

**A LOGIC OF CREATION
A NEW TENSE LOGIC FOR EMERGING TRUTH**

**PRIOR'S IDEA OF NON-STABILITY
AS A SOLUTION TO THE PROBLEM
OF CONTINGENT INDIVIDUALS**

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SUMMARY

In 1957, the founder of tense logic, A.N.Prior, proposed a modal system Q of which it is assumed that, for certain possible worlds, certain propositions simply do not occur because they concern individuals which are absent from those worlds. Axiomatised by R.Bull, K.Segerberg, and Prior himself, and later translated into tensed terms as QK_t , this logic of *non-stability* offers an interesting example of a system designed to solve the problem of non-permanent, or contingent, existents.

In the present paper the idea of *non-stability* is investigated in order to disclose its importance for the logic and philosophy of time. An alternative to QK_t is suggested which combines the logic K_b for future branching with certain features derived from Prior's interpretation of the systems of Peirce, Ockham, and Leibniz. It is opined that the tempo-modal system W , by opening new perspectives towards the idea of an emerging, or created, truth, competes favourably with QK_t .

QUOTATIONS

*The possible is necessarily general.
It is actuality, the force of existence, which bursts
the fluidity of the general and produces a discrete unit.*
C.S. Peirce (CSP 4.172)

*My view is that there are three modes of being ...
they are (i) the being of positive qualitative possibility,
(ii) the being of actual fact, and (iii) the being of law
that will govern the facts in the future.*
C.S. Peirce: (CSP 1.21)

*There can be no truths, not even logical truths,
that are distinguishable about Caesar and Antony, until
there are such persons to be the subject of these truths.*
A.N. Prior (PTT 77)

*Nothing can be surer than that whereof we cannot speak,
thereof we must be silent - though it does not follow from this that
whereof we could not speak yesterday, thereof we must be silent today.*
A.N. Prior: *Philosophy* 34, 11-17, 1959

*While the passage of time may eliminate possibilities
in the sense of alternative outcomes of actual states of affairs,
and cause that to be no longer alterable which once might have
been otherwise, with logical possibilities the opposite occurs.
For as new distinguishable individuals come into being,
there is a multiplication of the number of different subjects
to which our predications can be consistently attached, and so
a multiplication of distinguishable logical possibilities.*
A.N. Prior (PTT 77)

Mogens True Wegener

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A. INTRODUCTION

It is our purpose to construct a new system W of *Tense Logic (TL)* which is indeterministic not only in the sense that it permits possibles to branch towards the future, but also in the sense that it, more radically than standard TL , discards the idea of time-less truth by implying truth to emerge in time along with reality. Truth is nevertheless still assumed to be eternal in the sense that, once established, it can never be annulled or suspended, but is valid henceforth, i.e. in all future. We may see it as a virtue of the system W if it succeeds in reproducing the richest variety of linguistic forms by the simplest possible means of symbols and axioms. The final system will display features derived from sources as diverse as Aristotle, Diodoros, Anselm, Aquinas, Ockham, Leibniz, Kierkegaard, Peirce, and Prior.

K_t & K_b are two very simple TL -systems of which soundness and completeness are provable relative to a Leibnizian *possible-worlds* semantics as stated by Kripke. But with K_b time acquires a direction so that we can speak of *the arrow of time*, and for this reason alone it seems convenient to give priority to K_b , ahead of K_t . K_b is characterized by a successive loss of possibility. The actualization of only one among an infinity of possible futures means that most of the conceivable futures are successively eliminated. Hence what was possible in the past may now be excluded. But, making use of Prior's concept of statability, we shall claim that this perpetual loss of possibility is compensated by a steady increase in the sum of statable truth. This lends support to the view that *the passage of time* is mind-independent.

We conclude that the sum of statable truth is steadily increasing, due to the fact that assertions which were not statable become statable in the course of time. Being now statable, it is natural to assume that they will remain statable for all future, so that propositions feigning departed individuals to be present are simply false. Granted this, we shall claim that what is true now will necessarily have been true. By contrast it is often uncertain whether what is now statable was always statable, so mostly we cannot know whether what is true now was always going to be true. Our system W thus makes a difference between past and future in the sense that a perpetual loss of possibility is compensated by a successive gain of statable truth. It is in this sense that we are entitled to speak of a *created truth*.

§1. THE URGE FOR TENSES

It may be argued that the verb is the central part of any proposition, i.e., sentence to which a truth-value can be ascribed; but verbs are inflected by tenses. However, the translation of tensed statements into standard logic by means of a timeless copula presents difficulties: "the verbs are absorbed by artificial noun constructs - there is no direct way of handling tensed verbs". (*R&U 2*) Some logicians, e.g. Strawson, have taken these difficulties to be evidence of an inherent limitation of standard logic showing that it is incapable of depicting adequately the statements of ordinary language. (*PFS 150f*) Others, primarily Quine, have held that all statements containing tensed verbs are reducible to tenseless form by means of an extensional translation making use of quantification over 'instants'. (*WVQ 170f & 191f*)

This places us in a situation where we must choose between accepting the inadequacy of our formal translations or assuming the existence of dubious entities. But we are not stuck in this dilemma between bad philology or bad metaphysics. We can defend ourselves against the charge of misrepresenting the inflections of ordinary language without being forced to suppose the real existence of instants. According to McArthur, the value of *tense logic* is that it offers a third possibility by showing a way of escape between these equally unattractive alternatives. (*MA 1*) The point is that we do not have to accept the existence of temporal instants *á priori*: instead we may advocate tense logic as the proper means to construct a chronology which is intuitively plausible and independent of both physics and metaphysics.

The aim and purpose of *TL* is to systematize reasoning with tensed propositions. In order to do so properly we must distinguish between two types of statements:

- 1) *temporally definite statements - i.e. sentences with invariant truth-value*
- 2) *temporally indefinite statements - i.e. sentences with variable truth-value*

Against this distinction it has been objected that statements of the second kind are not proper propositions, but propositional functions which are not fully determined. But that objection can be dismissed as soon as we give attention to their context. Tense logic - or *the logic of change* - becomes relevant when we decide to consider statements in their natural context which is always a context of temporal change. What we call reality, the reality of experience, is evidently a reality in change and, just as reality itself is always a becoming and deceasing, an emerging and expiring, so our language, in order to represent this perpetual change faithfully, must needs reflect it in the successive origin and closure of the truth of its assertions.

The building material of *TL* consists for the major part of temporally indefinite statements, the definite statements being those which are omnitemporal, those which mark an absolute beginning or an absolute ceasing, and those which are unique in the sense that they are true *now*, but neither true in the past nor true in any future. With *TL*, the verb, or copula, can no longer be interpreted as timeless but should be understood as referring to the present: it is *now* the case that so-and-so.

It is usual to speak of *the transparency of the now*: if anything is *now* the case, then it is *now* the case that it is *now* the case, and *vice versa*. Another peculiarity of the *now* is the *elasticity* of its duration which is context-variable: what we call *now* may be the present second or the present century. In order to cope with these problems we shall use *instant-propositions* as our means of dating. (*PPF vi & PTT xi*)

§2. TENSED OR TIMELESS TRUTH

Logic is an instrument, *organon*, for all reasoning and all rational discourse. Its aim or task as an intellectual discipline is to investigate the formal conditions for the transferring of truth-value from some given premisses to a valid conclusion. But *TL*, due to its use of *intensional operators*, cannot be reduced to a pure truth-functional semantics. This fact has occasioned the application to tense logic of the so-called *possible worlds* semantics of Leibniz, as reconstructed by Kripke.

The present paper, however, will accentuate the importance of an axiomatic approach to *TL* as against a semantic approach. The position is that only an axiomatic approach does justice to the dynamic features of time whereas a semantic approach tends to obscure these traits. The latter approach, nevertheless, supplements the former by offering concrete, almost visual, models that enable us to check the syntactic axioms. So the *axiomatics* is fundamental whereas the *semantics* is illuminating.

The reason supporting this standpoint is to be found in the classical opposition, due to McTaggart, between the *A-term analysis*, and the *B-term analysis*, of time. McTaggart ingeniously distinguished the absolutist *A-concepts of past/present/future* from the relationist *B-concepts of before/during/after*. A deep chasm has ever since separated the *A-theorists*, who insist to explain the *B-series* in terms of the *A-series*, from the *B-theorists*, who attempt to interpret the *A-series* in terms of the *B-series*. Today it is a commonplace in logic to distinguish 'tensors' from 'detensors', but it was the founder of formal tense logic who first gave weight to this distinction. According to Prior, all real existence is present, and only present existence is real,

the past being no longer real and the future being not yet real - just as facts are true statements, and statements, if true, are true *now*, i.e. when said or read.

As it is, *A-theorists* or *tensers* (like e.g. Prior) would attempt to reduce talk of instants to tensed propositions, whereas *B-theorists* or *detensers* (like e.g. Quine) would attempt to reduce tenses to predicates of existing instants. A sort of half-way house in between is occupied by neutralists who prefer to treat these two positions on a par. Among the A-theorists we can further distinguish between moderates and radicals: while the former would insist on using modal primitives together with the tenses, the latter would follow Prior in his attempt to define modalities by means of tenses. Taken together, these distinctions give rise to *four grades of tense-logical involvement*. (*PTT xi*). The present paper, extending K_b with Peircean definitions and adapting it to deal with the problems of non-statability, goes full way to the fourth grade.

Given a present fact, what are you able to infer regarding its past and future? It is a fact that you are now studying a paper from the logic meeting at Poel 1995. From this fact you can infer not only that it will always have been the case that you were reading the present paper, but that it will inevitably have been the case. However, you cannot infer that it was always the case that you *would* once read *this* paper, merely that it was always possible that you *might* once read *a* paper. Our logic thus gives direction to *the arrow of time* by separating past from future: what is of the past is no longer possible and what is of the future is not yet realized - but, as possibilities are extinguished, new factual truths are created.

§3. MODALITY OR QUANTIFICATION

Since Leibniz, modality has been explained by reference to *possible worlds*. In line with this account, what is *necessary* is what is true in all possible worlds, what is *possible* is what is true in at least one possible world, and the *actual* world is merely a privileged possible world, viz. that which we ostentatively call 'our own'. Due to Meredith, Prior, and Kripke, this view has attained great precision in our time. In the same way tenses have been interpreted as quantifications over those 'instants' at which tensed propositions are true. Obviously, there is much to be said for a far-reaching *parallellism* between the *extensional systems of quantification theory* and the *intensional systems of tempo-modal logic*. This parallellism has often been marshalled as evidence supporting the view that the intensionalities of tempo-modal logic should be explained by means of extensional quantification. (*WTS 9f*)

However, it is less common to turn the parallels in the opposite direction and present quantification theory, or part of it, as a disguised form of modal logic. Such move is nevertheless possible and, claims Prior, there is much more to be said for it than might at first be imagined. Prima facie, possibility and necessity are rather metaphysical notions, and in an intellectual climate dominated by positivism it is only natural that there should be attempts to explain them away; cf. the famous phrase 'flight from intentions', coined by Quine. But, according to Prior, ordinary predicate logic, or quantification theory, has its own metaphysical presuppositions, in particular the assumption that the world consists of *things* about which this or that can be predicated. Those who would question this might welcome the replacement of quantification theory by the machinery of tempo-modal logic. (*WTS 10f*)

The semantics of possible worlds may now take one of several different forms, but in any case it amounts to a 'tall story', and it is difficult to believe that anybody seriously believes it, despite persuasive claims to the opposite by e.g. D. Lewis (*DL*). Nevertheless, plenty of people apparently put confidence in a similar story about tenses, believing that tensed propositions are nothing but the predicates of existing 'instants'. In contrast to this, C.S. Peirce displayed a persistent habit of treating quantification as a special sort of modality, and quantification over individuals as a special kind of quantification over states of affairs. He further suggested that individual terms are just general terms with a very peculiar feature: "Individuals are either identical or mutually exclusive .. (Of individuals), every predicate may be universally affirmed or denied". But, for Peirce, predicates were nothing but "slightly damaged propositions". (*WTS 40f*) Hence, in his view, the logic of propositions is prior to that of predicates.

At any event we can, said Prior, produce a *modal theory* of possible-world-propositions, a *tense-logical theory* of instant-propositions, or an *egocentric theory* of propositions about persons, of which neither assumes that such propositions must needs satisfy the definition of an individual, whether it be a world, a time, or a mind. (*WTS 42*) Suppose that we equate a mind, an instant, or a world, with some always storable proposition which is true of that mind, at that instant, or in that world, and there only, and suppose that we equate being true of that mind, at that instant, or in that world, with being true as conjoined to their corresponding propositions: mind, time, world. Then we can interpret the theory of *minds/times/worlds* as an extended tense logic, rather than as a special kind of applied standard predicate logic. (*WTS 112*) However, as stressed by Kit Fine, we cannot avoid *quantifying over propositions*; cf. §5.

Prior now offers an alternative to Quine's account of ontological commitment. The entities which we countenance in our ontology do *not* depend, as Quine says that they do, upon which kinds of variables we are prepared to bind by quantifiers; they

depend on which variables we are prepared to take seriously as individual variables in a first-order theory, i.e. as subjects of predicates. If we prefer to handle instant-variables, for example, or person-variables, as subjects of predicates, then we may be assumed to believe in the existence of instants, or of persons. If, by contrast, we treat either of these as propositional variables, i.e. as arguments of truth-functions and of modal functions, then we may be assumed to be sceptical about such metaphysics; Or maybe we think that such metaphysics is better defended by means of modal logic! In any case, using another of Quine's phrases, although in a sense quite opposite to his: "ontological commitment varies inversely with modal involvement". (PTT 142)

Kit Fine describes the philosophical stance of Prior by the following theses: A) *Modalism*: i.e., *only real objects exist*. B) *Actualism*: i.e., *only present objects exist*. (WTS 116) For a modal actualist like Prior, possible objects do not exist, rather, the possible is an openness of the future - not a real thing, but a conceptual mode. The modal actualist wants to eliminate talk of possible worlds and possible objects in favour of the ordinary modal idioms combined with quantification over actuals. A similar remark applies to his tense-logical counterpart. Consider, for instance, "possibly some individual is not actual". For the *possibilist*, this is an existential claim to the effect that some possible individual is not actual; hence there must be some specific individual which is not actual. But for the *actualist*, the singularity is spurious; there is simply no instance in virtue of which the sentence can be true. The proposition states an irreducible general possibility and, no matter how well the individual is described, it can possess no specific identity. (WTS 118)

The language into which one might attempt to reduce tense logic is that of the monadic predicate calculus. In order to effect a translation back into the modal language, Prior suggested that *possible worlds* be treated as 'world-propositions', i.e., propositions which are possible (conceivable) and which necessarily imply all truths. The primary reduction of tempo-modal terms to quantification over virtual worlds, or imaginary instants, may therefore be superseded by a reverse reduction of these entities into a higher-order language containing irreducible modal or temporal idioms. To take us back from this higher order language to the first order language we shall need a third translation (or maybe just an interpretation) in order to close the circle. The process described above of translating back and forth therefore involves us with three different languages and/or the correlated translations. (WTS 119)

Thus we have the simple modal language, the classical language of possible worlds, or individuals, and, finally, another modal language of higher order involving both tempo-modal terms as well as quantification over propositions. Fine, in passing, counts two important aspects of the reverse translation: the first is that a predicate

describing a possible world is translated into a rigid predicate of all propositions, one that necessarily holds or necessarily fails of any given proposition; the second is that the correctness of the reverse translation is dependent on two assumptions about the existence of propositions, namely that world-propositions necessarily exist, though no single world-proposition is in itself necessary, and that for each possible world at least one proposition is true of that world only. (*WTS 120 & 162f*)

§4. THE CONTINGENCY OF EXISTENTS

Quine claims that non-existents cannot figure as values of bound variables. Prior, by contrast, says that this is the *only* way in which non-existents can figure. His position is that we cannot directly refer to what does not exist but is merely imagined to exist, or is merely going to exist; however, we can make quantified, i.e. purely general statements about future or feigned denizens of the world. (*PTT 143*) This point is relevant to the question whether quantification over propositions implies such entities to exist: *if* propositions exist, it is only in a very abstract way.

Prior debates ancient, medieval, and modern, doubts about 'coming to be', 'being brought into being' and 'being prevented from being' (*PPF viii, 2 & 5-7, 12-13*), and he quotes Thomas Aquinas concerning a possible objection to the concept of *creatio ex nihilo* (*De Potentia Dei*, Q3, art.1, obj.17): "The Maker gives being to that which is made. If God makes a thing out of nothing, he gives being to that thing. Hence either there is something that receives being, or there is nothing. If nothing, then nothing receives being by that action, and so nothing is made. If something, .. then God makes a thing from something already existing, and not from nothing."

Russell often said that it is non-sense to attach 'exists' or 'does not exist' to what he calls a logical proper name, what we can do is merely to attach 'exists' or 'does not exist' to a description. This was questioned by Moore and, in Prior's opinion, Moore at this point propounds a view which fits much better than does Russell's own view into Russell's general logical position. What Moore suggested was that 'this exists' and 'this does not exist' need not be senseless but may be so used that, if they are not senseless, the former is necessarily true and the latter is necessarily false (for, if the function of 'this' is merely to indicate the object the sentence is about, then, if no object is indicated, the sentence really says nothing). In addition Prior notes that though Russell rejects 'this exists' as ill-formed, the form 'x is identical to x', as used in the *Principia Mathematica*, has the properties that are ascribed to 'this exists' by Moore, and could be used to define it. (*PPF 149*)

When variables for individual names and their proper predicates are introduced it may be argued that, before and after the individual x exists, there are no such propositions as ϕx , though there may be propositions saying that there has been or will be some individual with exactly the properties of x . This is the view of Moore. Prior, in fact, stresses the same point by saying that, at the time in question, when no individual x is present, the proposition ϕx is '*non-statable*'. This locution is not entirely fortunate since it suggests that the difficulty is just a question of reference. Prior therefore adds that there are no facts to be stated about x if x does not exist. But this is not meant to imply that facts, or propositions, exist as real individuals. So, although we quantify over propositions, their *esse* is solely *in intellectu*.

Formally, this line of argument makes it implausible to identify 'hitherto p ' with 'not past not p ', and 'henceforth p ' with 'not future not p '. Hence the classical rule of double negation seems suspended when the past or the future is concerned. Although we have 'if α is thesis, then not past not α is thesis' and 'if α is thesis, then not future not α is thesis', we neither have 'if α is thesis, then α was always a thesis', nor do we have 'if α is thesis, then α will always be a thesis', since these presuppose the unconditional past and future statability of α , which is problematic. (*PTT 147*)

In order to provide a solution to these problems Prior devised the system \mathcal{Q} . \mathcal{Q} is an actualist modal logic. What distinguishes it from other logics is its account of sentences containing names for individuals which do not exist in a given world. Such sentences are said to be undefined, or truth-valueless. This *gap convention* (K. Fine) can be broken down into two parts: (*a*) that atomic sentences are undefined in case of empty reference, and (*b*) that gaps are preserved under logical operations. It would be possible to accept the first part of the convention but not the second, e.g. by treating the gaps by the method of supervaluations or some other method. However, such an approach would evidently go against the intentions of Prior who viewed an empty name in any sentence, whether atomic or not, as a source of gaps. When reference is feigned, the sentence says nothing; it is just gibberish and lacks that identity which is the precondition of its being statable. (*WTS 148*)

If we use no individual name-variables at all, bound or free, and no device for direct reference to individuals, we only need standard modal, or tense, logic and a simple quantification theory. This procedure forces us to distinguish operators which form complex predicates from operators which form complex propositions. For instance, let A and B stand not for proper names, but for common names; then it is easy to see that the proposition 'for some A it will be that the A is a B ' is equivalent to the proposition 'it will be that, for some A , the A is a B '; cf. Barcan. But neither of these is equivalent to 'for some A the A is a thing that will be a B '.

Neglecting quantifiers, 'it will be that the *A* is a *B*' is still not equivalent to 'the *A* is a thing that will be a *B*', for the latter implies, what the former does not, that what will be a *B* now exists, since only what exists can properly be 'the *A*'. More exactly, the form 'the *A* is a *B*', whatever *B* might be, implies 'the *A* exists', i.e. 'the *A* is an object', or 'there is such a thing as the *A*' - but the form 'it will be that the *A* is a *B*' implies only that 'it will be that there is such a thing as the *A*'. Further, 'it will be that the *A* is a *B*' implies that 'what will be a *B* will be the *A* when it is a *B*', whereas 'the *A* is a thing that will be a *B*' does not imply this, because it may have ceased to be the *A* by the time it is a *B*. (*PPF 162f*)

There are many different solutions to the problem of non-permanent existents. We may omit individual names, using only the general names *A*, *B*, *C* and an undefined form ϵAB , to be read: 'the only thing ever to be an *A* is a *B*'. With such a name-logic, K_t appears reasonable. This led Prior to combine *Q* & K_t into QK_t . (*PTT 160*)

§5. INDIVIDUALS AND THEIR IDENTITY

Some of the things Leibniz said suggest that he thought of a *monad* as the conjunction of all the propositions that would ordinarily be said to be true of it. Wittgenstein in a famous phrase defined *the world* as: everything that is the case. In a similar vein C.A. Meredith claimed the only genuine individuals to be worlds, i.e. propositions expressing total world-states. A radical positivist would probably maintain that not only are instants not genuine individuals, but in fact there are no genuine individuals. The explanation of the apparent existence of individuals would then be that certain propositions can be treated as if they were individuals. Prior, however, favours the more moderate stance that *persons* at least are genuine individuals, whereas he does not accept *instants* or *worlds* as genuine. (*PTT 141-2*)

As regards *personal identity*, Prior has some interesting comments to a little puzzle of N.L. Wilson: "What would the world be like if Julius Caesar had all the properties of Mark Antony, and Mark Antony all the properties of Julius Caesar?" (*PTT 66f*) Wilson somewhat rashly claims that "our attempt to describe a distinct possible world has produced just the same old world over again". Prior disagrees, as he is not convinced - since nobody perceives everything - that even a world which looked to everyone exactly as the actual one does would necessarily be the same. Wilson then goes on to consider a particularly perverse person who maintains that what has just been supposed is in fact the case; with regard to this queer person Wilson opines that he is not guilty of factual error, but is just using the words

'Caesar' and 'Antony' with the sense we usually attach to 'Antony' and 'Caesar', resp. As Wilson includes 'being *called* Julius Caesar' and 'being *called* Mark Antony', respectively, among the properties supposed to be interchanged, he is clearly right; it is indeed absurd to say: "It isn't the person we call Julius Caesar that is called Julius Caesar, but he is rather a different person called Mark Antony".

Prior nevertheless sustained a doubt concerning the supposed interchange. There is, e.g., at least one property of Antony's which it makes no sense to suppose to be interchanged with the corresponding property of Caesar's, viz. the property of being Antony; thus "properties which entail *being* Caesar or entail *being* Antony are obviously to be exempted from the exchange if it is to be an exchange at all". But, as Wilson himself suggests, one way in which his question may be put is by asking whether there is a possible world, distinct from the actual one, in which Caesar has all of Antony's properties. Clearly, any such world would contain both Antony and Caesar, but it seems difficult to believe that a merely possible world can contain individuals which are identifiable as 'our' Caesar and 'our' Antony. Prior's stance is that *persons are genuine individuals*, and it is because Caesar is not just a collection of properties that we cannot separate his identity from himself in order to attach it to a merely imaginary person in a merely imaginary world.

In this connexion Prior hints at a new way of speaking of 'possible worlds'. We can say that a 'possible world' is (1) one of the many possible future outcomes of the present world-state, or (2) one of the many possible future outcomes of some past world-state - or (3) some possible future course of events in sense (1) or (2) together with its past, so that a possible world in sense (3) is a total world-course, comprising the past as its common history and the future as its specific program. Such a world is, at least partially, a linear string branching off towards the future. Hence, if we wipe out enough of the actual past world-course of events we would presumably reach a remote state of affairs of which any imaginable world would be a possible outcome - at least this would be the case if going back far enough takes us back to the creative act of God (granted that this act belongs to the proper past).

There may have been a world in which Julius Caesar was called 'Antony', since possible sequels to part of his life include, e.g., adoption by Antony's family. Can we go further yet and suppose Caesar to have had the whole of Antony's life? Here Prior remarks that it is always a useful exercise to ask: When was it possible? Thus, if Caesar could have had different parent: When could he have had them? Indeed, after his conception it was too late for him to have had different parents. Could he have had them before? Do the possible worlds in which Caesar exists include different sequels to what happened before he existed? The problem is that

before Caesar existed there would seem to be no individual identifiable as Caesar, i.e., *that* Caesar who is known by all of us and whom we are presently discussing. At least in this context it seems as if Prior is prepared to give up his previously stated view in favour of treating past statability as different from future.

It has been suggested by A.J. Kenny, that the naming of past individuals is easier than the naming of future ones, because of the indeterminacy of the future. For this reason persons who exist, or who did once exist, seem to be individually identifiable in a way in which unborn beings not yet in existence are certainly not. The only case in which there can be facts about future individuals, just as there are facts about past ones, is that of a perfect determinism where we can legitimately speak of an absolute determination of the future reaching down to tiniest details. Solely on that condition could the future of an individual be as determined as its past. But is such a determinism plausible? Only to hard-boiled believers. (*PPF 171f*)

To the present author it seems that individuals behave differently relative to past and future, and I feel that this asymmetry should be built into our logic. At this point I agree with Fine who assumes the domain of identifiable individuals to be steadily increasing. (*WTS 153f*) Therefore, although I accept the arguments of Prior for a limited statability of propositions concerning the past, I shall deviate from him by postulating the full future statability of all now statable propositions. In accordance with this position I shall not treat the proposition '*Sortes currit*' as being non-statable, rather I shall evaluate it as being false forever, i.e. in all future, its falsity being implied by the truth of the assertion '*Sortes mortuus est*'.

A possible objection to the unavoidable statability of all known propositions would stress the fact that not only particular nouns or verbs, but whole languages, sometimes run into oblivion - were not the forgotten utterances on tablets written in cuneiform or in linear-B at least temporarily 'unstable' until they were translated? This objection, however, goes astray by ignoring the difference between issues of *epistemology* and issues of *metaphysics*; the principle *once stable forever stable* does not specify a condition of knowing, but a condition of having truth-value.

To conclude, it seems as if Prior were willing to accept this saying of Berkeley: *Nothing properly but persons i.e. conscious things do exist, all other things are not so much existences as manners of the existence of persons.* (*Commonplace Book 24*) If so, he would be in line with the basic existential creed of Søren Kierkegaard.

§6. PRIOR ON LEIBNIZIAN EGOCENTRIC

Mogens True Wegener

For Leibniz, self-knowledge was the starting-point of his notion of reality: "Since I conceive that other beings have also the right to say 'I', or it may be said for them, it is by this means that I conceive what is called substance in general." Concerning truth he said: "In consulting the notion I have of every true proposition I find that every predicate, whether necessary or contingent, past, present, or future, is already comprised in the notion of the subject." For this reason the *ego*, as a subject, is identical to the conjunction of its predicates in a compound *egocentric* proposition. A subject *is* reality, or the world, as perceived in a certain perspective. (WTS 38)

In accordance with his *pre-established harmony*, the real world as a whole may be identified with the sum total of the multitude of egocentric perspectives. Although the world is described differently by different observers using their own egocentric languages, their various descriptions have to be correlated in the sense that how it is described by one observer is consistent with how it is described by any other. The Leibnizian idea of the pre-established harmony is mirrored in his metaphysical idea of the *compossibility* of substances and reflected in the logical principle of the *maximal consistency* of a possible world so distinctive of Kripke semantics.

Leibniz foresaw no place for genuine relations among individuals. (WTS 39) In *egocentric (E)*, two-place predicates as 'is less perfect than' vanish into modalizings of propositions, with the modalizing of a proposition in one individual requiring an appropriate corresponding modalizing in another individual. In *E*, individuals must not be mentioned, but all statements in *E* are understood as directly or indirectly relating to the tempo-spatial perspective of the speaker. *E* contains no devices for referring to other individual perspectives than that of the speaker. But can *E* be so enlarged as to contain such devices without losing its egocentric character?

Non-egocentric modes of individual reference can be constructed on these Leibnizian principles: (i) individuals form a linear series in the order of their perfection (ii) each individual has something that is true only of him in case that he is the speaker. Philosophically, the most interesting proposition that is true of a given individual is the conjunction of all truths related to him; but to the present purpose any proposition which is true of him only, i.e., any proposition true only when he says it, will do. In *E*, anyone can say: "I am the true proposition, and all other are false". (WTS 34)

Prior could see no reason why there should not be a perfect subject or monad, i.e. one than which none is more perfect; cf. the famous "ontological" argument usually ascribed to St. Anselm, although in this form it should rather be ascribed to Descartes. An egocentric logic which refers to God, the perfect monad, would contain this law: 'For any proposition *p*, either not-inferior-to-*p*, if I am the perfect monad, or inferior-to-not-inferior-to-*p*, if someone superior to me is the perfect monad'. (WTS 39)

E is thus a consistent *private language* admitting of effective communication. That a consistent egocentric logic can be construed, in spite of Wittgenstein, suggests that idealism may be a more defensible philosophy than is usually believed. (WTS 40) Much in the philosophy of Leibniz assumes a new significance if we regard him as a thinker who might have regarded *E* as being basic to his metaphysics.

§7. THE DEFINITION OF WORLD-STATES

Prior defined a 'world-proposition' as one which is necessarily maximal: being contingent, it implies any proposition or its negation. He notices that C.A. Meredith proposed three axioms to characterize *the world*: 1. n ; 2. $Ln \Rightarrow p$; 3. $p \Rightarrow L(n \Rightarrow p)$ Instead of the constant ' n ', R. Suszko suggested a primitive operator, ' W '. (PPF 78)

In the same vein Prior interpreted an 'instant-proposition' according to tense logic as the conjunction of everything that could be said to be true at that instant or, alternatively, as something specific that could be said to be true at that instant only. We could then define 'being true at an instant' as being omnitemporally implied by that instant when understood as a proposition. Further, an instant's 'being earlier' than another instant would be definable as the pastness of the former being co-present to the latter, i.e., as the latter omnitemporally implying the pastness of the former. The 'being later' of some instant relative to another could be defined analogously. In this way it would become possible for us to treat the theory of the quasi-relation of earlier-later as a part of tense logic, rather than vice versa. (PTT 138)

To perform the reduction, we dispose of some simple devices if the series of instants is linear and if each instant has something true at that instant only. Prior adopted these two assumptions in order to state some illuminating examples: (1) 'That p , is the case at the present only' = (2) '(It is the case that) p , but it has not been the case that p and will not be the case that p '. In a similar vein we have: (3) 'That p , is the case at one instant only' = (4) 'At some time (p , and it has not been the case that p , and it will not be the case that p)' = (5) 'At some time (2)' = (6) 'Either (2), or it has been the case that (2), or it will be the case that (2)'. We might then say that an 'instant' is a proposition of which (6) is true. (WTS 32f)

Directly coupled to tense logical priority is the stance that time is absolute. Now time can be absolute in two ways: (1) it may be absolute in the sense that a universal simultaneity is definable independently of any particular reference frame, or (2) it may be absolute in the sense that we can speak of simultaneous events belonging to different possible worlds. For the tense-logical theorist the present has

objective significance, and an absolute cross-world simultaneity can be introduced by supposing that the same 'now' is co-present in all possible worlds. (*WTS 158f*)

Fine claims that, once a logician has combined modality with tenses, he is almost committed to the view that time is absolute in the second sense at least. (*WTS 160*) We assent to this. However, it is not easy to see how simultaneity can be absolute in the second sense above without being absolute in the first sense too. This reflects on so-called *Special Relativity* where simultaneity is related to frames. I agree with Prior that: "We may say that the theory of relativity isn't about real space and time .. The time which enters into the so-called space-time of relativity theory is just part of an artificial frame-work which scientists have constructed to link together observed facts in the simplest way possible". (*Ø&H 201; cf. ICT, MW*)

§8. TENSE, MODALITY & DETERMINISM

It is a fact that we live in *an orderly world* apparently governed by eternal *laws* of universal scope that prescribe the *future* to be determined by the *present* in the same manner as the *present* has just now become determined by the *past*. Indeed, it is difficult to see how the world could be orderly at all if it were not ruled by laws ensuring that our notions of *cause* and *effect* are applied legitimately. Is there a place for *chance* in such world or for the *freedom* of creative spontaneity?

Presumably no one would claim that the world is devoid of determination, so the differences of opinion mainly concern the degree of lawlike determination. Thus a *determinist* would claim that the future is totally or absolutely determined by reasons or causes already hidden in the present whereas, by contradistinction, an *indeterminist* would insist that the predetermination of the future is never complete. This discloses a conspicuous difference concerning the pretensions of the two positions. The onus of proof is infinitely heavier for determinism than it is for indeterminism.

A philosopher who does not believe in fate, destiny, or determinism, should be prepared to defend the view that at least some future truth is now contingent. The problem is how this view should be construed in order to be easiest defensible. Lucas, who has criticized Prior for ignoring the implicit reference to dates of tensed statements (*JRL 98*) - an objection which cannot be raised against the system *W* - speaks of the 'defeasible' ascription of 'indefectible' truth to future events (*JRL 71*). This description, in our opinion, applies strikingly to the view of Peirce; but Lucas, regrettably, seems to ignore the important work of Peirce. [In spite of this remark Lucas later generously referred to this paper (1st ed.) with appreciation. (*ACT 14*)]

Peirce, as we know from quotations, accepted three so-called 'modes of being', viz.: 1) *accomplished fact*, 2) *future possibility* and 3) *future necessity*. (*Ø&H 137*) In this way "that which characterizes .. an assertion of possibility is its emancipation from the principle of contradiction, while it remains subject to the principle of the excluded third", just as "that which characterizes .. an assertion of necessity is that it remains subject to the principle of contradiction, but throws off the yoke of excluded third", whereas "what characterizes and defines an assertion of actuality or simple existence is that it acknowledges allegiance to both formulae" (*Ø&H 144*).

To the Ockhamist, Peircean tense-logic must appear incomplete; it is simply a fragment of his own system wherein contingently true predictions are not stable because, to Peirce, casual predictions of future contingents should be treated as false. However, to the Peircean, Ockhamist tense-logic treats what is still future in a way in which only what has been future should be treated. It is difficult to define a modality within Peircean tense-logic that makes all of the past, as well as some of the future, inevitable, but not predestined. (*PPF 130-2*) With **W**, this problem should be solved.

Following Kierkegaard we shall identify possibility with indeterminate futurity, thereby accepting 'the arrow of time' from the outset and, giving up the traditional definition of the necessary as that which is not possibly not the case, we shall keep possibility and necessity strictly apart, interpreting the latter as being omnitemporal. Let us now define what is inevitable as that which is not possibly not the case and what is conceivable as that which is not necessarily not the case. Then the necessary entails the inevitable, just as the possible entails the conceivable. This seems reasonable.

Translating all this into modern terms by combining system **K_b** as our logic of possibility with system **S5** as our logic of necessity, we get a very expressive logic. Accepting only minds and their worlds as ultimate referents, and covering their states with abstract dates in terms of unrepeatable 'instants', we obtain the system **W**.

§9. PROVIDENCE & FREEDOM OF WILL

Let us now consider the theological implications of the philosophical ideas behind our new system of tempo-modal logic. According to the Christian tradition, God is all-mighty, all-knowing and all-merciful. The exact logical relations between these properties of the divine trinity has always been of special import to theology. Intellectual opponents of religion construe the properties as being mutually inconsistent while intellectual believers in God naturally take the divine nature to be coherent, their only alternative being to scorn logic by admitting a creed in absurdity.

Christianity teaches us that the power of God manifests itself in the act of creation whereby something, viz. the temporal world, is called forth out of nothing; further, that the wisdom and mercy of God's providence manifests itself in creating man as an *imago dei* with freedom of will, foreseeing the fall and our ensuing evil deeds as well as his own divine decision to save us by sending his son and spirit. So far, there is no contradiction in this tale - but contradiction lurks if providence is construed as foreknowledge of the now unpreventable truth of all future events.

Even if we ignore the unstability of assertions relating to future individuals, it is difficult to reconcile our intuitive notion of freedom as unpredictable spontaneity with the assumption that the truth-value of any statement of future contingents is known from eternity, by God, at this very instant. In the words of Peirce (*Ø&H 139*): "They suppose that a man is perfectly free to do or not to do some given act, and yet that God already knows whether he will or will not do it. This seems to most persons flatly self-contradictory, and so it is if we conceive God's knowledge to be among the things which exist at the present time. But it is a degraded conception to conceive God as subject to time which is rather one of his creatures."

When we consider the semantical difficulties produced by the fact that some truths which have now become statable in the course of time were previously not statable, it seems as if the problem of God's providence has been wrongly posed. Might God have his own private language, incommunicable to us not only in fact but in principle, a secret language in which everything is written down *ab aeterno*? The idea is logically possible, but to the present author it seems to spurn reason.

Why should God's work of creation be predestined to repeat the eternal truth? Should God really be unable to create anything freely without a preconceived plan? Ockham, who believed truth to be immutable and known of eternity by God, although the divine way of knowing truth is inscrutable to us, never addressed this question. But, by nature, God must be a brilliant mathematician. Could we not think of him as an infallible intelligence calculating everything in advance, as suggested by Leibniz? God does not need a brain, of course; but if he decided to make use of one, how large would it have to be? One much less than the universe itself would hardly do the job!

Instead of continuing these vain speculations we shall follow Kierkegaard by taking the exact relationship between creation and creator, time and eternity, to be an absolute paradox: what transcends time and world defies all rational understanding. According to the Danish religious poet Grundtvig, *creation is a divine experiment*. Seen thus, God doesn't know future contingents because he has chosen not to do so. The reason why God created a world whose future is only predictable in general terms might well be that he wanted to convey spontaneity and freedom of will to man.

§10. AXIOMATICS FOR THE SYSTEM \mathcal{W}

PRELIMINARIES

1. All atomic propositions π are well formed formulae, wff.
2. The set \mathcal{W} of atomic propositions contains an unique constant ω called 'the world', together with a subset of abstract propositions τ termed 'instants', 'times' or 'dates'.
3. All instant-propositions τ are different and distinguishable by their indices: $\tau_i \neq \tau_k$.
4. In a certain way the constant ω may serve to characterize successive 'nows', cf. below.
5. If α and β are wff, then $\neg\alpha$, $\alpha \Rightarrow$ even β , $N\alpha$, $H\alpha$, are all wff.
6. For ' $\neg\alpha$ ' read: 'not α ' or 'it is not the case that α '
 For ' $\alpha \Rightarrow \beta$ ' read: 'if α (is the case), then β (is the case)'
 For ' $N\alpha$ ' read: 'henceforth α ' or ' α will always obtain'
 For ' $H\alpha$ ' read: 'hitherto α ' or ' α did always obtain'
7. All the formulas above with all their combinations, and no other, are wff.

DEFINITIONS & RULES

- df \vee $\alpha \vee \beta \equiv \neg\alpha \Rightarrow \beta$ read: '(either) α or β ' \equiv 'if not α , then β '
 df \wedge $\alpha \wedge \beta \equiv \neg(\alpha \Rightarrow \neg\beta)$ read: '(both) α and β ' \equiv 'not: if α , then not β '
 df \Leftrightarrow $(\alpha \Leftrightarrow \beta) \equiv ((\alpha \Rightarrow \beta) \wedge (\beta \Rightarrow \alpha))$ ' α iff β ' \equiv 'if α then β , and if β then α '
 df P $P\alpha \equiv \neg H\neg\alpha$ read: 'past α ' \equiv 'not hitherto not α '
 df M $M\alpha \equiv \neg N\neg\alpha$ read: 'maybe α ' \equiv 'not henceforth not α '
 df L $L\alpha \equiv HN\alpha$ read: 'forever α ' \equiv ' α in all past future' \equiv 'necessarily α '
 df K $K\alpha \equiv \neg L\neg\alpha \equiv PM\alpha$ read: 'once α ' \equiv 'conceivably α ' \equiv 'not necessarily not α '
 df T_{τ_i} $T_{\tau_i}\alpha \equiv (\tau_i \wedge \alpha)$ read: ' α is true at τ_i ' \equiv ' α obtains at τ_i ' \equiv ' α at τ_i '
 df P_{τ_i} $P_{\tau_i}\alpha \equiv P(\tau_i \wedge \alpha)$ read: ' α was true at τ_i ' \equiv ' α did obtain at τ_i ' \equiv 'past α at τ_i '
 df M_{τ_i} $M_{\tau_i}\alpha \equiv M(\tau_i \wedge \alpha)$ read: 'possibly α at τ_i ' \equiv ' α may obtain at τ_i ' \equiv 'maybe α at τ_i '
 df K_{τ_i} $K_{\tau_i}\alpha \equiv K(\tau_i \wedge \alpha)$ read: 'conceivably α at τ_i ' \equiv ' α might obtain at τ_i '
 df F_{τ_i} $F_{\tau_i}\alpha \equiv \{M_{\tau_i} \wedge N(\tau_i \Rightarrow \alpha)\}$ ("the now unpreventable future")
 read: 'inevitably α at τ_i ' \equiv 'maybe τ_i and henceforth, if τ_i then α '
 df D_{τ_i} $D_{\tau_i}\alpha \equiv \{K_{\tau_i} \wedge L(\tau_i \Rightarrow \alpha)\}$ ("the forever predestined future")
 read: 'necessarily α at τ_i ' \equiv 'once τ_i and necessarily, if τ_i then α '
 df $<$ $\tau_i < \tau_k \equiv L(\tau_i \Rightarrow M\tau_k)$
 read: ' τ_i before τ_k ' \equiv 'necessarily, if τ_i then $M\tau_k$ '
 RN $\vdash \alpha \rightarrow \vdash N\alpha$ if α is a thesis then $N\alpha$ is also a thesis
 RH $\vdash \alpha \rightarrow \vdash H\alpha$ if α is a thesis then $H\alpha$ is also a thesis
 provided that $\vdash H(\pi \Rightarrow \pi)$ for all π in α (all π were always statable)
 MP $\vdash \alpha \ \& \ \vdash (\alpha \Rightarrow \beta) \rightarrow \vdash \beta$ if α and $(\alpha \Rightarrow \beta)$ are theses, then β is a thesis
 RS rule of substitution the general rule allowing the substitution of equivalents
 proviso instant-propositions, being unique, are not replaceable

AXIOMS FOR PC (The Propositional Calculus - Łukasiewicz)

- P1 $(\neg\alpha \Rightarrow \alpha) \Rightarrow \alpha$ read: 'if, if not α then α , then α '
 P2 $\alpha \Rightarrow (\neg\alpha \Rightarrow \beta)$ read: 'if α , then: if not α , then β '
 P3 $(\alpha \Rightarrow \beta) \Rightarrow \{(\beta \Rightarrow \gamma) \Rightarrow (\alpha \Rightarrow \gamma)\}$ 'if, if α then β , then: if, if β then γ , then, if α then γ '

AXIOMS FOR THE SYSTEM K_b (Future Branching Possibility - Kripke, Prior)

- A1 $\alpha \Rightarrow NP\alpha$ [A1 entails $MH\alpha \Rightarrow \alpha$]
read: 'if α , then inevitably past α '
- A2 $\alpha \Rightarrow HM\alpha$ if $\vdash H(\pi \Rightarrow \pi)$ for all π in α [A2 entails $PN\alpha \Rightarrow \alpha$ with proviso]
read: 'if α , then hitherto maybe α , granted that all π in α were always statable'
- A3 $H(\alpha \Rightarrow \beta) \Rightarrow (H\alpha \Rightarrow H\beta)$ [A3 claims distributivity of H]
read: 'if hitherto: if α then β , then: if hitherto α then hitherto β '
- A4 $N(\alpha \Rightarrow \beta) \Rightarrow (N\alpha \Rightarrow N\beta)$ [A4 claims distributivity of N]
read: 'if henceforth: if α then β , then: if henceforth α then henceforth β '
- A5 $MP\alpha \Rightarrow (\alpha \vee M\alpha \vee P\alpha)$ [A5 entails linearity of the past]
read: 'iff maybe past α , then α or maybe α or past α '
- A6 $N\alpha \Leftrightarrow NN\alpha$ [A6 entails transitivity and density of N]
read: 'iff henceforth α , then henceforth henceforth α '
- A7 $H\alpha \Leftrightarrow HH\alpha$ [A7 would be provable with unconditioned RH]
read: 'iff hitherto α , then hitherto hitherto α '
- A8 $N\alpha \Rightarrow M\alpha$ [A8 claims that inevitability implies possibility]
read: 'if henceforth always α , then maybe α '

AXIOMS FOR THE SYSTEM $S5$ (Omni-Temporal Necessity - Leibniz, Lewis)

- L1 $L\alpha \Rightarrow \alpha$ [In \mathcal{W} , L1 is derivable from dfL , $PC1-3$, A2, A6]
read: 'if forever α , then α '
- L2 $L(\alpha \Rightarrow \beta) \Rightarrow (L\alpha \Rightarrow L\beta)$ [In \mathcal{W} , L2 is derivable from dfL , $PC1-3$, A3, A4]
read: 'if forever: α implies β , then forever α implies forever β '
- L3 $KL\alpha \Rightarrow L\alpha$ [L3 is the basic characteristic of system $S5$]
read: 'if it only might be that forever α , then forever α '

AXIOMS FOR TEMPORAL INSTANTS (Dates - Wegener)

- T1 $\tau_i \Rightarrow \neg M\tau_i$ 'instant-propositions are unrepeatable'
T2 $K\tau_i \Rightarrow (\tau_i \vee M\tau_i \vee P\tau_i)$ 'the order of instant-propositions is linear'
Cor $K\tau_i \Rightarrow L(\tau_i \vee M\tau_i \vee P\tau_i)$ 'instant-propositions are necessarily statable'

AXIOMS FOR UNIVERSAL TRUTH (The Present - Meredith)

- N1 ω 'the world is present'
N2 $L\omega \Rightarrow \alpha$ 'the world is contingent'
N3 $\alpha \Rightarrow L(\omega \Rightarrow \alpha)$ 'the world is universal truth', or
'the world necessarily comprises everything true just now'

*Oh source of grace who granted me the courage
to look so steadfast on thy blaze eternal
that all my power of vision was exhausted!
Within thy depths I clearly saw collected
all leaves that in the universe are scattered
bound up with love as in a single volume!*

Dante Alighieri: *The Divine Comedy*, canto xxxiii 82f.

§11. SEMANTICS OF THE SYSTEM \mathcal{W}

Our system \mathcal{W} is expressible in an ever growing language $L_{\mathcal{W}}$ consisting of a dense, partially ordered, backwards linear set \mathcal{W} of individual states σ , an ordering relation $<$ and, for any $\sigma \in \mathcal{W}$, two sets of propositional atoms: \mathcal{S}_{σ} (those statable at σ) and \mathcal{T}_{σ} (those true at σ).

\mathcal{I} is a totally ordered set of always statable temporal instants τ covering all conceivable individual states. Instant-propositions are abstract and differ from state-propositions by being statable over all conceivable individual states. State-propositions are concrete and differ from ordinary propositions, simple as well as complex, by being maximal, i.e. no further proposition can be added to them, or conjoined with them, on pain of inconsistency. Future possibilities differ in that different possible states are correlated, or conjoined, to the same future instants.

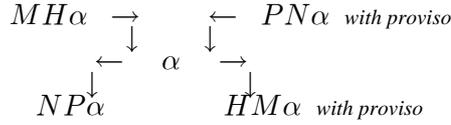
1.
 - a) For all $\tau, \tau' \in \mathcal{I}$ (subset of \mathcal{W}) we have: $\tau < \tau'$ or $\tau' < \tau$ or $\tau = \tau'$.
 - b) For all $\sigma, \sigma', \sigma'' \in \mathcal{W}$, if $\sigma < \sigma'$, there is some σ'' so that $\sigma < \sigma'' < \sigma'$.
 - c) For all $\sigma, \sigma', \sigma'' \in \mathcal{W}$, if $\sigma' < \sigma$ and $\sigma'' < \sigma$, then $\sigma' < \sigma''$ or $\sigma'' < \sigma'$ or $\sigma' = \sigma''$.
 - d) For all $\sigma, \sigma', \sigma'' \in \mathcal{W}$, if $\sigma < \sigma'$ and $\sigma' < \sigma''$, then $\sigma < \sigma''$.
2. In $L_{\mathcal{W}}$, at any $\sigma \in \mathcal{W}$, \mathcal{S}_{σ} (subset of \mathcal{W}) is the set of all statable atoms π , and \mathcal{T}_{σ} (subset of \mathcal{S}_{σ}) is the set of all atoms π stating definite truths (facts).
 - a) Any given world-state σ is true in or at itself: $\sigma \in \mathcal{T}_{\sigma} \subset \mathcal{S}_{\sigma} \subseteq \mathcal{W}$.
 - b) A wff α was statable, $S\alpha$, at a past world-state σ - i.e., $\alpha \in \mathcal{S}_{\sigma}$ - iff, for all π in α , either π or not- π was true at σ , i.e., $\pi \in \mathcal{T}_{\sigma}$ or not- $\pi \in \mathcal{T}_{\sigma}$.
 - c) For any $\sigma \in \mathcal{W}$, and for any wff $\alpha \in \mathcal{S}_{\sigma}$, we define $\mathcal{V}(\sigma, \alpha)$ such that $\mathcal{V}(\sigma, \alpha)$ takes the value 1 (true) or the value 0 (false), but not both; if a π in α was not statable at σ , $\mathcal{V}(\sigma, \alpha)$ was not defined (had a gap).
 - d) Whenever a wff α has become statable it will be statable forever after, i.e., if $\sigma < \sigma'$, then $\mathcal{V}(\sigma, S\alpha) = 1$ entails $\mathcal{V}(\sigma', S\alpha) = 1$ for all $\sigma' \in \mathcal{S}_{\sigma}$.
 - e) Whenever σ is restricted to a linear (totally ordered) subset $\mathcal{L} \subset \mathcal{W}$ (a world-course), the bijection $\zeta(\sigma)$ yields a mapping of \mathcal{L} onto $\mathcal{I} \subset \mathcal{S}_{\sigma}$.
3. The \mathcal{V} -functions of $\pi, \neg\alpha, \alpha \Rightarrow \beta, S\alpha, N\alpha, H\alpha, L\alpha, K\alpha, M\alpha, P\alpha, W\alpha, \tau, \Pi\tau: \phi(\tau)$:
 - a) $\mathcal{V}(\sigma, \pi) = 1$ iff $\pi \in \mathcal{T}_{\sigma} \subset \mathcal{S}_{\sigma} \subseteq \mathcal{W}$
for: π read: ' π is true (at σ)'
 - b) $\mathcal{V}(\sigma, \neg\alpha) = 1$ iff $\pi \in \mathcal{S}_{\sigma}$ for all π in α , and $\alpha \notin \mathcal{T}_{\sigma}$
for: $\neg\alpha$ read: ' α is false (at σ)' or ' $\neg\alpha$ is true (at σ)'
 - c) $\mathcal{V}(\sigma, \alpha \Rightarrow \beta) = 1$ iff $\mathcal{V}(\sigma, \beta) = 1$, or $\mathcal{V}(\sigma, \neg\alpha) = 1$, or both
for: $\alpha \Rightarrow \beta$ read: ' α then β (at σ)' or ' α implies β (at σ)'
 - d) $\mathcal{V}(\sigma, L\alpha) = 1$ iff $\mathcal{V}(\sigma, S\alpha) = 1$ & $\mathcal{V}(\sigma', \alpha) = 1$ for all $\sigma' \in \mathcal{W}$
for: $L\alpha$ read: ' α forever' or ' α necessarily'
 - e) $\mathcal{V}(\sigma, N\alpha) = 1$ iff $\mathcal{V}(\sigma, S\alpha) = 1$ & $\mathcal{V}(\sigma', \alpha) = 1$ for all $\sigma' \in \mathcal{S}_{\sigma}$ where $\sigma < \sigma'$
for: $N\alpha$ read: ' α henceforth' or ' α in the future always'
 - f) $\mathcal{V}(\sigma, H\alpha) = 1$ iff $\mathcal{V}(\sigma, S\alpha) = 1$ & $\mathcal{V}(\sigma', \alpha) = 1$ for all $\sigma' \in \mathcal{S}_{\sigma}$ where $\sigma' < \sigma$
for: $H\alpha$ read: ' α hitherto' or ' α in the past always'
 - g) $\mathcal{V}(\sigma, K\alpha) = 1$ iff $\mathcal{V}(\sigma, S\alpha) = 1$ & $\mathcal{V}(\sigma', \alpha) = 1$ for some $\sigma' \in \mathcal{S}_{\sigma}$
for: $K\alpha$ read: ' α might occur' or ' α conceivably'
 - h) $\mathcal{V}(\sigma, M\alpha) = 1$ iff $\mathcal{V}(\sigma, S\alpha) = 1$ & $\mathcal{V}(\sigma', \alpha) = 1$ for some $\sigma' \in \mathcal{S}_{\sigma}$ where $\sigma < \sigma'$
for: $M\alpha$ read: ' α may occur' or ' α possibly'

- i) $\mathcal{V}(\sigma, P\alpha) = 1$ iff $\mathcal{V}(\sigma, S\alpha) = 1$ & $\mathcal{V}(\sigma', \alpha) = 1$ for some $\sigma' \in \mathcal{S}_\sigma$ where $\sigma' < \sigma$
for: $P\alpha$ read: ' α did occur' or 'past α '
- j) $\mathcal{V}(\sigma, W\alpha) = 1$ iff $\mathcal{V}(\sigma, \alpha) = 1$ & $\mathcal{V}(\sigma', \alpha) \neq 1$ for all $\sigma' \in \mathcal{S}_\sigma$ where $\sigma' \neq \sigma$
for: $W\alpha$ read: ' α is an individual (a mind, a world)'
- k) $\mathcal{V}(\sigma, \tau) = 1$ iff $\sigma \in \mathcal{L}, \tau \in \mathcal{I}$ & $\mathcal{V}(\sigma, \zeta(\sigma) \Rightarrow \tau) = \mathcal{V}(\sigma, \tau \Rightarrow \zeta(\sigma)) = 1$
for: τ (at σ) read: 'world-state σ is realized at the instant τ '
- l) $\mathcal{V}(\sigma, \Sigma\tau: \phi(\tau)) = 1$ iff $\mathcal{V}(\sigma, \phi(\tau)) = 1$ obtains at some $\tau \in \mathcal{I}$
for: $\Sigma\tau: \phi(\tau)$ read: 'some τ phi-es'
- m) $\mathcal{V}(\sigma, \Pi\tau: \phi(\tau)) = 1$ iff $\mathcal{V}(\sigma, \phi(\tau)) = 1$ obtains at all $\tau \in \mathcal{I}$
for: $\Pi\tau: \phi(\tau)$ read: 'all τ phi-es'

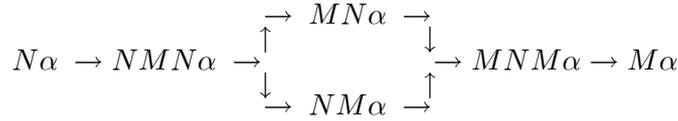
In $\mathbf{L}\mathcal{W}$, some given storable wff α is called valid iff $\mathcal{V}(\sigma, \alpha') = 1$ for all $\sigma \in \mathcal{W}$, α' being derivable from α by replacing its variables with atomic constants in \mathcal{S}_σ .
It can be verified that all axioms of the system \mathcal{W} are valid according to this definition.

§12. MAP OF THE SYSTEM \mathcal{W}

Kripke modality (K_b)



Lewis modality ($S4'$)



Brouwer modality (B)

$$NH\alpha \rightarrow MPNH\alpha \rightarrow \alpha \xrightarrow{\text{with proviso}} NHMP\alpha \rightarrow MP\alpha$$

Leibniz modality ($S5$)

$$(L\alpha \leftrightarrow KL\alpha) \rightarrow \alpha \rightarrow (LK\alpha \leftrightarrow K\alpha)$$

Kierkegaard modality

$$L\neg\alpha \rightarrow \neg M\alpha$$

Ockham future

$$D_\tau\alpha \rightarrow F_\tau\alpha \rightarrow M_\tau\alpha$$

Peirce future

$$F_\tau\alpha \rightarrow \neg F_\tau\neg\alpha$$

Ω. CONCLUSION

It is remarkable that we can construct a logic combining the features of a great number of modal systems for an ever growing language, the basic axioms being:

$A1 \alpha \Rightarrow NP\alpha$ *read: 'if α , then inevitably past α '*

$A2 \alpha \Rightarrow HM\alpha$ *if $H(\alpha \Rightarrow \alpha)$ 'if α , then hitherto possible α , granted $H(\alpha \Rightarrow \alpha)$ '*

$A1$ is identical to the major premiss used by Diodoros in his famous master-argument, also reflected in the principle: *unum quodque, quando est, oportet esse*, by Leibniz. $A2$ is a weakened version of the law $\alpha \Rightarrow HF\alpha$, criticized by Prior (*PPF vii, TT iii*), respecting the past non-statability of some now statable propositions. $A1$ has not been weakened by a similar proviso since we assume, against Prior, that any proposition which has just been stated will remain statable forever after, i.e., in all future.

\mathcal{W} is restricted by the fact that the idea of 'true future' is left inexpressible. So \mathcal{W} takes more from Prior and Peirce than from Ockham. According to the latter, God knows all future contingents, although we don't know how. But opinions diverge: what believers in a true future consider as a defect, the present author counts as a virtue. The issue is not the obvious one whether we must be silent about what we cannot know, but whether it is sensible to suppose that the future was always already known by God. Of course, if the future were predestined from eternity, then, granted that there is a God, God would forever know the future - but human freedom would then be a delusion.

At least it seems evident that it does make sense to speak of a created truth. Accepting with Peirce that God knows whatever can be known, and that this comprises what is not decided by blind chance, or by the will of man, we leave the issue.

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A New Tempo-Modal Logic for Emerging Truth

Faye & al.: *Perspectives on Time*, Boston Studies, Kluwer 1996.

The axiomatics has been simplified and the semantics adjusted accordingly.

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