:

$\sim \Diamond (\exists y) (\text{MOY} \rightarrow \sim \text{Tor}) \Rightarrow \Box \text{Tor}$

This is unworkable, since it says that the impossibility of bringing about that an event will not occur implies that it will necessarily occur. Even worse, it implies that chance events cannot occur, for chance events are ones which cannot be predetermined one way or another, that is which it is not possible that present action should bring about or prevent, and so for which

$\sim \Diamond (\exists y) (\text{MOY} \rightarrow \text{Tor}) \cdot \sim \Diamond (\exists y) (\text{MOY} \rightarrow \sim \text{Tor})$

But by the above principle this implies the contradiction $\Box \text{For. } \Box \sim \text{For.}$ Now then can we formulate the doctrine that we can have power over the future?

Another way of expressing our power over the future is as the faith that there are some events which will occur if we act now to ensure that they do, but which will not occur otherwise. This belief can be formulated as follows

$$(\exists x)(\exists y) [(\Diamond \text{Now}) \cdot (\text{Now} \leftrightarrow \text{For} x)]$$

and applies, of course, to events which are neither certain to occur nor certain not to occur, so that our proposition can be amended to

$$(\sim \Box \text{For.} \sim \Box \sim \text{For.}) \rightarrow \Diamond (\exists y) (\Diamond \text{Now} \cdot (\text{Now} \leftrightarrow \text{For} x))$$

If we check the transposition of this, we find that it has no damaging consequences, for it asserts only that if it is impossible that some present event should imply a future one, that future event is either necessary or impossible. A consequence which might seem damaging, that chance events are necessary events, which follows from the definition of a chance event as one which cannot be predetermined, is not in fact troublesome, for it does not conflate necessity and chance as fatalism does, since it permits that necessary events not be chance events, that is that a necessary event may have prior causes, which was, we saw, denied by fatalism (but not by what often goes by the same name, but wrongly, predeterminism). That this conflation does not occur can be seen from writing the transposition in this form:

$$\Box(y) [\sim \Diamond \text{Now} \vee \sim (\text{Now} \leftrightarrow \text{For} x)] \rightarrow (\Box \text{For} \vee \Box \sim \text{For} x)$$

where we can clearly see that the antecedent can be true even though $(\text{Now} \rightarrow \text{For} x)$ and $(\Diamond \text{Now})$ be true, since $(\sim \text{Now} \rightarrow \sim \text{For} x)$ may be false.

The principle we have thus evolved to express our power over the future does not guarantee that there are events which can be the result of human action for it does not assert that there are contingent events, it only asserts that among contingent events some might be the result of human action. A defect in the principle as we have stated it is that it does not have the structure of our earlier conjecture for changing the future. It does not say that that which is not necessary can possibly be avoided by preventative action. Following the structure of our belief in the efficacy of human action, that is:

$$(\exists x)(\exists y) [(\Diamond Noy).(NOy \leftrightarrow Fox)]$$

this earlier conjecture becomes:

$$\sim \Box Fox \rightarrow \Diamond(\exists y)(\Diamond NOy.(NOy \rightarrow \sim Fox))$$

which asserts that given that x is not certain to occur, it is possible that there is presently possible action which would ensure x does not occur. The question is whether the extra $\Diamond$ in this formulation is sufficient to avoid the earlier problems with it. The transposition does give considerably different results:

$$\sim \Diamond(\exists y)(\Diamond NOy.(NOy \rightarrow \sim Fox)) \rightarrow \Box Fox$$

The problem with chance no longer arises, for chance events are chance not because presently possible events, if they occurred, could not determine them, but because it is not possible for actual present events to determine them. That is, the addition of the extra possibility operator means that the antecedent of our proposition does not meet the conditions for the definition of chance. For a similar reason, the inference from the impossibility of $\sim Fox$ being determined to the necessity of Fox is no longer distressing, for the impossibility is of there being any present possible circumstances whatsoever which would bring about $\sim Fox$, not just actual present circumstances.

THE SYMMETRY OF PAST AND FUTURE.

Now the assymetry of the past and future is crucial to an elimination of time travel, for only thus is it possible to conclude that a moment of a man's past cannot be also a moment of his future. Consequently I shall attempt to show that the past and future could be symmetrical, and that it is not possible to conclude from the nature of the human condition that they are not.

As I have shown, the idea of changing the past is no more impossible than changing the future, which is a logically incoherent notion. When we try to formulate what our power over the future is, or our lack of power over the past, we must bear in mind what we would mean by our lack of power over the future. So, when we say that it is impossible to change the past, we must interpret this according to what we would mean by saying that it is impossible to change the future, that is by fatalism. Equally, we must interpret

what we mean by saying we can change the past according to what we would mean by changing the future. Several true principles have emerged in connection with this.

The first that we formulated was that present actions cannot have incompatible future results. This was the conclusion of the non-modal form of the correct argument that fatalism is a deviation from. It is perfectly symmetrical with respect to time, for it is impossible that present actions should have incompatible past results. The second that we formulated expressed the modal variant on this conclusion, and stated that either it is now the case that an event will happen necessarily, or nothing that is now the case implies that it is now necessary that the event will occur. This principle is also symmetrical for future and past, for its correlative is that either it is now the case that an event has happened necessarily, or nothing that is now the case implies that it is now necessary that the event has occurred.

The symmetry of these principles is, however, of minor interest except that it shows that fatalism with respect to the past is as unnecessary as it is with respect to the future. More important is that we be able to show that our power over the future has a true correlative for the past. As I formulated it, our understanding of our power to influence the future consists of a belief and a principle. The belief was that:

$$(\exists x)(\exists y) [(\Diamond NOy) \cdot (NOy \leftrightarrow Fox)]$$

and the principle that:

$$\sim \Box Fox \rightarrow \Diamond (\exists y) (\Diamond NOy \cdot (NOy \rightarrow \sim Fox))$$

The past correlatives of these are

$$(\exists x)(\exists y) [(\Diamond NOy) \cdot (NOy \leftrightarrow POx)]$$

and

$$\sim \Box POx \rightarrow \Diamond (\exists y) (\Diamond NOy \cdot (NOy \rightarrow \sim POx))$$

The first of these may well be true, but the second is more problematical, for it is often assumed that all statements of the form POx are necessarily true. But there is no need to assume so. Suppose there is a past event which has not occurred, but not necessarily so. Then it may well be that there is an event now possible which if it occurred would imply that that event did not occur. Thus the proposition can be true without assuming that past events are necessary. What is necessary

in this case is that no present event imply the event did occur. But this is equally true of the future correlative, for no present event can imply that what will not happen will.

The conclusion we must draw is that no assymetry of the possibility of the efficacy of human action exists between the past and the future. Of course we could build in such an assymetry by making temporal qualifiers apply to the logical operators as well in such a way that it was never possible to truly state anything that was not assymmetrical. Such an approach might be illuminating about the structure of our talk about such assymetries, but is hardly to the point when we are considering whether such assymetries hold. And for the purposes of introducing time travel it is sufficient that they need not hold, a result which is guaranteed by the generality of passage as discussed in the last chapter.

Now since we cannot find the required assymetry in the logical conditions for the efficacy of human action, we must look for them, if they exist, either in the structure of causation or in the facts of human knowledge. So far as causation goes, it is hardly germane to assume it must have its normal temporal sense, for the necessity of so doing is, with time travel, in question. Similarly the assymetry of the causal relation is in question. The other place to look an assymetry between past and future is, then, in the facts of human knowledge.

One myth we must quickly dispose of alleges that when we say we know the past but not the future our experience gives us certain knowledge. That we remember something is not certain knowledge of the past, it is memory, a fallible and erratic guide to the past. Nor, as we were exploring last chapter, is it strictly speaking possible that we can know the past if by that we mean that we can know the past as we know the present.

The foundation of our knowledge of events in time is our fallible experience, and when we remember the past, and anticipate the future, our knowledge of the past is uncertain, as is our knowledge of the future. However, we do, it seems, have more evidence for the past than for the future, through memory and other traces that things

leave. These are the facts. On what grounds could we conclude that the assymetry of our knowledge is necessary?

There is one way we can make the assymetry of knowledge necessary, and that is by pointing out that the transmission of knowledge is a causal process, so that only those things can leave their evidence in the present that have causally affected the present. This principle we must admit as being true, but it is not on assymetry with respect to past and future, but with respect to the causal series. Thus, since the assymetry of causation with respect to time is called into question by time travel, the assymetry of knowledge cannot be used to establish that of time. I shall return to this question later.

Are there any other grounds for asserting the difference of our knowledge of the past and the future? I do not think so, but certainly none except the fact of the assymetry can be found within the facts of our knowledge, for all we can discover there is that our knowledge of the past is more or less uncertain, and our knowledge of the future at least equally so. Let us examine the enterprise involved in gaining knowledge about other times.

If we consider the activity of discovering the truth about the past and the corresponding activity for the future, in what does the difference consist? The rules of inference are the same, the structure of the human activity is the same. The actual business of forecasting is much the same as that of discovering the past, consisting of the isolation of present evidence and the extrapolation either forwards or backwards to the time of interest. In this sense our knowledge of the past and the future can only be as good as the present evidence for them. A difference between past and future must, then, be of one of two kinds: a difference in the nature of the evidence from which the inferences to each is made, or in the nature of those inferences. When we consider the matter, there is no difference in nature between the evidence for the past and the future, for what presently is the case is evidence for both. It is simply not true that the evidence for the past exists in the present but that for the future does not. What is evidence for how things have been is equally evidence for how things will be.

Nevertheless, there is a defacto difference in quantity at least between our knowledge of the future and of the past, and it does correspond to a difference in the nature of the inference from the evidence. In predicting the future we have to predict the result of a confluence of causes and processes, so that it is necessary to know a great deal of the present evidence in order to be reasonably successful in predicting the future, because one must account for all the operative causes and processes. The past, on the other hand, is easier to manage, for all that is necessary to have a reasonable confidence in the nature of past events is that their traces have remained. That there was a cataclysm in Pompeii we can tell from a relatively few pieces of the evidence that remain. But to have predicted it beforehand one would have had to have known a vast amount about the behaviour of volcanoes, and Vesuvius, in particular.

This difference between the past and the future can be overestimated, for it does not extend to certain knowledge of either. If I wish to be sure that a certain event occurred, and that I am not mistaken in my reading of the evidence, then I must know all the forces operating between then and now, so that I know there is no alternative explanation for the evidence. But equally, if I know all the forces operating between now and some time in the future, I can be sure of what is going to happen.

Now it may be that such certain knowledge is impossible. For so far as the past goes, there may be alternative possibilities which it is impossible to resolve even on the total of the evidence between now and then. For, if an event is to occur by chance, then no amount of evidence however close will allow one to predict it. The equivalent for the past can be easily seen. Suppose we wish to trace back to the way things were at the instant of an explosion. No matter how close we reach with what quantity of evidence, there will be influences at work up to the moment of the explosion which were at that moment totally obliterated. Since we do not, by parallel with the future, know what happened before the instant, we cannot then tell for certain what did happen at it. The obliteration of a previously existing thing or influence is the past equivalent of chance, for in both cases the occurrence of a thing is not determinable on the evidence

up until then and this lack of determination is, as I remarked earlier in this chapter, definitive of chance.

There is thus a great deal of symmetry between our knowledge of the past and the future. Our fallibility about both has the same grounds, as does the possibility of our certainty. The future as being the location of chance has, so far as knowledge is concerned, its past correlative. What then of the difference between knowledge of the past and future as we have been characterising it?

CAUSATION AND KNOWLEDGE.

In a simple characterisation of knowledge of the past or future relative to the present such as I have given, one major aspect of human life is ignored which is the foundation for the acquiring if not the very concept of knowledge, and that is the persistence of objects. The reason that our knowledge of the past is more secure than our knowledge of the future lies in this persistence, for it is the vehicle by which we can accumulate evidence and knowledge.

As I have shown this security is not that of certain knowledge, but nevertheless it is sufficient to differentiate past and future, because even uncertain belief does not accumulate from the future. Now, persistence is closely allied with causation, to the extent that some writers believe that persistence is a special form of causation. I have argued in Chapter Two that I do not believe this, but I shall not go into that matter here. Let us rather look at the connection of the three ideas of knowledge, persistence and causation.

We begin as sentient creatures which know nothing at all. The process of acquiring knowledge that we go through consists in the first place of direct causal interactions with the world. Some of these causal interactions form regular patterns, and, as psychology has shown, the habits formed thereby persist even when the particular form of interaction which originated them has ceased. Such habits are not knowledge, though they are the first stage in the acquiring of it.

After simple habits come more complex ones where a sign or symbol is associated with the interaction, followed by recognition and

manipulation of the symbol in place of its referent. The persistent sign becomes the mark of a piece of knowledge, and from there an elementary capacity for language develops. Knowledge at this stage is represented by persistent objects which are the traces of causal interactions.

Now consider a man learning a subject, say philosophy. He also learns by a causal interaction, by the spoken and written words of philosophers setting up persistent traces in his mind and in his notebook. It seems evident that anyone must learn everything that he knows in a similar fashion, unless it was innate in him in the first place. Now knowledge so gained through causal, that is interactive, relations with the world is of two kinds, discovered and transmitted. Discovered knowledge is that which has previously been rendered into thought, that is into manipulable sign or symbol form. Transmitted knowledge is that which has been so rendered.

Now he who discovers knowledge (or invents it if one prefers to think of things that way) knows what he has discovered is true in virtue of the process of discovery. Others do not, for the knowledge is only transmitted to them, and they know it to be true by a process of analysis and test. The medium of knowledge, namely language, is such that a conjecture can be made concerning knowledge which might be true but requires test. Such conjectures are formulated by some person in the first place, and then there is an original confirming analysis and test.

Given the human condition, we suppose that the way a society or community learns is subject to the same constraints as the way an individual learns. That is, if a person in a community knows something to be true, one of three circumstances must be true:

1. He discovered that knowledge himself.
2. It was transmitted to him, he is satisfied with the evidence for it, and the chain of transmission has a beginning where someone discovered the piece of knowledge.
3. It was transmitted to him, he is satisfied with evidence for it, and the chain of transmission has a beginning where someone conjectured that piece of knowledge.

Thus all human knowledge has a definite origin in time, at least in the sense that before a certain time it did not exist. Human knowledge is, then, a human creation (though perhaps invention is somewhat off the mark). Further, whatever knowledge per se may be, its acquisition is a causal process and its perpetuation the result of the persistence of various entities.

The consequence of this intimate connection between causation and knowledge is that it is impossible to acquire knowledge except as a result of causal interaction with the world, with the result that it is not possible to have knowledge which has not been acquired. Now, are there any lessons to be learned from how we acquire knowledge for what we can have knowledge of? We cannot, we have seen, have knowledge of anything if that knowledge has not been acquired. Thus, since no knowledge that is not available as the result of a causal interaction with the world can be acquired, the only knowledge that is available of past or future is that available as a result of causal interaction with the world. But 'available as a result of causal interaction' is ambiguous, for it could mean either that only the information explicit in such an interaction is available, or that all the inferences from it as well. As we saw, the past and future are symmetrical with respect to such inferences. Thus we still have no grounds for saying that possible knowledge of the future is different in kind from possible knowledge of the past.

The only principle that could lead to such a difference in kind, given the foundation of knowledge on persistence, is that the past persistence of a thing is more certain than its future persistence. But as we have seen, what is certain here is not our knowledge of the past but the acquirement of our knowledge from the past.

The asymmetry of our acquiring knowledge seems to be a necessary one, there is no other way in which we could gain knowledge, but it also seems that there is no way that we can derive an asymmetry from this between our knowledge of the past and of the future, in order to further derive a further asymmetry between the past and the future.

TIME TRAVEL AND KNOWLEDGE.

With this demonstration that the character of the human condition does not further restrict the possibilities for the nature of time beyond those allowed by the manifold on the one hand or the psychological structure on the other, the main purpose of this work is achieved, which is to discover the grounds for the plausibility of time travel. Ultimately this plausibility rests on its compatibility with the structure of the world as we know it necessarily to be. Admittedly time travel is incompatible with many things we believe to be true of the world, but this does not destroy its plausibility. Also it is incompatible with many features of the world which are taken to be necessary. But which of such features really are necessary? I have attempted to uncover the elemental features of our theories of time and the principles on which they are ultimately based, and found that the notion of time travel fits these easily. Further it is compatible with the facts, rather than the metaphysics of the human condition.

I do not know what principle could be shown both to be necessary to the world and to be incompatible with time travel. Certainly there seem to be none that are essential to our concepts of time. Nevertheless despite the arguments of this book, I believe that there must be some such principle, and that it must be a fundamental epistemological one. I have not, however, any idea of how to go about formulating this principle or showing its necessity.

My grounds for this belief are as follows. If, as they appear to, our concepts of time admit the possibility of time travel, then since time travel admits of causal circles, we are committed to the possibility of a particular result of the possibility of a particular result of the possibility of causal circles, namely epistemological circles. Some of these I have already mentioned in Chapter One, though I have not discussed them. In one, a time traveller learns a language from a phrase book which he later writes from the knowledge he gained of it. In one, a time traveller returns to the past in order to teach himself how to time travel.

Two examples of these epistemological circles show the problem. In the first the only origin of a body of knowledge is due

to time travel. For if time travel is possible it could happen that a person acquires knowledge from somebody and then time travels, turning out to have been he from whom he earlier acquired the knowledge. He then disseminates what he has learned. Such information has a definite origin, but it was never worked out, or discovered, only transmitted from person to person.

The second example is of a different kind. Suppose a time travelling survey team wishes to discover facts about some distant time. They do so, and then return to a time before their departure and inform their earlier selves of the results of the mission. There is nothing logically inconsistent in this story, it is simply a special sort of causal circle, but what could be the motivation of the team to take the trip?

The two examples are dependent, the second being an elaboration of the first, but this remains even if the second be discredited.

I believe that these examples show that there is something wrong with time travel, because such epistemolgical circles permit that human knowledge be not always the outcome of human effort and discovery based on an investigation of the world. But how, given that any individual has much knowledge that is merely transmitted to him and that he transmits to others, can it be shown to be necessary that all human knowledge have such origins, since this fact cannot be derived from the necessary structure of time? As I said, the principle looks as if it ought to be epistemological in character, but what it might be, I do not know.

BIBLIOGRAPHY.

1. Isaac Asimov, The End of Eternity, Panther Books, London, 1959.
2. H. Bergson, Time and Free Will, trans. F.L. Pogson, George Allen, 1912.
3. C.D. Broad, 'Mr. Dunne's Theory of Time', Philosophy, Vol.X, 1935.
4. R. Coburn, 'The Persistence of Bodies', American Philosophical Quarterly, Vol.13, No.3, July 1976.
5. Stillman Drake, 'Galileo and the First Mechanical Computing Device', Scientific American, April 1976.
6. J.W. Dunne, An Experiment with Time, Faber & Faber, London, 1939. (First Ed. 1927).
7. J.W. Dunne, The Serial Universe, Faber & Faber, London, 1942. (First Ed. 1934)
8. A. Einstein, Relativity, The Special and General Theory, A Popular Exposition, trans. R.L. Lawson, Crown, New York, 1961.
9. R.M. Gale, The Language of Time, Routledge and Kegan Paul, London, 1963.
10. R.M. Gale (Ed.), The Philosophy of Time, MacMillan, London, 1963.
11. G.E.M. Ancombe & P.T. Geach, Three Philosophers, Blackwell, Oxford, 1967.
12. K. Godel, 'An Example of a New Type of Cosmological Solutions of Einstein's Field Equations of Gravitation', Reviews of Modern Physics, Vol. 21, No.3, July 1949.
13. J. Harrison, 'Dr. Who and the Philosophers or Time-Travel for Beginners', The Aristotelian Society, Supp. Vol. XLV, 1971.
14. R. Heinlein (Anson McDonald), 'By His Bootstraps', Astounding Science Fiction, 1941.
15. P. Horwich, 'On Some Alleged Paradoxes of Time Travel', Journal of Philosophy, (72) 14.
16. D. Hume, A Treatise of Human Nature, Everyman, London, 1911.
17. I. Kant, Critique of Pure Reason, trans. N. Kemp Smith, Papermac, MacMillan, London, 1933.
18. H.R. King, 'Aristotle and the Paradoxes of Zeno', The Journal of Philosophy, XLVI, No.2, Oct. 1949.
19. H.M. Lacey, 'Empiricism and Augustines Problems About Time', Review of Metaphysics, Vol. LXXII, No.2, Dec. 1968.
20. D. Lewis, 'The Paradoxes of Time Travel', American Philosophical Quarterly, Vol.13, No.2, April 1976.

21. J. Locke, An Essay Concerning Human Understanding, ed. A.S. Pringle-Pattison, Clarendon Press, Oxford, 1924.
22. J. McTaggart, The Nature of Existence, Cambridge University Press, 1927.
23. J.W. Meiland, 'A Two Dimensional Passage Model of Time for Time-Travel', Philosophical Studies 26, 1974
24. D. Pears, Wittgenstein, Fontana Modern Masters, London, 1971.
25. W.V.O. Quine, Word and Object, MIT & Wiley, 1960.
26. H. Reichenbach, The Direction of Time, University of California Press, Berkeley, 1956.
27. H. Reichenbach, The Philosophy of Space and Time, Dover Publications, Inc., New York, 1958.
28. B. Russell, The Principles of Mathematics, George Allen & Unwin, London, 1937.
29. P.A. Schilpp (ed.), Albert Einstein: Philosopher-Scientist, The Library of Living Philosophers, Inc. Evanston, Illinois, 1949.
30. P. Thom, 'Time Travel and Non-Fatal Suicide', Philosophical Studies, 27, March 1975.
31. H.G. Wells, The Time Machine, First published 1895.
32. G.J. Whitrow, The Natural Philosophy of Time, Thomas Nelson & Sons, London, 1961.
33. G.J. Whitrow, What is Time?, Thames and Hudson, London, 1972.
34. T.E. Wilkerson, 'Time and Time Again', Philosophy, Vol. 48, no.184, April 1973.
35. B.A.O. Williams, 'Personal Identity and Individuation', Journal of the Aristotelian Society, March 1957.
36. D.C. Williams, 'The Myth of Passage', The Journal of Philosophy, XLVIII, No.15, July 1951.
37. L. Wittgenstein, Philosophical Investigations, trans. G.E.M. Anscombe, Blackwell, Oxford, 1972.

TIME AND TIME TRAVEL

Supplementary Volume

by Paul Andrew Balnaves

Being submitted supplementary to my
thesis Time and Time Travel first
submitted for the degree of Doctor
of Philosophy in March 1978

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All my own work

P. Salanes

24 April 1980

Abstract

This supplementary volume pursues matters arising from the examination of the principal volume. It is presented primarily in response to Professor Nerlich's recommendation that I should investigate the question of causally closed curves in the light of the conditions that thermodynamic and related principles would impose on them, that I should place the concept of structural outcome introduced in Chapter 2 in this context, and that I should similarly place the difficulty I identify in Chapter 6 that time-travel allows the acquisition of information in unusual ways. The volume contains two independent papers presented as appendices to Chapters 2 and 6.

The aim of the appendix to Chapter 2 is to investigate further the foundations of the idea of 'structural outcome', an idea presented in that Chapter for a criterion of identity through time which is tolerant of discontinuities in space and time. It argues that this idea needs to be understood as one aspect of a systematic reinterpretation of the ideas of genidentity and causation according to parameters other than the spatio-temporal.

The appendix to Chapter 6 has the specific aim of showing that the difficulty raised there (that the idea of time travel allows the possibility of acquiring information - including developed theories - which has not been discovered or worked out by anyone) cannot be solved by appeal to principles based on the asymmetry with respect to time of certain laws applicable to physical systems, such as the Second Law of Thermodynamics.

APPENDIX TO CHAPTER TWO

GENIDENTITY, CAUSATION & STRUCTURAL OUTCOME

In Chapter 2 of my thesis I argued that two ideas, those of time travel and of temporal motion, could be developed in an analogical sense parallel to ordinary ideas of travel and motion, but dissociating the two so that travel might in principle be spatially discontinuous, whereas motion could not. Ordinary travel between two points of course implies motion between them.

I argued that the basis of developing these analogies fully was the development of a criterion which would associate events together as the history of an object without appeal to spatio-temporal parameters. This criterion I called that of 'structural outcome', the idea being developed as follows.

The structure of an object at a given moment has implications for what its structure can be for a period around that moment, and vice versa. That is, based on the principle of continuity of change, changes in the structure of a thing do not happen instantaneously. In a sufficiently short period of time we can equally as well infer temporal order (though not necessarily direction) from the order of changes in structure as vice versa. Furthermore, the same principle of continuity of change shows that the structural properties will vary continuously with other parameters, though not necessarily all.

This appendix seeks to put the concept of structural outcome on a more rigorous footing, and investigates particularly the concept of identity through time in order to draw out the dependence of it and related concepts on spatio-temporal locative parameters. In this context a qualitative analogue of identity through time is developed, together with a qualitative analogue of the direction of time. My beginning point is the criterion we commonly use of reidentifying a thing by distinctive marks.

Identity Through Time

We do in fact use a criterion for judging identity through time which is tolerant of temporal discontinuities. We use this criterion whenever we reidentify something by a distinctive mark or set of marks, i.e. by virtue of aspects of its internal or external composition. I shall call this the structural criterion of identity, but before discussing it I would like to make a few general observations about the concept of identity through time.

Identity through time is a special case of strict identity, i.e. of the logical law known as Leibniz's law. At first sight it seems this must be wrong, because we wish to identify through time objects whose properties differ, i.e. of objects can change and yet remain the same object. However, this is a mistake(1) essentially because the logical law includes in the specification of the properties those time references implicit in our ascription of identity through time, i.e. if a is identical through time with b, then if at time t a has property f, at the same time (namely t) b has that property also (and conversely, a has those properties b has at the time when b has them).

Leibniz's law is not a great deal of help in the present circumstances, because what we are interested in is the conditions necessary for the reidentification of the same object. Further, Leibniz's law as such compatible with any kind of temporal discontinuities or otherwise of bodies. It provides no indication of what it is that persists through time, no criterion of identity as Geach(2) would call it, and no criterion for individuation or reidentification of the same object.

Indeed, asserting the identity of any two physical objects would not as such contravene Leibniz's law, because the properties of one would apply to the other insofar, and only insofar as the object was in a certain time and place.

- (1) as has been cogently argued by Robert Coburn,
'The Persistence of Bodies', American Philosophical Quarterly,
Vol. 13 No. 3, July 1976, p. 173
- (2) Reference and Generality

Identity through time is to use Geach's term a form of relative identity, i.e. what is involved is an assertion of the form 'a is the same ... as b', where the blank is to be filled with the relevant general term. This can be clearly seen when there is an issue of reidentification, e.g. when a question is raised such as 'Is this man the same man as the one I saw yesterday?' This relativity is acknowledged by Reichenbach and Grunbaum, who call it genidentity. Reichenbach introduces the term thus:

This physical identity of a thing, also called genidentity, must be distinguished from logical identity. An event is logically identical with itself; but when we say that different events are states of the same thing, we employ a relation of genidentity holding between those events. A physical thing is thus a series of events; any two events belonging to this series are called genidentical. The relation of genidentity is thus a two-place propositional function which is symmetrical, transitive and reflexive.(1)

Without buying into the metaphysical position which interprets objects in terms of events, it is clear that Reichenbach sees an assertion of identity through time between two elements as holding only in relation to a general term, in this case one designating classes of events. According to the metaphysical position being propounded, genidentity is an equivalence relation on events, and the events genidentically related form an equivalence class but are not identical. Genidentity is according to Reichenbach and Grunbaum a special case of a causal relation, but we will defer discussion of this point for a short time.

A true statement of relative identity shows that two objects belong to the same equivalence class, but does not show per se that they are identical.(2) We do, however, require this of a true statement of identity through time, though we do not expect to have to show that all the properties at whatever place and time of each candidate

(1) The Direction of Time, p. 38

(2) Note that while Geach would say that relative identity is incompatible with Leibniz's law, since a & b while the same A could be different B's the notion of equivalence classes shows that the two can be compatible. cf. Relative Identity and Leibniz's law, Leslie Stevenson.

for identity are true also of the other at those times and places. That is, we do not expect to have to demonstrate by catalogue that Leibniz's law holds in any particular case.

A statement of identity through time, therefore, must meet the conditions for a statement of relative identity, but it must also meet a criterion which ensures that objects involved are identical rather than merely belonging to the same equivalence class. At this point it would be useful to examine the ways in which we actually go about reestablishing that an object is identical with one we were earlier acquainted with.

As I remarked above, one criterion we very commonly use is that of a distinctive mark, such as a birthmark, a serial number, fingerprints, a mannerism, a unique memory. This criterion does not require knowledge of where the individual has been in the meantime or what has happened to it, it works by examining the structure of the individual, whether in surface or internal characteristics, coupled with a supposition that the relevant characteristic is unique to the individual. We can call this the structural criterion for reidentification, and is evidently only effective to the degree that duplication of the relevant characteristic can be ruled out.

Another less used (because less easy to establish) criterion is that of tracing the history of the location of the individual. We generally only do this when we do not for some reason have confidence in the result of the structural criterion. We examine the history of the individual in order to compile a continuous record of its location which is intended to connect its earlier and later appearances. We would of course ordinarily rely at many points on the structural criterion, but this is not in principle necessary.

Because of the sorts of histories ordinary individuals in our world have, we can generally have greater confidence in this spatio-temporal continuity criterion than the structural criterion. It does not, however, give a guarantee of the uniqueness of the individual unless it is assumed that only one object of the relevant kind can be continuously connected through its history to the earlier one. This is not necessarily so. We can imagine a world where reproduction by budding, producing two or more similar independent individuals, was

much more common than in our world. It would be imaginable that human-like individuals in this world might at the point of their separation have a very similar mental pattern of memories, mannerisms, ways of thought and so on. In such a world the spatio-temporal continuity criterion would not always unambiguously reidentify a given individual, although the structural criterion might. One could imagine an artificial way in which this could be achieved, by stamping each individual with a serial number in such a way that it could not be duplicated.

While the structural criterion for reidentification is tolerant of discontinuities in an individual's history, unlike the spatio-temporal continuity criterion, another significant difference should be pointed out. The former criterion depends on internal features of the individual, i.e. on features that can be determined by an examination of the object itself. The latter, however, depends not on internal features but on the place the individual occupies in the world. It can be successfully applied, therefore, even when the internal features of the individual are unknown.

The two principles I have described have been considerably discussed in the literature, especially in the context of whether spatio-temporal continuity is always a necessary condition for the conclusion of the identity of two persons.(1) In particular, both criteria might be considered as derivatives in special cases from a requirement for continuity of change. Reichenbach uses this term to refer to the fact that material physical objects are expected to trace a continuous path in space and time, but he also says that marks by which we reidentify an object 'remain on the object in accordance with the continuity criterion'.(2) Continuity is thus expected not only

- (1) This has been argued for by e.g. B.A.O. Williams 'Personal Identity and Individuation' and G.C. Nerlich 'Sameness, Difference & Continuity'. Robert C. Coburn argues against this in 'Bodily Continuity and Personal Identity', essentially for the reason that what I call the structural criterion can be sufficient for concluding identity when there is no reason to suppose the contrary.
- (2) The Direction of Time, p. 225

of the location of the object but also of at least some of its characteristics. It will not always be expected of all, as Reichenbach's invocation of the discontinuous transmittability of the kinetic energy of an object shows.

Of what characteristics should it be expected? We will need a little background to decide this.

Reichenbach enunciates the principle of continuity of change as a fundamental necessary criterion for genidentity. He describes two main forms of this - 'material' and 'functional', though he says that we can define 'genidentity' to suit our purposes. He characterises material genidentity - that appropriate to material physical objects, by three necessary conditions:

- a. continuity of change, as described above
- b. spatial exclusion, namely that the space occupied by one object cannot be occupied by another
- c. existence of distinguishing marks.(1)

He suggests that a sufficient condition of identity would involve not only these necessary conditions, but also the existence of certain continuing interrelationships between the parts of the thing. What this would seem to be indicating in a parenthetical way is that two objects which are to be judged for identity through time should have a certain identity of form which is related to their structure.

Functional genidentity, as contrasted to material genidentity, meets only the first necessary criterion listed above, and is proper not only to material objects, but also to non-material physical entities such as particular quantities of kinetic energy. Reichenbach first suggests that a residual property of functionally genidentical but indistinguishable particles according to the above criteria is that they are countable on masse, i.e. that it is possible to say how many there were at a given time; he then questions this for the realm of elementary particles.(2)

(1) *ibid* p. 225 ff

(2) *ibid* p. 262 ff

While Reichenbach demonstrates the problems of the concept of material genidentity when this is applied to the elementary particles of quantum physics, many of these are equally applicable to any particle which ex hypothesi has no internal structure, is indivisible, and does not undergo qualitative change, i.e. to atoms in the classical sense.

Such particles would meet only the criteria of continuity of change and spatial exclusion. The latter criterion, however, is not precisely met by most macroscopic physical objects, and it is quite conceivable even without involving quantum physics that it should not hold for any objects whatsoever. The ultimate constituents of material objects might turn out to be interpenetrable. This would not prevent an atomic interpretation of a kind unless as is the case with gases and fluids the interpenetration of distinct objects implied a loss of their distinctness. Here we can observe that for wave-particles the principle of superposition both denies the necessity of spatial exclusion and guarantees the distinctness of those waves which are superimposed, because the resultant wave can be analysed into its components.

This leads us to entertain a general principle of which the principle of spatial exclusion is a particular case. This principle is to the effect that any object which remains identical through time maintains its form integrally, and is clearly closely related to the requirements for relationships between parts that Reichenbach imposes on genidentity. The latter indeed can, like spatial exclusion, be regarded as a particular case of the former general principle.

Not all functionally genidentical objects would meet the criterion of integrity of form, in particular quantities of energy regarded as objects would not, because no form can be attributed to them. Such objects, however, are derivative objects, in the sense that they must be defined either in relation to a material physical system, or in relation to the properties of wave systems. That is, energy is always the energy of something, though this need not be a material physical object. Integrity of structure or form does, however, characterise a much wider range of physical objects than material ones. Indeed it would seem that even in classical physics waves under certain

circumstances can behave as particles. These are called solitons, and are waves that do not disperse or dissipate but retain their size and shape indefinitely.(1)

Let us return now to the interpretation of continuity of change. It has become clear that the criteria for genidentity Reichenbach uses are closely related to considerations of the existence of definitive relations between parts of the objects, i.e. to formal aspects of its structure. We can, therefore, distinguish between properties an object has in virtue of its structure and properties it has in virtue of other considerations such as its relations to other objects. We can call the former characteristic properties of the object. These will include many properties other than the definitive relationships between parts which the genidentical object has. The minor differences in weight, scratches, colouration etc. of very similar billiard balls are examples. We can then define continuity of change as the continuity relative to changes in the spatio-temporal parameters of the characteristic properties of the object. This is not to say that these will all persist indefinitely, however if some cease to hold then we would not call the resulting object the same object as before.

We can now, still using Reichenbach's terminology, define a sense of genidentity which meets the following conditions:

- a. continuity of change in the structural elements of the object
- b. integrity of structure of the object
- c. countability of groups of the object-kind.

One thing we observe about these criteria is that despite the kinds of objects, material or otherwise, to which they may be applied, they are all defined relative to spatio-temporal parameters. That is: continuity of change is continuity relative to changes in its spatial and temporal location; integrity of structure is similarly relative; and countability is of the number of objects in a given space at a

(1) 'Solit ons' by Claudio Rebbi, Scientific American, February 1979, p. 76

given time. The basic tests of genidentity occur, as one would expect from the definition of genidentity as a relation holding between the causally related elements of a series of events, in the context of spatio-temporal contiguity.

We can now consider whether it is possible to define the above set of criteria for genidentity relative to a different set of parameters. There is no intrinsic reason why this should not be possible, for there are other quantifiable physical parameters, both objective and subjective, which might be used for this purpose. Contiguity would then be between events having closely similar 'positions' in a qualitative matrix, in the sense that one could since the parameters would be quantifiable define an n -tuple of real numbers specifying a given state of each of the in chosen parameters, and then define increasing contiguity as the approach of the n -tuples associated with two objects towards identity in the same manner as is done in a topology with a specified distance function.

Whether such a qualitative rather than positional locative system can be carried through as the parametric system for the conditions of genidentity depends on whether it is possible to make a qualitative distinction equivalent to the spatio-temporal one that one can draw between the spatio-temporal arrangement of the parts of a thing, and the spatio-temporal position of a thing (and its parts) relative to other things, in that the former can in principle hold without change despite variations in the latter. It is necessary to demand this in order that we can specify the structure of the object independently of its place in the locative system.

There is such an equivalent distinction, because parts in this context will be qualitative parts, and the same structural relationships can hold between elements at different parts of a qualitative range, as for example the same melody can be raised or lowered in pitch.⁽¹⁾ Clearly, however, we cannot interpret this in terms of material genidentity, where the ultimate elements would be unchanged in character through time.

(1) Olaf Stapledon in his novel Star Maker, Penguin, 1972, p. 236 ff draws the picture of a 'musical' space particularly well

We can conclude, therefore, that it is possible to establish a sense of genidentity which works according to other parameters than the spatio-temporal. We have, however, neglected the primary role of causation in the definition of the relation of genidentity. Before we turn to that, let us review what we wish to achieve with the apparatus we have established.

The driving idea is that we want to be able to say that events can form a continuous sequence, in particular the history of an individual person or object, even though that sequence of events be spatio-temporally discontinuous. The first step in this direction was the observation that the structural criterion for reidentification provides a criterion for identity through time of material physical objects which can under favourable circumstances be sufficient, and which is tolerant of spatio-temporal discontinuities. This criterion, however, is usually derivative from criteria which do require such continuity, and furthermore it does not as such provide any basis for asserting the kind of continuity through a space-time 'jump' that we would wish to assert in order to maintain the possibility that a time or space traveller might make use of such 'jumps' while maintaining a personal and immediate environmental continuity of history. The qualitative version of the criteria for genidentity will allow us to do this in the following way.

These criteria are tolerant of spatio-temporal discontinuity, although they do not demand it. That is, neighbouring points in the qualitative matrix need not necessarily be spatio-temporal neighbours. However, by the requirement for continuity of change, which as we saw need apply only to those properties characteristic of the object, all such properties must vary continuously relative to variations in the qualitative matrix. Thus we look for structural identity in the context of events contiguous in the qualitative matrix.(1)

- (1) This fits well with the supposition in novels such as many by Heinlein that a ship which 'jumps' through space can only do so under certain very specific physical conditions, and will also reemerge in a particular place under very specific conditions. The nature of these conditions determines where the jump will be from and where to.

We do not yet, however, have any grounds for taking anything in the sequence of events so qualitatively and structurally related as corresponding to the history of an object, as the temporal dimension corresponds ordinarily to the history of objects, let alone anything corresponding to the evolutionary sense associated with the temporal dimension. For standard genidentity this connection of time with the history and evolutionary sense of an object is given by the properties of the causal relation between events. It is these that give character to time over and above its function as a purely locative parameter in the spatio-temporal complex.

Causation and Physical Laws

In considering the role of causation in the sort of philosophy of space and time propounded by Reichenbach and Grunbaum, we must first off locate the idea of cause in that philosophy.

Causation in this philosophy is apparently to be located as an aspect of the functional relationships reported by physical laws. Not all physical laws assert a directed cause-effect relation, though they always assert a causal connection. Two events A & B are causally connected if A is a cause of B, B is a cause of A, or there exists an event C which is a cause of A and of B.(1) Boyle's law for perfect gasses, the law of conservation of energy and Ohm's law for electric circuits are the examples Reichenbach gives of laws of this symmetric kind. He continues:

'When we wish to find a directed cause-effect relation, we have to look for other kinds of laws. ... We have to look for laws that describe physical processes, and do not merely lay down causal connections. Such laws exist. They can be grouped into two kinds: the first kind consists of laws describing mechanical processes; the second, of laws describing thermodynamical processes. The difference between these two kinds of processes is well known: mechanical processes are reversible, whereas thermodynamical processes, apart from certain exceptions, are irreversible.'(2)

(1) DT p. 29

(2) PPST p. 189 and p. 193

As an aside we note at this stage that genidentity, the concept in which we are primarily interested, is considered by Reichenbach to be derivative from causal order, according to the conditions outlined in the previous section. Grunbaum, who presents a very similar overall program for the reduction of temporal to causal order to that of Reichenbach in 'The Direction of Time', takes the genidentity exhibited by material physical objects as a primitive concept, and treats genidentically connected events as the primary exemplar of a primitive symmetrical causal relation (k - connectedness).(1) It would seem, therefore, that genidentity is introducible at an early stage in the development of the concepts of causal order.

How are physical laws which do assert causal order to be distinguished from those that do not? Though Reichenbach does not explicitly say so, it would appear from the quote given above that he intends those that contain a reference to the temporal parameter, this being characteristic of those laws which describe physical processes, to provide the necessary distinction. We can summarise Reichenbach's causal story thus:

- a) all physical laws formulate the causal connectedness of events.
- b) all physical laws formulating physical processes (i.e. those which refer to the temporal parameter) formulate the causal ordering of events.
- c) all physical laws formulating irreversible physical processes formulate the causal direction (as well as order) of events.

The use of physical processes in this preferential way presupposes that in the laws which describe them time is an independent variable. This independence is the distinguishing feature of such laws, the symmetric laws (such as Boyle's or Ohm's) do not permit an inference of which variables are dependent and which are independent. That time is an independent variable is, however, a presupposition, a point which will be useful later.

(1) PPST p. 189 and p. 193

The free inference of causal relations from functional relations expressed by physical laws is somewhat disturbing. It is true that all physical laws formulate a causal connection between events? It is true that all physical processes exhibit the causal ordering of events? I have argued against these in Chapter 2 of my thesis, and I would like to approach the matter from a somewhat different angle here.

To argue against the immediate inference from true functional relations to causal connectedness is to argue against a specific version of the tradition deriving from Hume that 'we have no other notion of cause and effect, but that of certain objects which have been always conjoined together, and which in all past instances have been found inseparable'.(1) Causation here is characterised by contiguity, succession and constant conjunction.

I would assert that even if we accept these conditions as necessary for causal connection, they are demonstrably not sufficient. I argued in Chapter 2 of my thesis that there are law governed regularities dependent on the time variable to which there does not seem to be sense in attributing causal relation unless all this means is that the relevant series of events in fact displays the regularity it does. I cited as examples the persistence of a thing through time, apparent qualities that a thing has only in relation to a given reference frame, and spatio-temporal continuity.

I do not intend to address these particular matters here, but will rather examine the foundation of Reichenbach's, and as I understand it Grunbaum's also, conception of causation as being rooted in the functional relationships characteristic of theoretical physics.

I would observe that this conception has an intimate connection with the concept of genidentity as is shown by the following argument.

The reason for requiring that genidentity should be a kind of causal relation is that if it were not then a sequence of events which

(1) A Treatise of Human Nature Vol. 1, Book 1, Part III, Section VI

met the Reichenbachian conditions outlined in the last section could be genidentical even though its events could each be demonstrated to be caused by some event external to the series. The difficulty involved can be seen by considering a finite causally connected series of events $(A_1 \dots A_i \dots A_n)$. Each A_i may be such as to cause an event B_i . There would then be a causally unconnected series $(B_1 \dots B_n)$ which could conceivably (apart from the property of having the denseness of the real continuum which we have only omitted for simplicity and which as Grunbaum argues can always be reintroduced(1)) meet the kind of regularity criteria required for genidentity.

Concluding that any genidentical sequence should be a causal chain is, however, not directly warranted by this consideration. The immediately warranted conclusion is that the events of a genidentical sequence should not be effects of external causes in the manner indicated. But how would one tell the difference between a set of events which displayed the relevant regularities, which was not the result of external causes, and which did not form a causal chain, and an otherwise similar set which did form a causal chain?

Perhaps one ought to conclude that there is no difference. This would commit us to saying that in the absence of externally operative causes the events of any spatio-temporally continuous set of events displaying regularity form a causal chain. The plausibility of regarding a genidentical set of events as necessarily causally related depends therefore on the plausibility of this hypothesis, which is a reformulation of the Humean characterisation of causation.

In order to develop the apparatus necessary to make the relevant distinction, let us turn to a closer examination of the form of physical laws. I shall follow Nagel's classification in this(2), who distinguishes four major kinds of law in the physical and other sciences:

- (1) PST Chapter 7, cf p. 179-80 and p. 208 where Grunbaum specifically alludes to this.
- (2) Ernest Nagel The Structure of Science, Routledge & Kegan Paul London, 1961, p. 75H

- a) a basic and pervasive type of law, which is involved in the assumption that there are 'natural kinds' or 'substances'. Laws of this type assert that there is an invariable concomitance of determinate properties in every object that is of a certain kind. This type of law clearly does not assert causal connectness of properties.
- b) a type of law which asserts an invariable sequential order of dependence amongst events or properties. There are two subtypes; causal laws and developmental or historical laws.
- c) a type of law, common in the biological and social sciences as well as in physics, which asserts invariable statistical (or probabilistic) relations between events or properties. Such laws are not causal, though they are not incompatible with a causal account of the events they formulate.
- d) a type of law characteristic of modern physical science, which asserts a relation of functional dependence (in the mathematical sense of function) between two or more variable magnitudes associated with stated properties or processes. There are two subtypes, corresponding to Reichenbach's distinction between laws of causal connectedness and laws of physical process. The former state an interdependence between magnitudes such that a variation in one of them is concurrent with variations in the other. The latter consists of numerical laws asserting in what manner a magnitude varies with time, and more generally how a change in magnitude per unit time is related to other magnitudes.

All these types of law are present in the physical sciences, and none of them is incompatible with an underlying causal explanation. This does not imply, however, that all scientific laws, or laws of physics in particular can be grounded in causal laws. The situation could be rather similar to that of axiomatic systems in logic, where at least one statement must be not deducible in the system (i.e. the axioms), but it may be a matter of choice which statements these are. I believe that the situation is in fact like this.

The first type of law of natural kinds and the second subtype of the second type of law - developmental or historical - are of particular interest here. The former specifies a kind of thing and

the concomitant, i.e. simultaneous, properties that it has. The latter also specifies a kind of thing, but in addition rather specifies the sequential properties that the thing has. A developmental or historical law can therefore be regarded as a temporal analogue of a law of natural kinds, specifying certain sets of events and properties invariably associated with them or subsets of them.

Every physical law of the fourth type - i.e. functional dependence presupposes laws of this type, which specify the sorts of entities, quantities and parameters with which it is concerned. That is, every physical law of functional dependence is formulated relative to a physical system whose structural features are already given. This is not, of course, to say that such features are not arrived at empirically or cannot be disproven, but relative to workings of the system they are not empirical but prescriptive. I am here but touching on a large problem in the methodology of the sciences about the relation between theory and empirical investigation, but this will suffice to indicate what I wish to say. Laws of natural kinds (including developmental or historical laws) are appropriate to the specification of structural features of a physical system, and to the reidentification of that system.

A similar conclusion follows from a consideration of the circumstances under which causal laws can fail. A chemical reaction may fail to occur not only because the specified conditions for it to occur were not met, but because of external interferences - the solution may become contaminated, for example. General causal laws are always predicated on the proviso that there is no such interference from outside, i.e. they hold in an identified system (physical or chemical etc.).

As briefly indicated above, the physical system within which physical laws hold must meet conditions sufficient for its identification and reidentification. It must persist through time. The states of the system are, in other words, genidentically related.

Given a real system of a kind in which one is interested, one would look for causes for a given event in two areas. First, one would look to determining the prior condition of the system, and

second one would look to working out the implications for the actual system that follow from the assumption of its being of a certain kind. These would inter alia form a classificatory system for the events of the history of the system. Now certain inferences will normally be possible from those aspects of the structure of the system which embody developmental laws. For example, the principle that an event does not have zero duration is a normal structural one for most physical systems. These inferences will concern what kinds of events must exist at other places and times given a certain event, and how these must be related. If these inferences do not hold true in the real system, then this is grounds not for saying that other factors intervened, but that the system is not of the kind that it was supposed to be. It is within the context of such inferences holding good that the empirical laws of the system are established.

Laws which refer to the system in this way I shall call laws of structural relation. They can be causal in the Humean sense because the events they relate may meet the conditions of contiguity, succession and constant conjunction. They must, however, be distinguished from those we more readily call causal, namely those which refer to the actual history and interactions of the system.

Laws of structural relation do not as such necessarily discriminate which of the events they imply belong to an events history and which to its future. The grounds for this distinction will be discussed in the next section. Before proceeding with that let us apply the results of the above discussion to the concept of genidentity.

The problem was whether genidentity should be regarded as intrinsically a causal relation, in the context of developing a criterion of identity through time which was tolerant of spatio-temporal discontinuities. If the criteria for regarding a series of events as the history of a single individual necessarily included that those events formed a causal chain, then the qualitative version of the Reichenbachian conditions for genidentity could not guarantee this individuality unless the events it connected were causally connected and therefore spatio-temporally continuous.

Now genidentity follows principally from laws of structural relation. The fact that an object persists through time can be concluded from its existence at a single moment, provided that it is the sort of thing that the system identifies as persistent. It cannot be inferred precisely how long it has or will persist, nor exactly where it will be, although standardly it will be possible to infer that the path the object takes during its existence will be continuous. The materially genidentical chain of events associated with an event of the right kind is discovered by assuming that such a chain exists (this assumption being warranted by the continuity rules associated with the system) and then searching the spatio-temporal neighbourhood of the event for a chain of events of a similar kind which includes it and which meets the relevant criteria for genidentity associated with an event of that kind, these criteria including the absence of any other chain the events of which are causes of the events of the chain under consideration. (This latter criterion is not necessary if the genidentity in question is functional.) There is no need to establish that the events of the series are causally rather than merely developmentally or historically related.

We can further observe that the structural relations on which the genidentity of a series of events is based go hand in hand with the genidentity of the states of the physical system within which the individual whose states are genidentically related is located. This is because characteristic features which make the system the kind of system it is must persist if the system persists.

Now as we discussed in the previous section in ordinary sorts of physical system in which genidentity is defined the structural relations underlying genidentity are defined in relation to spatio-temporal parameters. Thus if we wish to carry through the program of definition of sufficient conditions for identity through time of an individual according to qualitative parameters, we must also do this for the physical system within which the individual is located.

The History of Objects

I have shown in the last section that the description of relations between events as being causal in nature on the basis of physical laws is a complex matter which cannot be straightforwardly reduced to the holding of functional temporal relations between the elements of sets of events and the properties of those events, because those of such relations which are identified as causal depends on the characteristics of the appropriate physical system. I argued in particular that genidentity is not itself a causal relation, even though it occurs in a context of causal relations, in the sense that it does not hold in virtue of any prior state of the system in which genidentically related events occur, though it does hold in virtue of structural characteristics of the physical system in which such events occur, and though the existence of the chain does hold in virtue of states of the system earlier than the beginning of the genidentical chain.

I based this argument on the idea that physical systems can have developmental laws as well as laws of natural kinds, and that neither of these need of necessity be accounted for in terms of a two place causal relation between different temporal states of the system. I pointed out further that if one takes a world picture in which events are located in a spatio-temporal framework, then no distinction can be made for such a system between laws of natural kinds and laws of development, because the distinction between these depends entirely on a distinction of laws which relate properties which hold at distinct times for objects. In the event language appropriate to the world picture described, both these kinds of law would correspond to laws of natural kinds, only these would be laws for events, not objects.

In order to complete the picture we need to develop for such an event language an equivalent of the distinction between the structural features of a physical system and its boundary conditions, i.e. those terminal conditions (initial or final) including both the distribution of objects and their laws of behaviour which are not determined by the structural features of system.

This distinction is based on the idea that systems of a specified kind have necessary features which leave open many parameters (some specifically defined as such, others not) allowing of many possible

actualisations of a system of that kind.

The system formed by events in space-time will be similar. It will have certain necessary features depending upon what kind of system it is, and will specify some, and leave unspecified other, parameters of variation, so that a great many possible instantiations of the same kind of system will be possible. On this level if there were to be a question for events equivalent to that of the reidentification of objects, it would be of the reidentification of the same event in different possible event systems.

These considerations make it clear that the necessary features of an event system have only an indirect bearing on those for an object system because the former are related to the sorts of patterns of events there can be in different possible event systems. They may, however, have a bearing on the features of the causal relation, which is a relation between events. Clearly what features of this relation are necessary will be relative to what kind of event system is chosen. If, however, the causal relation is to be reidentifiable in all event systems, some features of it must be necessary to all.

We know that the causal relation only exists between two events when in the relevant system each is a necessary and sufficient condition for the occurrence of the other, as characteristically expressed in the form of a law of physical process, i.e. a law which is a continuous function of the temporal parameter. It does not always exist then, however, because it is necessary to distinguish laws which describe a causally related process and those which describe byproducts of it. For example the state of a water wave at any moment is not the cause of its state at the next, rather the causal process is that of the relative motion of water molecules under the forces which govern them, and the state of the wave at any moment is a byproduct of the state of motion of the water molecules at that time. Similarly when a knife cuts through butter the increasing separation of the parts follows a continuous law, but the relation is not a causal one, the separation at each stage being caused by the motion of the knife. Clearly whether a relation following a law which obeys the relevant sorts of continuity is taken as causal in character depends on the character of the system one is working within, and in

particular on what its ultimate constituents are taken to be.

(As a note, the belief that any sense of causal relation belongs irreducibly to the world implies a belief in an irreducible system to which all others can be reduced.)

We can, then, isolate causal relations to relations between events which are not reducible to other relations between events, this being relative to a system and the irreducible constituents it presupposes, and which are expressed as continuous functions of the temporal parameter. Genidentity is a relation which meets these criteria.

There is however a stronger sense in which events can be said to be causally related, and that is when the relation which is said to be causal in character holds in virtue not of the character of the system but of a specific state of the system or part of it. As I have already argued, genidentity is not a relation of this kind.

This sense of causal relation is, however, quite possibly symmetrical, in the sense that events of precisely the same kind may appear in both the x and y positions of an Rxy relation which is by the above criteria causal. In order to give what Reichenbach calls a direction to time (what Grunbaum calls its anisotropy) it is necessary to associate with these causal relations and with genidentical chains at least one asymmetric relation expressed by a continuous function of the temporal parameter which is monotonic in character⁽¹⁾, and which is sufficiently pervasive to provide a directional ordering for all events (at least in a given system).

These considerations of causal relation together with those discussed earlier for genidentity suffice to identify the history of an object at a given time. This is done by associating all those

- (1) It may of course be doubted whether on the cosmological scale there is any such function. Doctor Hinckfuss argues persuasively in The Existence of Space & Time that thermodynamic considerations or considerations of the improbability of coherent convergent processes without a common cause do not provide adequate grounds for such a function (these being the candidates suggested by Reichenbach, Grunbaum and others).

events which are causally related to given events an object participates in at a given time into a pattern or net, using the principle of transitivity proper to that relation. Those portions of the net which are associated with a certain quality of the asymmetrical relation (similarity of sign of the difference between the value of the relevant monotonic function at the time of the given event) will be identified as belonging to the history of the object at that time. The entire history of the object at a given time will be the integration of all those nets thus defined relative to all the events which are genidentical to the given event and for which the relevant asymmetrical condition holds.

Qualitative Parameters and Structural Outcome

We observed in connection with the idea of genidentity that formally speaking the same relation could be defined as relative to other parameters than the spatio-temporal. When we examine the synopsis of the programme for the causal foundation of historical order given above (reserving 'temporal' as an adjective for that ordering exhibited by the temporal parameter, namely that of the real line), we see that it also can in form be defined relative to other parameters than the spatio-temporal (especially the temporal in this case).

The various stages in the development of the theory of causal order were based on the concept of physical processes, where these were expressed by physical laws which were continuous functions of the temporal parameter. The elaboration of the theory was entirely within those bounds. Excluding any terms which to use Doctor Nerlich's phrase may be in this connection 'special pleaders' in that they presuppose the temporal parameter in their definition (the idea of 'physical process' may be one such), it is quite clear that there can be (and are) physical laws which are not expressed in terms of temporal or necessarily even spatial parameters. It is therefore quite possible in principle to define the same formal structure relative to other parameters than the spatio-temporal.

If we can do this then we can relative to those parameters define objects (through the generalisation of genidentity outlined before), causal relations and histories of objects. The question then

arises as to what the relative status of a world picture based on qualitative parameters would be compared with the ordinary one.

It might be objected, for example, that we expect other parameters to be functional in space-time, but not vice-versa. Two points can be raised here. Firstly, the principle of superposition might be argued to provide a counter example. Secondly, an individual parameter amongst the spatio-temporal group is in no better position in this respect than an individual qualitative parameter. The location of events in space and time may turn out to be on the whole or everywhere functional relative to the n-tuples of a particular set of related qualitative parameters. This would not, however, necessarily imply that these locations were a continuous function of variations in such n-tuples.

Whether such an alternative parametrical systemisation of the events which make up the world (if it is in practice possible), were to be more than an elaborate artifice for redescribing the world would depend on whether the objects which were genidentical in such a scheme bore any relation to those which were genidentical in the spatio-temporal scheme. The questions involved here are complex, but I would suggest that they at least could, for the following reason.

A primary feature of events that are genidentical was identified earlier as the integrity of form of the relevant object through time, together with the persistence of certain characteristics. It was pointed out that at least the most important of these referred to the relative arrangement of parts and characteristics, and not to the position of the object in the locative framework of space and time. Furthermore, the features by which genidentity is defined do not necessarily refer to all features the object has at a given time and place. It would seem quite possible, therefore, that precisely the same features should be relevant to the determination of genidentity in both a qualitative and spatio-temporal frame. It would therefore seem further possible, and perhaps then to be expected, that on the whole spatio-temporal continuity implied continuity relative to the qualitative frame and vice versa.

If there were such a large scale conformity of parametric frames, but this was not complete, so that some object continuous according to the qualitative frame were to correspond to a series of disconnected objects in the spatio-temporal frame the history of each of which corresponded to a portion of the history of the object in the qualitative frame, this would provide good reason to suppose that the series of objects were really disconnected stages of the same object.

We would therefore have systematic grounds, based on a generalisation of the concept of genidentity and related concepts, for accepting that the structural principle of reidentification of objects through time could genuinely allow the discontinuity of objects through time, rather than merely be a principle derivative ultimately from that of the spatio-temporal continuity of objects and the tendency of their characteristics to persist.

CONCLUSION

In the body of my thesis I argued for the concept of structural outcome, being the idea that the state of an object at a given time has definite implications for its states at immediately surrounding times, so that if an object were abruptly to cease to exist, and an object with the consequential states were later abruptly to appear, these two could be connected as one being the structural outcome of the other.

The problem with such a notion is that it has no basis in the features of the cluster of concepts surrounding identity through time, these being referred to spatio-temporal parameters. In particular, the criteria by which events are located as the history of a single object are all ultimately based on continuity according to those parameters.

The above discussion shows that a formal system can be developed on the basis of other parameters which will allow sense to be made of the identification of spatio-temporally discontinuous series of events as forming the history of the one individual.

In conclusion I would like to raise an interesting question which occurs naturally on the basis of that discussion. Suppose that there were an alternative locative system, based on qualitative parameters, to the normal spatio-temporal one. Would there be any grounds for claiming that one system rather than the other was more fundamental? General Relativity Theory has already postulated that the character of the spatio-temporal framework cannot be considered to be independent of what it locates. Nevertheless, space and time have remained as the locative parameters for events. Do they have some privilege in this regard, or are they unique in this respect merely because we do not know of or have not developed a system for any other parameters which would perform a similar function?

APPENDIX TO CHAPTER 6

CAUSATION AND TIME TRAVEL

Chapter Six concluded with the identification of a problem that time travel brings up concerning the ways in which it is possible to acquire information. This is that if closed causal loops are possible, then information and theories about the world can become available to people without that information ever having been discovered, or the theory ever having been worked out.

This appendix follows up the question of this possibility in greater depth. It particularly addresses Professor Nerlich's suggestion that aberrant modes of information acquisition cannot occur around causal loops because if they did this would involve properties which are monotonic functions of time being required to so vary around a closed loop.

Now the recording of information is the creation of a more or less permanent trace in a given medium of events which have occurred. The connection may be relatively direct, as in the case of photography or sound recording, or very indirect, as in the transcription of a symbolic record which has itself been transcribed. In the former case it is plausible to say that the events are the cause of the record. In the latter case we do not so readily admit this, because the acts of writing and transcribing a record of events are voluntary human actions, and there is no inevitable result such as one is inclined to ascribe to the case of photography. Even so the original events and their ultimate record are connected by causally related complexes of events in the evolution of the larger system to which the events, the record and the media and instruments of recording belong.

The concern with time travel is that it allows sequences of events which correspond to the continued existence of a trace without there ever being an event or complex of events which causes that trace. Thus as described above a time traveller could hand a book to his younger self, who keeps it only to hand it over leading to the possibility of human kind acquiring bodies of information and therefore knowledge which no one, human or otherwise has developed.

This possibility is not unique to time travel. One could for example for a time stretching infinitely into the past postulate that a similar kind of book has always existed. Or if one postulates that the features of the world are chance combinations of basic elements, then such a book could arise by chance, albeit a very slim chance indeed. The possibility of such a book raised by the idea of time travel differs from the former in that it implies that the information and the book would only exist after a certain point of time in the normal time frame; it also differs from the latter in that its existence is not (apparently) governed by the laws of chance. Another differentiating feature about the time travel case is that it allows the possibility that such information could exist as the result of human agency, as for example when a time traveller copies a notebook which he then destroys, this notebook turning out to have been the very one into which he copied the information. The difficulty all three versions introduce is the same, in that they all allow aberrant ways by which humans could gain knowledge.

To this extent the causal loops implied by time travel pose but a particular case of a more general problem, and if there is a true principle which shows that any such possibility of aberrant information acquisition must be excluded then this will apply in any theory of time and only as one consequence would it preclude the kind of causal loops under discussion. However if an investigation of the conditions that would have to appertain in systems containing causal loops were to show that such aberrant cases could not arise as a byproduct of such loops, then the reasons for this may have significant implications for what principle would exclude similar cases in other theories of time. Unfortunately this investigation does not provide such a result.

In what follows I examine what is involved in the idea that a closed causal loop must be self contradictory if it has an indicator of time direction because this would require a monotonically varying function to so vary around a closed loop; as Professor Nerlich puts it 'something essentially equivalent to the quite naive idea of a closed spatial curve which is everywhere redder as we follow it in a clockwise direction'.

My aim will principally be to show that there is nothing about the nature of causal loops or the indicators of time direction which there might be for them that precludes the kind of information acquisition which I have identified in Chapter 6 and here. In the second part I will also work towards indicating where problems with the concept of such causal loops might lie.

The Internal Consistency of Causal Loops in Time Travel Stories

A useful beginning point as indicated by Professor Nerlich is the kind of time travel story told by Godel and commented on by Einstein(1). Godel gives a qualitative description of what a time traveller's journey would involve, supported by a set of field equations for General Relativity within which, he claims, time travel is possible.

To digress for a moment, it appears that Godel may have been mistaken about his field equations, for Chandrasekhar has demonstrated that interpreted as geodesics they do not lead to the consequences he thought but only to world lines all of which terminate in the future. This is apparently a matter of some dispute. Nevertheless, it would appear that other appropriate cosmological models can be constructed.(2) The details do not matter, because what is of primary interest is a certain sort of topological structure in time, not the definitions of a metric which might generate such a topology.

A simple example of such a topology is given by Reichenbach:

Mathematically speaking, it is possible to conceive a world in which the special theory of relativity applies in infinitesimal domains without exception, yet in which causal chains may be closed in the world as a whole.

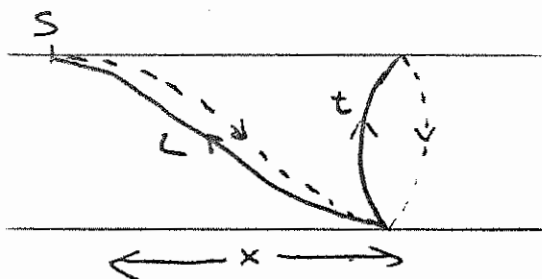


Fig. A two-dimensional world, without singularities containing closed time-lines.

- (1) See Chapter 1 pp. 10-13
- (2) The Nature of Time (NT), ed. T. Gold & D.L. Schumacher, Cornell University Press, Ithaca, N.Y. 1967. pp. 68-70; also Philosophical Problems of Space & Time (PPST), A. Grunbaum, Alfred A. Knopf, New York, 1963. pp. 201-202, footnotes; 'On Some Alleged Paradoxes of Time Travel', P. Horwich, *The Journal of Philosophy*, 1972, p. 432, footnotes

To understand this result let us consider a graphical representation of a two-dimensional world, with one space and one time co-ordinate, drawn on the surface of a cylinder (fig.). The time co-ordinate corresponds to a line encircling the cylinder, while the space co-ordinate corresponds to a line going to infinity in both directions, parallel to the axis of the cylinder. Such a manifold has no curvature and satisfies the special theory of relativity in every respect in finite cut-out regions. Only as a whole has it the peculiarity that time lines may be closed.

A light signal L will travel like a spiral to infinity, yet it may be reflected (at S) so as to return to its starting point.

This simple model demonstrates strictly that closed timelike world lines can exist in a world in which the special theory of relativity holds without singularities.(1)

While this example demonstrates and justifies in terms of general relativity theory the essential topological structure of time travel, it does not provide a picture of how a time travelling object might be related to its environment because it involves only particles restricted to a single spatial dimension. For the wider picture, Reichenbach uses a similar but four-dimensional example of a man who meets his former self. I will present this example later.(2)

It is clear from the above example, as it is also clear from the Godel cosmological model that what is intended is that only some world lines (causal chains) would be closed. Indeed, Reichenbach assumes just this.(3) Furthermore, this thesis is fundamental to Godel's attack using this time travel story on the idea of an absolute time which lapses. For if causal closure were to apply only to the world as a whole, the idea of a universe-wide 'present' could still be applicable, and the issue would concern rather the interpretation of such a world as cyclicly recurrent or as having a closed time. This is the sort of example that Grunbaum discusses, using as his paradigm the circular motion of a particle alone in the universe.(4) Godel's point

- (1) The Philosophy of Space & Time (PST), H. Reichenbach, trans M. Reichenbach and J. Freund, Dover Publications, New York, 1958 pp. 272-273
- (2) The Direction of Time (DT), H. Reichenbach, ed. M. Reichenbach, University of California Press, Berkeley and Los Angeles, 1956, p. 36-38. cf also PST p. 141-2
- (3) PST p. 141
- (4) PPST p. 197

is that the existence in at least one cosmological model of both open and closed time lines implies that the conception of the universe as a whole as having the same causal sense and hence evolution through time must be regarded as a contingent matter.(1)

Einstein's comments can be taken at first sight as applying equally to either kind of temporal circle, for his concern is with conditions governing the legitimacy of inferring large scale topological features of space-time from local ones. What he emphasises is that 'if ... B and A are two, sufficiently neighbouring world points, which can be connected by a time-like line, then the assertion: "B is before A" makes physical sense'. He observes that if a series of such connected time-like lines were to be closed on itself, then the distinction 'earlier-later' is abandoned for world-points which lie far apart in a cosmological sense.

He concludes his comments by noting, as Godel does, that it would be interesting to weigh whether closed time-like lines are to be excluded on physical grounds.

There is however, an important conceptual difference between the two cases of closed time. For if we suppose, as Grunbaum does, a cosmically closed time, then we must conclude that 'it could not everywhere be locally serial with respect to "earlier than".'⁽²⁾ I take this to mean that those sorts of events occurring in a universe in closed time which mark the direction of its evolution cannot consistently mark the same direction at every time.

This can be seen as follows. A closed universe as described must be composed entirely of reversible processes, for if it contained irreversible ones then the events at the point of closure would be at both ends of the irreversible process, this corresponding to the idea of a circle getting always redder as one travels around it in a clockwise direction. In such a universe, therefore, all reversible processes

(1) For Godel's comment here see p. 11

(2) PPST p. 202

must at some stage reverse, if the universe is to return to its original state. Thus no one or any combination of these processes can provide an unambiguous indicator at every point of time of the local direction of time at that point because the points at which the processes reverse will be points where one standard of time order applies from the left and another from the right. This is also, I take it, essential to the point to which Professor Nerlich has drawn my attention.

As Einstein similarly points out, if the directional sense of time can always be given locally by the connectibility of close world points by a time-like line (the transmission of a signal which is irreversible in the sense that it is associated with an irreversible increase in entropy) then closed time-like lines are impossible. The choice of a thermodynamical marker for time direction is here of topical rather than intrinsic significance, for the point would remain valid for any quantity which behaved monotonically with time.

I do not think, however, that this point can be simply transferred to a partially temporally open, partially temporally closed universe, i.e. one where some world lines are closed, others are not. For a start, there is not necessarily any equivalent of a closed physical system returning to its original state. Take Reichenbach's example, which I quote:

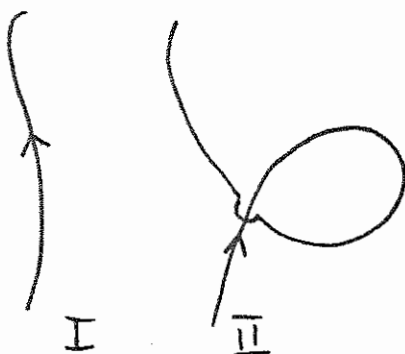


Fig. A closed and an open world-line next to each other.

If you were the individual of world line II, you would have the following experience.

Some day you meet a man who claims that you are his earlier self. He can give you complete information about your present condition and might even tell you precisely what you

are thinking. He also predicts your distant future, in which you will some day be in his position and meet your earlier self. Of course, you think the man insane, and walk on. Your companion on world-line I agrees with you. The stranger goes on his way with a knowing smile; you lose sight of him as well as of your companion on world-line I and forget about both of them. Years later, you meet a younger man whom you suddenly recognise as your earlier self. You tell him verbatim what the old man had told you. He doesn't believe you and thinks you are insane. This time you are the one that leaves with a knowing smile. You also see your former companion again, exactly as old as he was when you last saw him. However, he denies any acquaintance with you and agrees with your younger self that you must be insane. After this encounter, however, you walk along with him. Your younger self disappears from sight, and from then on you lead a normal life.(1)

One of the points of this story (the same one emphasised by Godel) is that because some events would each be associated with distinct causal chains having contrary senses, it would be impossible to regard the entire spatial universe as a single physical system, i.e. it cannot be regarded as a physical system whose state can be described as a function of a single temporal variable.

Grunbaum's reason for rejecting such a version of closed time is interesting. He says:

'It might be asked why we have been assuming that the structure of a closed time would have to be that of a knot-free circle rather than that given by the self-intersecting closed time line in the numeral 8. The reply is that the framework of our models of a closed time is deterministic and that the course of the phase curve representing a finite (closed) mechanical or other deterministic system is uniquely determined by any one of its phase points.'(2) By contrast, we remark that the closed time-like lines of interest in Reichenbach's story (and Godel's) have essentially the character of a self-intersecting line, rather than a circle (consequently it cannot be deterministic in Grunbaum's sense).(3)

(1) PST p. 141-2

(2) PPST p.203

(3) cf. PST p. 140-1

It is quite clear, then, that these time travel stories (which correspond to those of fiction of a 'trip to the past') cannot be straightforwardly assimilated to the idea of a closed curve around which some quality increases, on the analogy of a closed spatial curve which gets redder as we follow it in a clockwise direction. The closed temporal curves appropriate to these stories are self-intersecting, not topologically equivalent to circles.

It will be enlightening to approach this issue from a different angle. The difficulty according to Einstein with closed time-like lines is that entropy would be required to increase around them. It must be pointed out, however, that entropy is a property belonging properly to physical systems, not objects (unless these happen, like the human body, to be physical systems), whereas the time-like line corresponds, properly not to a physical system but to the history of an object or a signal (for which the following points also hold true). Normally speaking the one can be naturally associated with the other, because the evolutionary sense of the object is that of the physical systems of which it is a part, and so a change in a quality of the system can mark the temporal sense of an object's history in the system. It is, however, precisely this association which is questioned by cosmological models like those of Gödel or Reichenbach, because in them, by virtue of only some time-like lines being closed, the evolutionary sense of an object cannot everywhere be identified with the evolutionary sense of the larger physical system within which it is located. This is, I think, why Einstein commented finally that the matter of closed time-like lines was yet to be settled by physical considerations.

A further point is appropriate here. There is no conceptual reason why an object which is not itself a physical system should not remain completely changeless, and so fail to provide internally a function suitable for time ordering. This is indeed often supposed of certain elementary particles. (As an aside - this is the principal ground for objecting to the interpretation of electron/positron or other elementary particle interactions as possibly involving time travelling particles.(1) A similar point applies to cyclical changes

(1) cf. eg. DT section 30 p. 262 which allows such an interpretation

in an object which do not degrade. There may then be, as Grunbaum argues for a closed cosmos(1), reason for a directed temporal ordering within certain segments of the cycle, but none for the whole because the changes in the object which constitute the cycle do not include the kind of monotonic function which unambiguously provides a directed temporal ordering relative to every given time.

These considerations lead us to conclude that we can generalise the point made above about Einstein's use of thermodynamic properties of a system to provide an 'arrow' for time. It is not necessary that two points in an object's history, whether they occur on a closed time-like line or not, should be associated with any internal process which would serve to provide a monotonic function suitable for ordering the states of the object between those two points in an unambiguous temporally directed sense. Indeed this is the main motivation for the introduction in the causal theory of time of methods of inferring local time direction from the time sense attaching to larger ensembles, whether this is based on statistical or nomological considerations. This matter will arise in a later context.

Having said all this, and having emphasised that time-travel stories are based on the analogy of self-intersecting rather than circular spatial lines, I must observe that these stories do allow of subsidiary time-like lines which are, properly speaking, analogues to circular spatial lines. A simple example would be if the older man in Reichenbach's story were to give an object to the younger one, who then kept it until he later met his younger self.

There is one matter I would like to deal with before I go on to discuss these causal circles and that is the possibility hinted at by Rindler (2) that it may never be necessary to regard any theoretical construct of a universe in General Relativity Theory as containing temporally closed lines, since there is always a possible interpretation available of that universe as temporally open. As I understand it, Rindler's suggestion is that either there will always be techniques available for redescribing the geometry of world models which exhibit

(1) PPST p. 197 ff

(2) NT p. 70

temporal closure in such a fashion that this closure does not occur in the re-described geometry, or it would be possible to regard only a part of the world model as physically significant. If this were in truth always so then the fact that world models could be described which contained closed time-like lines would be physically meaningless.

Grunbaum, following the pattern of proponents of the causal theory of time, would argue that definite restrictions must be placed on the possibility of such re-description, because as well as its metrical properties the topology of time must be derived from the empirical facts about causal relations between events, and in particular that events which are precisely similar in both their attributes and relations except for their spatial and/or temporal locations, must be identified. If this is so, then a direct physical sense can be given to the difference between closed and open time lines. However, this approach of Grunbaum has been severely criticised by Doctor Hinckfuss in a discussion on the possibility of the closure of time.(1)

Grunbaum considers a simple deterministic closed physical system - a single particle moving in a circular path without friction. He then argues that unless there is some reference to an external system, whether covertly or overtly, this system must be interpreted as temporally closed, rather than cyclic and open. He argues this from Leibniz's principle and on related verificationist grounds. Doctor Hinckfuss considers both of these arguments fraudulent.

Grunbaum argues for the interpretation of the history of the particle in terms of temporal closure, saying, 'This conclusion rests on Leibniz's thesis that if two states of the world have precisely the same attributes, then we are not confronted by distinct stages at different times, but merely by two different names for the same state at the one time; and against the interpretation of this history in terms of periodic motion in an open time because this interpretation is illegitimate since a difference in identity is assumed among events for which their attributes and relations provide no basis whatsoever.(2)

- (1) The Existence of Space & Time, I. Hinckfuss, Clarendon Press, Oxford, 1975, p. 74-78
- (2) PPST p. 197

Doctor Hinckfuss emphasises quite correctly that if it is regarded as a tautology of logic, as it generally is in modern philosophy, Leibniz's law provides no support for this claim, because both the closed and the open interpretation will provide temporal relations which will respectively identify or differentiate the related world-states according to this law, and such relations cannot be excluded if the law is to remain tautologous. While chastising Grunbaum for such misuse of Leibniz's law he notes that it is fairly innocuous in context, and though he does not explicitly say why, it is interesting to follow this up.

Leibniz's law is not always considered the logical tautology it is now conventionally understood to be. Indeed to call the conventional law 'Leibniz's' is something of a misattribution. Bertrand Russell, for example, reports Leibniz on the identity of indiscernibles: 'Leibniz says that besides the difference of time and place there must be an internal principle of distinction, and adds that places and time are distinguished by things, not vice versa'(1) As Russell argues, Leibniz does not mean that differences of place and time cannot be used to differentiate objects. Russell insists that the differentiation must not be supposed effected by difference of place, per se, but by differences as to the predicates to which, on Leibniz's theory, place must be reduced.(2) That is, in Leibniz's reductionist program, it is self-contradictory to suppose that a difference in place and time is possible between two otherwise identical objects.

In any reductionist program (especially in Doctor Hinckfuss's terminology, any ontological reductionist program) not all properties which are ordinarily regarded as distinct can be regarded as logically independent. In particular, if one believes as Grunbaum does, (following Reichenbach, Carnap and ultimately Leibniz) that the topological structure of time and the very definition of temporal ordering and position must be constructed from causal relations between events, then in that context it is appropriate to use Leibniz's law as Grunbaum does, because temporal relations must be constructed out of

(1) The Philosophy of Leibniz, (PL), B. Russell, George Allen & Unwin Ltd., London, 1937, p. 57

(2) PL p. 56-57

causal ones. That is, because Grunbaum is already committed to a constructionist program for temporal relations he can use Leibniz's law in a form divested of temporal relations. This law does not then give any independent support to the constructionist program, but it will do the job Grunbaum wants of it.

This same point carries over to Doctor Hinckfuss's critique of what he supposes Grunbaum's argument (quoted above) to be when divested of the 'Leibnizian red herring'. He supposes it to be of the form

P does not entail Q

∴ P is inconsistent with Q

where P would read something like 'there is no difference in attributes and relations (other than those related to the temporal variable) between an event at time t and an event at another time t_1 '; and Q would read something like 'time t is not identical with time t_1 '. As Doctor Hinckfuss states, this argument is blatantly invalid as it stands. There is, however, a suppressed premise, clear enough in context, to the effect that Q must be cashed out in terms of the reduction of the temporal order of instants to the causal order of events.

The form of Grunbaum's argument is clearer in his own example of means by which scientists might verify that their world has a closed time. This example is along the following lines. Suppose that these scientists discover that their world follows deterministic laws, and that a complete description of it is a complex function of a single variable ranging over the real numbers. If the scientists then calculated that for the conditions obtaining in their world this function is periodic, 'upon discovering this result ... these scientists would have to conclude that the different values of the time variable for which this sameness of state obtains do not denote objectively distinct states but are only ... different numerical names for what is identically the same state'.(1)

The argument involves the following steps:

The world history is deterministic

The world history is apparently periodic

The world history is really temporally closed.

(1) PPST p. 202

Clearly it is the premise of determinism that is the key here, a fact which has two consequences. First, each period of the apparently periodic world history will be exactly similar to all other periods. Second, determinism guarantees a co-ordination of time order to causal order so that the reductionist program can clearly be carried out. (Note that as Grunbaum says, the direction of time, its anisotropy, is irrelevant here.) That is, there is no compulsion to conclude real closure of the world time unless the reduction of time order is already supposed. But, in Grunbaum's case, it is, and the issue is rather of the sense of the distinction between closed and open time.

We can conclude therefore that the causal theory of time does not run into serious trouble on the issue of the identity of indiscernibles, so long as the reduction of temporal relations to causal ones can be justified independently of this principle. We can further conclude, that a definite meaning can be given to the distinction between closed and open times according to which the difference can be verified, and that this distinction is far from an arbitrary one. Time would be closed if, on the assumption that it were open, the complex function of time formed by the conjunction of all laws expressing whatever kind of process were to turn out to be exactly periodic. If it did not, then time would be open, as assumed.

Let us return now to our main theme, namely the interpretation of causal circles. I pointed out that despite the character of time travel stories as implying self-intersecting time-like loops rather than fully closed ones, the possibility of such self-intersecting lines generated the possibility of time-like lines analogous to circles. My example was of the older man in Reichenbach's story giving an object to the younger one, who then kept it until he later met his younger self. It might be said that this possibility of objects which exist only in a fully closed time loop is interesting but unparadoxical, being on a par with objects which have and will exist eternally (such as elementary particles have sometimes been presumed to do) and are thus uncreated. The worry comes, however, when the object is a human artefact, something which we would ordinarily think had to have been made by somebody. If we reconcile ourselves to this, as we might by noting that there is no logical problem in supposing that what would ordinarily be man-made should exist naturally we are nevertheless faced with a more troubling possibility.

The older man may pass on not only objects but also information, which might be retained by the younger man, who later passes it on. There is no apparent reason why this information should not be widely disseminated, and its truth verified. It is thus possible that information, and in particular human theories, should enter the world without ever having been invented or discovered, but merely transmitted from one person to the next. A synoptic picture of this problem is of the older man passing to the younger man plans for a time machine.

It may be objected in this context, as in earlier similar ones that the problem with such examples is that they require some quantity to increase monotonically around a closed loop (analogous to requiring a physical circle to always get redder in colour as one progresses around it). It is not clear however, that the problematic cases are of this sort, and I do not believe that they are. What is involved within the fully closed temporal loop need only be the mere continuation of an object or state of affairs (such as having available to memory the relevant information), and there is no logical reason why there should be an accumulative time marker internal to either unless mere continuation is thought to necessarily involve such an internal marker. I have already argued against this, saying that such markers require a physical system or a changing object, and there is no necessity to regard all objects either as physical systems or as having to change.

Furthermore, while it is perfectly consistent to suppose the object in the fully closed time loop to be changeless around the loop, there is no necessity for this to be so. The younger man could destroy it, or mark it in some way to differentiate it from when he received it. However, by the fact that the exchange took place, we know that it would be recreated or restored to its original condition.

The case is similar for information. All that is required for information to exist is that an object be marked in such a way as to convey information to a person when it is read. The case of information can thus be treated as of a kind with that of objects above. The interaction involved in reading is not a problem either, for the only condition or interaction is that the history of the object carrying the information around the fully closed temporal loop must be consistent with the state of the object at the time of the exchange.

Nor need we restrict ourselves to objects. We can introduce physical systems, including thermodynamic ones (a thermos of hot tea perhaps), so long as we do not require these to be closed at every point in the temporal loop. There is no problem here, these systems can interact with their environment in a perfectly ordinary way.

A further objection should be taken into account here, to the effect that there are no grounds for regarding the events of what has been described as a fully closed temporal loop, such as the unchanging continuation of an object, as causally related. The point here is that there would seem to be no way of telling which way round the loop the object goes, or whether there might not be two objects originating at the same event point and being annihilated at the same event point. Since there is no internal marker of time direction such interpretations of the facts as hypothesised above would be equally legitimate.

The answer to this objection is that while it is true that there is no internal time marker, we have supposed that the object or system in the fully closed time loop does not form an isolated system but rather is an object in a larger system the time line to which is not fully closed but is self-intersecting. This larger system (the man who carries the object, or retains the memory) provides the time sense for the object whose time line is fully closed.

Causal Loops as Part of the Larger System

In the light of these considerations it would seem that the conception of closed causal loops that I have propounded does not fall foul of the kind of objection proposed by Professor Nerlich. I have however explicitly disclaimed that this conception is of an entire cosmos with a closed time. I have said rather that the examples under consideration represent a sort of cosmos in which there would be both closed and open time lines. This leaves open the possibility of a related sort of objection to the effect that processes on the cosmic scale could provide that kind of temporal indicator necessary to preclude the possibility of temporal loops. It turns out, however, that either the existence of such an indicator would presuppose the non-existence of such loops, or its existence would not be an empirical

matter. Nevertheless consideration of this sort of objection leads to the identification of systemic worries about worlds with closed causal loops.

The reasoning behind the supposition that there might be processes of the requisite kind can be sketched as follows. If sequences of events representing the history of an object or physical system do not always exhibit features which indicate the direction of time for the object or system, this can usually be discovered from the larger environment in which the object or system exists. That is, one infers that the time order of events in a small scale system is the same as the time order of events in a system on a more inclusive scale.

If this is taken as a general principle, then subsystems whose histories are apparently counter-directed to that of the majority of subsystems and of the system itself or whose history are neutral in this respect might be prescriptively said to have a certain direction. Take a subsystem which has been isolated for a certain length of time. The history of such a subsystem would be connected to that of the main one much as a handle to a jug, the points of joining representing the beginning and the end of the isolation of the subsystem. Which was which would be decided from the time direction associated with the system as a whole, and the identification of these points (or either one of these alone) would indicate the time direction to be associated with the subsystem even though the history it exhibits may represent what relative to the larger system is a reversal of the normal sequence of events.

The question is, can such a scheme rule out the possibility of time travel. Let us draw out its implications further.

A prerequisite for the possibility of everywhere carrying through such a scheme is that systems can be connected together in the relevant way to form ever larger systems. Taken to its extreme, this process would end up with the spatial universe as being the largest system. It is necessary to go this far if time direction is to have an absolute rather than relative sense. For if the largest such system were smaller than the entire spatial universe, then there would be at least one system which could not be integrated with the rest, and time direction could be defined relatively to either one or the other.

The line of reasoning outlined here clearly has much in common with the constructions of Reichenbach and Grunbaum, where the entropic and informational properties of ensembles of branching physical systems (i.e. of larger and larger groups of physical systems which separate, are isolated and perhaps merge with one another - these separations and mergers being the modes of the branches) are used to regularise the time direction of particular systems in the ensemble for which the entropic function provides a local direction counter to that which the function provides for the ensemble.

In their case the properties of such ensembles are arrived at by inference from the empirical properties of ensembles with which we are familiar. The possibility of iteration of the process of integrating physical systems into larger and larger ensembles is then guaranteed by an empirical fact - as Reichenbach says - that there are no closed causal chains, where the definition of causal chains involves temporal order, and not temporal direction. The imposition of time direction on particular systems in virtue of the direction associated with more inclusive systems therefore pre-supposes that the aberrant cases of closed causal chains are already to be ruled out on other grounds, (empirical grounds, Reichenbach says).(1)

The reason for asserting that the grounds are empirical is adherence to the general principle that the larger scale structure of the universe is to be discovered from its local structure by investigation, subject only to continuity constraints related to the assumption that the locative framework of the universe is a Gaussian co-ordinate system.

If the assertion that the grounds for precluding closed causal chains are empirical can be taken without question, then the objection to them under examination can be taken as no more than the assertion that there are no such things.

(1) DT p.36

Should we accept that the matter is empirical? Let us return to a consideration of the process of constructing a hierarchy of physical systems. We noted above that if a systemic principle of time direction is to be always able to preclude the possibility of closed causal loops, then the system relative to which this is done must include all systems (for if it did not, then the way the system which was chosen was related to the rest might be of the aberrant kind that it is desired to preclude). We are then, it would seem, faced with the following choice: Either we must assume that the requisite integration of systems can be carried through, or we must found this belief in the local properties of small scale systems. The necessity for this choice arises because the existence of cosmological models with the properties described by Godel (whether or not his solution in fact has those properties) demonstrates that it is not always possible to integrate physical systems in a suitable way to produce a universe-wide physical system.

Since the assumption of a global time direction is neither an attractive option given that it would appear not to be necessary on the general postulates of Relativity Theory, nor warranted on the existence of a locally well defined time direction (what is warranted is perhaps that every locality has a well defined time direction), can we found a non-empirical integrative principle in the local properties of small scale systems?

Let us begin by examining in more detail than previously some of the properties of the sort of cosmological model proposed by Godel. The primary objective of Godel's demonstration of a solution to the field equations of General Relativity Theory which permitted time travel was to show that worlds could be imagined in which physical systems could not be integrated one with another to form a single universe-wide system. He expressed this by denying that a universe-wide present could be consistently defined which is equivalent to denying that the whole universe could itself be regarded as something which evolves through time.

This denial was made on the basis that in a certain cosmological model the topology of certain time-like lines prevented a consistent attribution of a single direction to these geodesics, since they had a

symmetrical property that meant that the connection of branch systems represented by the geodesics would have to be represented by a diagram such as the left rather than the right.

In both diagrams the segments of the loops at A & B represent one physical system diverging from that represented by the straight line, and one converging. This is so regardless of whether the direction of time is chosen from A to D or from D to A. The spatio-temporal proximity of the main and branch systems is represented by the proximity of the segments of the loop at B and C to the straight line AD. In the diagram on the right these are both proximate to the straight segment BC. In that on the left however, they are not proximate to BC, but one to AB and one to CD. In both cases this situation is symmetrical. For the left diagram we observe that if the time direction were taken from A to D then the branch system at B would be convergent to and that at C divergent from the main system. Since these are the same system as represented by the loop, that system would converge from the main system before it diverged from it. And symmetrically if the time direction is taken from D to A.

Locally speaking the various branchings involved in the diagrams are well-behaved. What makes that on the left distinctive is that the two branches are supposed to belong to the same system. This system also is always locally well-behaved, since by the cosmological model, the time direction around the loop is always locally well-defined, and the particle or system corresponding to it need not be isolated from the local physical system. The definition of time direction breaks down only globally, because of the sequences of events it is apparently necessary to consider genidentical. That is, if one were to construct the hierarchy of physical systems at each of points A and B in the above left hand diagram, one would find that the assumption that the two branches considered represented distinct systems could not be maintained.

The crux of the matter is evidently how the concept of genidentity is related to that of a physical system. For the concept of a physical system is, as argued elsewhere in this thesis, of a thing which endures

through time, i.e. the states of its existence are genidentically related. Furthermore, when it is assumed that the events around the loop are genidentical, this must be assumed relative to a set of events constituting the history of a physical system, or series of such, because it is relative to such local histories that the temporal direction of the sequence of events around the loop is locally determined.

The problem that these considerations raise is what the conditions of identity through time of a particle are (i.e. of the genidentity of the events of the particle's history) when the particle ceases to be identifiable in one physical system and we wish to consider it as now identifiable in another. In the ordinary world there is no difficulty, because the two systems involved form part of a larger system. For example, when a particle moves from one piece of apparatus to another in the laboratory, the laboratory forms the relevant larger system. It, and the two pieces of apparatus endure through time. However, ex hypothesi, this manoeuvre is not possible for the entire length of the kind of loops under discussion.

Genidentity of the events constituting the history of the particle around a loop follows rather from the transitive property of the relation. Since neighbouring physical systems are connected by a continuous space, a larger (but still local) system exists containing both. This interlocking feature exists all around the loop. There is, therefore, no single system relative to which the identity of the particle is determinable, but the particle which leaves one system is identifiable as the particle which enters the next and so on.

Here we ought to be suspicious, because it seems odd to say that a single thing has endured right around the loop. That a single thing has done so follows from the fact that genidentity amongst events is an equivalence relation. There is, however, no physical system relative to which the particle can be said to be the same thing reidentified, except the system that may also have travelled around the loop. But the reidentification problem recurs for this system.

That the problems are to do with how questions of identity through time must be related to particular physical systems can be highlighted if we approach the matter from a different viewpoint,

returning again to Reichenbach's story of the man who meets his earlier self, and considering to what extent that man can remain sceptical that the events he experiences constitute a case of time travel. (The story is quoted in full on pp. 35-36.)

From his point of view several stages in this period of his life can be distinguished:

- a) That up to his meeting with his older self
- b) that of the duration of this meeting
- c) that from the end of this meeting up to his meeting with his younger self
- d) that of the duration of this meeting
- e) that thereafter.

So far as the unwitting time traveller is concerned his local spatial environment (no other enters into the story) always behaves normally in any of these periods. What is abnormal from his point of view is that his experience leads him to entertain the identification of periods b) and d) as the same objective period of time, despite them being psychologically distinct for him.

Reichenbach implies that the evidence possessed by the older man after leaving the time loop is sufficient to convince him that these two periods are the same (the older man leaves the scene with a knowing smile). Is the evidence really sufficient? What would prevent him (even if he believes the younger man and his companion, and himself, to be always truthful) from concluding that they were precisely similar, so far as his memory went, but not identical? We note that:

- a) the precise similarity of the spatial locations in which the meetings occur is no evidence one way or the other;
- b) the sensory perspective of the older man (and the younger) is limited, no matter how good his memory is. The conclusion of identity between events he perceived from a certain perspective as a younger man and events he now perceives from a different perspective is therefore based on inferences from only partially overlapping data;
- c) the older man might hypothesise that the identical course of events in the meeting was caused by his acting out according to his recollection (perhaps subconscious) of earlier events and that the younger man reacted very

similarly to the way he remembered himself to previously because of similar stimuli;

- d) he might further hypothesise that the striking resemblance on the one hand between himself as a young man and the young man in front of him and on the other between the young man's companion and his own remembered companion forcibly demonstrated how strong genetic resemblance could be;
- e) upon learning details of the course of the young man's life and discovering them to be identical with details of his own to a similar age, he concludes how strange coincidence can be, and how similar the histories of people from similar backgrounds can be;
- f) upon remembering the striking accuracy of the predictions he received from the stranger years ago, he wonders if perhaps this might not have been brought about by himself as some kind of subconscious wish fulfilment;
- g) the decisive factor in the story is intended to be the world line of the companion, whom the man knows at two widely separated times in his own life but who is the same age at both times. However, if there is latitude for him to interpret his meeting with the man who looks like his younger self as actually a meeting with someone else, then this latitude exists for the companion also.

The sort of consideration which would give him pause would not be events which could be explained in this fashion on the hypothesis of parallellism of history or self-fulfilling prophecies, but would rather be the location of apparently unique events by the younger man in precisely the period of his life that the older man would place those events in his own history. A superficial example would be what the young man said the date and year to be, since this could be put to one side as an aberration of time keeping of a sort that can happen to whole communities (perhaps despite appearances they adhere to a different calendar). The sort of event that would be unique in the relevant way would be one which was so minutely specified and of such an unusual kind that its recurrence could be at least for all practical purposes ruled out.

In order to rule out the possibility that the young man might be lying about events of this kind we could add the condition that only the older man was witness to them, and he never divulged his knowledge of them. That is, knowledge of the requisite events is supposed unique to a certain individual.

Would considerations of this sort compel the man to conclude that the younger man was indeed himself? I think not. Even though they are extremely often sufficient in the circumstances for reidentification of the same individual, their uniqueness of occurrence and of observation is from the possible time traveller's point of view not a matter of absolute certainty.

While in normal circumstances the length of the odds would rule out the recurrence of the event, his circumstances are not normal. He is faced with an episode in which a man unsettlingly like himself as a young man, with a history unsettlingly similar to the earlier portion of his own, is acting out a series of events exactly as he remembered himself to have done years before. In this context he would not find the odds so long, and they would certainly not provide any independent grounds for supposing that the two events thought to be unique were not in fact two.

It is not the internal details of what he remembers about his own past which preclude him from concluding that what occurred was a strange repeat of history; what precludes this is that in the larger scheme of things the hypothesis that the young man's history is distinct though similar to his own as a younger man is untenable. However widely and far back he investigated, he would find that the history of the young man, his ancestors and his environs was precisely similar to his own up to the same age. Furthermore, he would fail to find in the world around him, any record of his history corresponding in apparent length to his years between the two similar meetings. To cap it off, he would find no evidence that the young man continued to exist in his own locale after they parted. It would be in attempting to reconcile this vast body of facts into a coherent whole that he might conclude that what actually occurred was a form of 'time travel', or closed causal loop.

So far as Reichenbach's story goes, the evidence available to

the older man is strictly limited to his own memory, and so he has (at that point at least) no conclusive reason for his knowing smile.

The considerations raised in the above discussion do not hinge on the way in which this particular story was told. Getting into a machine and going back in time would raise exactly similar considerations. It is possible for a sceptical time traveller to hypothesise that his episodes in exotic times with interludes in a machine he is told is a time machine were really episodes in spatially distinct places and the machine an unusual vehicle for spatial travel. When he went to a place where events exactly reduplicated those of his earlier life he could conclude that parallel evolution could be remarkably exact in its detail.

Since the spatial extent of the time traveller's field of experience at any given time and place would be strictly limited, he could maintain his hypothesis until the accumulating weight of evidence from other sources that his own experience showed that the process of integrating larger and larger physical systems made the hypothesis untenable.

Conclusion

I have argued in this appendix that no consideration of markers of time direction will serve to eliminate the possibility of the aberrant ways of gaining information through causal loops outlined in Chapter 6 and in the introduction to this appendix.

I have however indicated that there are problems in a different area, namely to do with the concept of genidentity and the relationship of this to the concept of physical systems and the ingenidentity. In particular, if we regard the two objects on opposite sides of a causal loop as identical we ought to be able to ask what the criterion of reidentification is. This cannot be external, because there is no single physical system to which both objects belong, and so we cannot say for example that the object has traced a continuous path in the one system (although we can say that a continuous spatio-temporal line corresponds to its history).

If a plausible connection could be established between the concept of being identical through time and belonging to a physical system, then this might form the basis for precluding closed causal loops. If and whether this idea can be developed is a matter for further investigation.

I would note however that the complete exclusion of the possibility of causal loops would not be necessary merely to eliminate the difficulties with aberrant means of acquiring information. All that would be necessary for this would be a principle, not ad hoc, which would guarantee that for each genidentical chain at least one event would have a cause which was not itself a member of the chain, and which was of the relevant sort to produce that event.

This would mean that all objects and information would have what in the ordinary way would count as their source or origin. It would also mean that material objects could not occur in completely closed causal loops because that would imply that the events in the neighbourhood of the externally caused event would contradict the principle of continuity of change (the genidentical chain around the loop and the causal chain from outside would form a y - figure at this point). It

would not necessarily eliminate causal circles for information acquisition because this does not have to obey the continuity criterion, i.e. one can acquire through a chain of transmission information that one already knows. The reverse is also readily conceivable - one could learn from a message what one will later experience directly. That such occurrences should be manifest via a closed causal loop is not of itself disturbing. What would be disturbing would be if the message were transmitted but that there was no ultimate source of the transmission. The requirement for a beginning outside the genidentical chain eliminates this possibility.

Do we have grounds for believing that there is such a principle? If there were it would be something characteristically to do with the beginnings and ends of objects. Since the concepts of coming to be and ceasing to be are intimately connected with criteria of identification and identity through time, and these are relative to the character of the system within which they are to be applied, we would suppose that questions of beginnings and ends are similarly connected. This would imply that the elements of the system and not just the system as a whole followed developmental laws. If there is a principle of the desired kind, then, it would be appropriate to look for it in this area.

Bibliography

- Robert Coburn: "The Persistence of Bodies", American Philosophical Quarterly, Vol 13, No. 3, July 1976
: "Bodily Continuity and Personal Identity",
Analysis, 20, 1959-60.
- P.T. Geach: Reference and Generality, Cornell University Press,
Ithaca and London, 1962.
- T. Gold and D.L. Schmacher: editors, The Nature of Time,
Cornell University Press, Ithaca, New York, 1967.
- A. Grunbaum: Philosophical Problems of Space and Time,
Alfred A. Knopf, New York, 1963.
- I. Hinckfuss: The Existence of Space and Time, Clarendon Press,
Oxford, 1975.
- P. Norwich: "On Some Alleged Paradoxes of Time Travel",
The Journal of Philosophy, 1972.
- D. Hume: A Treatise of Human Nature, Everyman Edition,
Dent, London, 1911.
- E. Nagel: The Structure of Science, Routledge and Kegan Paul,
London, 1961.
- G.C. Nerlich: "Sameness, Difference and Continuity",
Analysis, 18, June 1958.
- Claudio Rebbi: "Solitons", Scientific American, February 1979.
- H. Reichenbach: The Philosophy of Space and Time,
trans. M. Reichenbach and J. Freund, Dover Publications,
New York, 1958
: The Direction of Time, ed. M. Reichenbach,
University of California Press, Berkeley and Los Angeles, 1956.
- B. Russell: The Philosophy of Leibniz, George Allen and Unwin Ltd,
London, 1937.
- Olaf Stapledon: Star Maker, Penguin 1972.
- Leslie Stevenson: "Relative Identity and Leibniz's Law",
Philosophical Quarterly, 22, April 1972.
- B.A.O. Williams: "Personal Identity and Individuation",
Proceedings of the Aristotelian Society, LVII, 1956-57.