A SYSTEM OF TEMPORALLY RELATIVE MODAL AND DEONTIC PREDICATE LOGIC AND ITS PHILOSOPHICAL APPLICATIONS (*)

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1. *Aim and structure of the article*

As the title already indicates, this article presents a system of temporally relative modal and deontic predicate logic together with some philosophical applications.

The motivation for constructing this system is the fact that the languages of the current systems of deontic logic are far too poor as a means of formulating cues for the moral agent. In order to solve problems in this connection a semantics is constructed for a notion of temporal necessity in terms of a strict-accessibility relation, upon which a semantics of a temporally relative 'ought' is based, and time-indices are introduced in the formulas.

In chapter I the limitations of the traditional monadic and dyadic system of deontic logic are exposed.

This leads to the main point of criticism: there is no practical accessibility relation between the 'real' world and (nearly) deontically perfect worlds (see the Conclusion of chapter I). This relation is introduced in chapter II: A system of quantificational modal temporal logic (QMTL); section 2 shows its importance as a tool for philosophical analysis in modal contexts, apart from its function as a basis for a system of quantificational deontic temporal logic. That system (QDTL) is presented in chapter III as an extension of QMTL. All problems arising in chapter I are brought to a solution here (see the

(*) The four chapters of this article appeared as chapter II - V of my dissertation of the same title of 1981. Apart from a few redactional adaptations and addition of the items (13), (17) and (27) to the bibliography, also dealing with (systems of) temporal ought-propositions, but unknown to me when I finished the manuscript, the text has remained the same.

Conclusion of chapter III). Finally a pair of desiderata for QDTL are brought to the fore in chapter IV, which may help to increase its possibilities of application.

I. PROBLEMS

Deontic logic is said to deal with ethical normative notions like 'ought', 'permitted', 'forbidden', 'obligated', etc. In this chapter we will examine how far the current systems of deontic logic succeed in doing this task. Characteristic of the concepts involved is their role in evaluative and directive language. This immediately offers us a criterion for criticizing a deontic logic: what we may require from such a logic is that *it should define validity for a language that is rich enough to function as a satisfactory medium for formulating cues for the moral agent.*

It is easily seen how the above systems provide for a language of cues. They contain an operator that enables us to form formulas, saying what is the case in a (nearly) deontically perfect world, a world in which (nearly) everything is the case that ought to be the case. The reason for realising p(1), when Op (resp. qOp and q) is true, is that otherwise something (or perhaps several things) is morally wrong with our world. So if we want to avoid a discrepance between reality and norm, we have to see to it that p. In the next sections we will investigate the workability of the languages of the current systems of deontic logic, testing their adequacy as languages in which cues are formulated for the moral agent.

1. *Some ethical concepts*

We may expect of a language of sufficiently specific cues that it

(1) Sometimes we use the letters p, q, r, s to represent formulas, especially in contents of application. Furthermore we have the notation (pOq) instead of the customary O(q/p) for: 'under circumstances p it ought to be the case that q', analogously to such other dyadic formules as $(\Phi \wedge \Psi)$ or $(\Phi \supset \Psi)$, which will not be written as $\wedge(\Psi | \Phi)$ and $\supset(\Psi | \Phi)$ either.

enables us to form, on the basis of analyses of the relevant notions, certain distinctions among concepts that are important in contexts in which the moral agent asks himself 'What should I do?', such concepts as conditional and unconditional obligation, primary and secondary duty, prima facie- and actual obligation and commitment, the 'ceteris paribus' proviso, conflicts of duty, etc.

Let us now examine the traditional systems with respect to this point.

1.1. *A criticism of Hintikka's analyses*

The author who has pre-eminently exploited the possibilities of the monadic systems is J.Hintikka (see (18)). He introduced the important notion of deontic consequence in contradistinction to that of logical consequence. He says that q is a logical consequence of p if $(p \supset q)$ is valid; q is a deontic consequence of p if $O(p \supset q)$ is valid. This distinction is important, because a lot of apparently plausible principles, formulated as logical consequences in the literature of deontic logic, lead to paradoxical results, whereas if they are formulated as deontic consequences they are valid in systems satisfying the D.T.requirement(2). One of the examples Hintikka mentions is 'If the doing of A and B jointly necessitates the doing of C, then if we do A and are obliged to do B, we are obliged to do C' (see (18), p. 83)). According to Hintikka this principe cannot be interpreted as a logical consequence. '... the straightforward formalization $((p \wedge q) \supset r) \supset ((p \wedge Oq) \supset Or)$ is invalid...'. A counterexample can be obtained by assuming that q is false, i.e. that the obligation to do B is not fulfilled(3). But $O(((p \wedge q) \supset r) \supset ((p \wedge Oq) \supset r))$ is valid in D.T. Here we have a deontic consequence; the above counterexample is blocked because now we are dealing with perfect worlds, worlds in which every obligation is fulfilled.

It is in terms of the distinction between deontic- and logical consequence that Hintikka gives a definition of the concepts of prima

(2) The D.T. requirement is a condition to the effect that all worlds that are pertect alternatives to some world are also perfect alternatives to themselves. Let W be a set of worlds and R the relation 'having as a perfect alternative'; then for each $w \in W$, if there is a $v \in W$ such that $w R v$ then $v R w$.

facie- and actual obligation, but first he distinguishes two kinds of commitment, rendered by (1) $O(p \supset q)$ and by (2) $(p \supset Oq)$ respectively, as an answer to the question what is meant by the statement that something (p) commits one to (say) acting in a certain way (q). On interpretation (1) it means that it is impossible to realize p in a deontically perfect world without realizing q too. This is called a prima facie commitment, whereas (2) is called an absolute commitment because from a fact (p) and this form of commitment $(p \supset Oq)$ we can detach a non-conditional obligation (Oq).

The objection has been raised to these formalizations that if you read $O(p \supset q)$ as 'p commits to q' you get unacceptable consequences, for in the light of this interpretation the theorems $\models (O \neg p \supset O(p \supset q))$ and $\models (Op \supset O(p \supset q))$ are absurdities and accordingly the theorems are regarded as the paradoxes of commitment. If we take $(p \supset Oq)$ as a formalization of commitment, similar difficulties arise on the basis of the so-called paradoxes of material implication.

Against this objection Hintikka argues: 'One obvious reason why the notion of commitment is often employed is to prevent our actual world from departing from a deontically perfect world. If p is the case and if it commits us to q..., then the actual world will not match the standards of deontic ideality unless q will also be the case.' (See (18), p. 88). In this case (1) $O(p \supset q)$ correctly renders this notion; (1) says that in all deontically perfect worlds $\neg(p \wedge \neg q)$ is true, in other words that p does not occur without q in any world that meets all norms. From this point of view neither of the two theorems is paradoxical. The first one says that if p cannot be the case in any deontically perfect world, then certainly neither can p together with $\neg q$; the second says that if p is the case in all ideal worlds, there is no ideal world in which q is the case without p being the case too (for p is the case in such a world anyhow). The theorems apply to situations in which p is not normatively neutral: in the first p is forbidden, in the second it is obliged. But in these cases a commitment with the above intention, formulated as (1), does not make sense: 'if p is forbidden, a discrepancy between the actual world and deontically perfect worlds has openend as soon as p has been realized, irrespective of whether q

(3) For example, let p and Oq be true and Or, r and q false. We get another counterexample if we assume p,Oq,q and r to be true and Or false.

is realized or not' (see (15) pp. 88-89) and if p is obliged, there is no question of a deontically perfect world if p is not the case, whether q in addition is realized or not. In these situations a commitment in the sense of $O(p \supset q)$ resp. $O(q \supset p)$ is meaningless.

Of course we agree with Hintikka that, when p is not neutral, as in the antecedents of the theorems, using $O(p \supset q)$ respectively $O(q \supset p)$ as a notion of commitment does not make sense. But you cannot play this down by calling such circumstances unusual as Hintikka does (see (18), p. 89). On the contrary, unfulfilled duties usually commit you to other obligations, so-called secondary duties.

In view of this kind of situation dyadic systems have been introduced. Thus when $O \neg p$ is the case, the commitment could be expressed by the dyadic formalization pOq ([22]): if p is the case, the actual world will not match the standards of deontic ideality – given p, unless q will also be the case. So, far from being 'devoid of any special interest for a student of deontic logic' as Hintikka says (see (18), p. 88), the paradoxes of commitment show an important flaw in the possibilities of his monadic system.

On the basis of his two notions of commitment, Hintikka also gives a reconstruction of the distinction between prima facie- and actual obligation. Where 'n' designates the conjunction of a number of normative principles, and 'p' designates the conjunction of a number of descriptive statements, assumed to be our factual premises,

- q is a prima facie obligation on the basis of the set of norms n iff $O((n \wedge p) \supset q)$ is valid ([4]);
- q is an actual obligation on the basis of the set of norms n iff $((n \wedge p) \supset Oq)$ is valid.

Again objections to these definitions have been raised, akin to the criticism of the definitions of commitment (see Purtill (31), Bergström (3)). According to Bergström, for instance, Hintikka's notion of prima facie obligation is useless, since everything seems to be a prima facie obligation in his sense. We have $\models O(Op \supset p) \supset O((Op \wedge \neg p) \supset q)$ and $\models O(Op \supset p)$, and therefore $\models O((Op \wedge \neg p) \supset q)$. So, on the basis of $(Op \wedge \neg p)$, q is a prima facie obligation. But there is always such a

([4]) In Hintikka's system, which satisfies the D.T. requirement.

basis. That is why everything seems to be a prima facie obligation.

Now, if we assume that sometimes we use the notion of prima facie obligation because we want to prevent our world from deviating from an ideal world, then, in these cases, that q is a prima facie obligation on the basis of $(n \wedge p)$ means that q is a deontic consequence of n and p; in other words, that there is no perfect world in which $(n \wedge p)$ is the case, without q being the case too. But, if $n = O \neg p$, a prima facie obligation with the aforesaid aim does not make sense, for, if an obligation has not been fulfilled, the possibility of keeping the world ideal is excluded anyway. However, sometimes we have a prima facie obligation on the basis of unfulfilled obligations. In such a situation Hintikka's reconstruction does not work(5).

But this does not mean that the validity of the formula $O((O \neg p \wedge p) \supset q)$ makes the reconstruction useless. Just because the formula is trivial, talking as it does about perfect worlds that are not perfect, it cannot be read as 'there is a prima facie obligation that q (on the bases of $(O \neg p \wedge p)$)'. This last proposition could be rendered with the help of a dyadic formula: $(O \neg p \wedge p) O q$.

Thus, the essential point we can derive from the criticism is that in some cases the monadic systems cannot offer means for formulating cues for the moral agent, viz. those cases in which reparational duties are at issue. Therefore it is not surprising that the objection could be met, changing over to a dyadic system, for it is precisely with an eye to this kind of duty that dyadic systems have been constructed.

So this attack on an analysis of prima facie-vs. absolute commitment and obligation in terms of the semantics of existing systems of deontic logic turns out not to be devastating.

However, we can bring to the fore another criticism, not dependent on the phenomenon of reparational duties, that challenges both monadic and dyadic systems in their capacity to provide a language of cues, pointing out that none of them is rich enough to enable us to give a satisfactory analysis of the notions at issue.

Hintikka's analysis of the above notions is based on the difference between the formulas $O(p \supset q)$ and $(p \supset O q)$ from a semantical point of view. Allegedly $O(p \supset q)$ would be the logical form of a prima facie

(5) See for Hintikka's own defence Hintikka (19).

commitment, whereas $(p \supset Oq)$ would be the logical form of an absolute commitment. But the very example he uses to illustrate the point makes clear that this difference does not matter for moral practice.

Hintikka points out that, in contradistinction to the set of propositions $\{p, (p \supset Oq), \neg Oq\}$, the set $\{p, O(p \supset q), \neg Oq\}$ is consistent; you cannot infer, then, Oq from p and $O(p \supset q)$. As an example he takes the case in which p states 'I give a promise' and q 'I fulfil this promise'. This is an illustration of the fact that sometimes I do not have the actual duty to keep my promise, for instance when my promise is overruled by a stronger obligation.

But now, let actually $V(p,w)=1$ (6) (w is 'our' world) and $V(O(p \supset q),w)=1$; then $V(P(p \wedge \neg q), w)=0$. From this it follows that the proposition $\neg Oq$ does not say directly something about the absence of an obligation of mine. Why not? Because there is no deontically perfect world w_i such that both $V(p,w_i)=1$ and $V(q,w_i)=0$. The proposition $\neg Oq$ refers to a world w_j such that $V(p,w_j = 0$, but *this* world w_j is no longer accessible to w *as soon as* $V(p,w)=1$. Therefore $\neg Oq$ is no moral cue in this situation, because, if I want to prevent our world w from departing from a deontically perfect world, then I must see to it that $V(q,w)=1$.

So, as contrasted with Hintikka's claim, this cannot be an illustration of the fact that sometimes a genuine prima facie commitment does not give rise to an actual duty. And this time a retreat to the dyadic formalization of commitment will not be helpful; if we replace $O(p \supset q)$ by pOq in the above paragraph, we get a similar argument and we reach the same conclusion: $O(p \supset q)$ and pOq play the same part here for the moral agent. Given p together with either pOq or $O(p \supset q)$ or $(p \supset Oq)$ he has to conclude that it ought to be the case that q in that sense, that otherwise the world will not meet the standards of a world as perfect as possible. The fact that nevertheless the sets $\{p, O(p \supset q), \neg Oq\}$ and $\{p, pOq, \neg Oq\}$ are consistent shows that in this situation $\neg Oq$ cannot be read as 'it is permitted that $\neg q$' and therefore is no real cue for the moral agent.

Of course the argument equally discredits Hintikka's analysis of (the difference between) the notions of prima facie- and actual obligation.

(6) I write $V(\phi,w) = 1$ for 'ϕ is true in world w'.

But what, then, is the difference between a prima facie- and an 'actual' duty? What makes a duty prima facie and what happens when a prima facie obligation passes over to an actual one? When does a commitment give rise to an actual duty and when not? When is an obligation overruled by a stronger one? These questions cannot be answered in the light of the semantics of the current monadic and dyadic systems of deontic logic. The following considerarions will make this clear.

1.2. *Prima facie- and actual obligation; the 'ceteris paribus' proviso*

Suppose, John and Suzy have a date. John promised Suzy (p) to have a cup of coffee with her (q)(7). Now we may say (3) 'John ought to have a cup of coffee with Suzy'.

Before we ask ourselves what kind of 'ought' this is I want to stress that (3) cannot be interpreted in terms of deontically perfect worlds simpliciter, for if we want to see whether it is true we must consider the point of time to which the 'ought' pertains. This may make all the difference. Assume that John has just made his promise and that I now (at time t) assert that (3) is the case. It may be that I am right, that I utter a true statement. But (3) need to be true if 'ought' pertains to a point of time earlier than t: if John has no obligation to Suzy and he has not yet made a promise, he is not obligated to realize q. We see that the truth-value of (3) depends on the moments of time to which 'ought' pertains. That is why (3) cannot be interpreted in terms of deontically perfect worlds simpliciter.

Let us now return to the question what kind of 'ought' is expressed by (3). The situation outlined suggests that we have a prima facie obligation here. Why? Between the time of utterance of the promise and the time of realization of q unforeseen things can happen that may prevent me from fulfilling the promise. This, of course, is silently understood in the situation, (3) is an elliptic sentence, it bears the hidden 'ceteris paribus' proviso, rendered by the phrase 'other things being equal'. What does such a phrase mean? In my opinion at least two things:

(7) I.e. let 'q' state: John has a cup of coffee with Suzy (then and there);
let 'p' state: John promises that q.

1. provided no situations will arise that render the realization of q impossible
2. provided no stronger obligations will arise, the fulfilment of which renders q impossible. ([21])

Now, if nothing of the kind has happenend when the moment of realization of ($\neg$)q has come, the prima facie duty passes into an actual duty: at the moment of realization of ($\neg$) q it is still obligated that q. If, on the other hand it becomes impossible in the meantime to realize q, for instance because John lands in a hospital, that passing does not take place; at the agreed time John does not have the actual duty to keep his appointment. Nor will he have the actual duty when the obligation to keep his promise is overruled by a stronger one, e.g. to visit his father (who has become suddenly ill) at the very moment of the data. Fulfilling this obligation makes it impossible to fulfil the earlier one. The commitment 'p commits to q' does not give rise to the actual duty to realize q in this case.

The difference between a prima facie- and an actual duty is that the former presupposes a course of time between the moment of arising of the duty and the moment of its fulfilment, whereas the latter does not leave room for 'other things (not) being equal'. (I imagine that this is why it sometimes is called an absolute duty).

A system of deontic logic may be expected to enable us to give an analysis of these notions of obligation and commitment that fits in with this outline. But it is clear that it cannot be done within the language of the traditional systems. So Hintikka's attempt was bound to fail ([8]). On his approach you cannot express the change of a prima facie duty into an actual one, and we saw what was wrong with his treatment of a situation in which a prima facie duty was overruled by a stronger one. His analysis led him to the view that you have done

([8]) According to Hintikka '... what prima facie obligations specify is precisely what happens in deontically perfect worlds.' (See (18), p. 93). This simply is not true. Sometimes we have a reparational obligation that arises because a primary obligation has not been fulfilled. This is a prima facie obligation that does not specify what is going on in a deontically perfect world. On the other hand, his own account implies that some things that happen in a deontically perfect world are not prima facie obligations but actual ones: when, on the basis of $(n \wedge p)$ (and the validity of $(n \wedge p) \supset O\,q$) we have $O\,q$, according to Hintikka the actual duty to realize q.

something wrong, when it is not the case that you ought to keep your promise. On page 93 of (18) he says that the actual duty you can infer in such a situation is the duty not to give the kind of promise that will be overruled by other obligations. This is an error. Even in his own system such an inference is not justified; you cannot infer from p, $O(p \supset q)$ and $\neg O q$: $O \neg p$ (at most $\neg p$).

What is wrong then, in case someone ought not to keep his promise? Usually nothing at all. He has taken a risk in the sense that in giving the promise, he reduced the set of best possible worlds to a subset, i.e. the set of these worlds in which q will be the case, and the chance that our world will be an element of this subset is smaller. But later he finds (for instance when by an accident a stronger obligation arises), that another set, disjoint from the earlier subset, has become the best one (from a later point of view). But this is all in the game of giving promises.

1.3. *Primary and secondary duty; conditional and unconditional obligation*

We found that the paradoxes of commitment are so interesting, because they revealed a certain flaw in the possibilities of the monadic systems. In their language we cannot express the kind of obligation that arises when other obligations have not been fulfilled. These are called reparational duties or secondary (in contradistinction to primary) duties. To repair this defect in deontic logic dyadic systems were constructed.

The occasion was given by the so-called Chisholm-paradox, by means of which Chisholm drew attention to this type of obligation in the context of deontic logic (see Chisholm (8)) '... we are required to consider the familiar duties associated with... remedial justice, in order to be able to answer the question: 'I have done something I should not have done – so what should I do now?' (Or even, 'I am going to do something I shouldn't do – so what should I do after that?')' (See (8), p. 36).

It is generally believed that dyadic logic can do that. See, for instance, Hilpinen (16), p. 31: 'This (i.e. Hansson's) theory is in accord with Chisholm's requirement: according to Hansson's theory, it is possible to give reasonable answers to the question of what we ought to do after we have failed to fulfil our 'absolute' obligations'.

But does dyadic deontic logic really meet this requirement?

Let us go back to the situation outlined in section 1.2. John has made an appointment, in virtue of which he has a (primary) obligation, again expressed by (3) 'John ought to have a cup of coffee with Suzy'. But, although 'other things are equal' John does not go, because he has no mind to go. Now, according to John's Daemon, this creates a reparational duty to 'repair' the ethical situation, for instance by offering an apology the next day (r).

If I try to formalize the situation with the help of the traditional means I get the set of formulas $\{O\,q, \neg q, \neg qOr\}$, of which the last element renders the proposition that John has the (secondary) obligation to realize r if he fails to realize q. But having failed to realize q he has the obligation (4) 'John ought to make an apology'. Surely (4) is not rendered by $\neg qOr$, this being a *conditional* obligation, whereas (4) gives an *unconditional* obligation, on the basis of $\neg q$ by a kind of natural-language detachment. But such a detachment is not possible in the current dyadic systems (see also section 2.1). Furthermore, as (4) is a reparational duty, and thus does not pertain to ideal worlds, it cannot be formalized as Or.

In short, the interrelation between primary and secondary obligations has the following structure. Propositions to the effect that someone has a secondary duty serve as a kind of reserve cues for the one who will not, or does not want to, fulfil his primary obligations, and they are, in that sense, conditional obligations. When in course of time one indeed has not fulfilled his primary duty, the obligation that initially was secondary takes over the part of a cue. In our example the secondary conditional obligation passed over into an unconditional (if prima facie) obligation as soon as John had not met his promise, and acquired the role of primary (if reparational) cue in the new situation, beside which other secondary obligations tell John what he should do if he fails to satisfy this one, etc.

Thus, as contrasted with the way one talks about them in the literature of deontic logic, the notions of primary and secondary obligations here are relative. But these contexts, in which obligations that were at first secondary become unconditional obligations, cannot be dealt with by the traditional systems (see also section 3.2.).

Incidentally, using the term 'unconditional obligation' may perhaps cause confusion. It may have two meanings: a. that of absolute obligation, i.e. an obligation you never are allowed to neglect. It is in force in all circumstances, ceteris paribus or not, there is no justification of disregarding it; b. that of an obligation not connected with a specific condition. (3) is an example of such an obligation. But it is clear that (3) is not unconditional in the first sense: it is a 'ceteris paribus' obligation that, for instance, can be overruled by another one (9).

Sometimes the notion of absolute duty is used in the sense of actual duty, viz. when it is opposed to the notion of prima facie duty (cf. Hintikka). In our sense, a prima facie duty that has passed over into an actual duty is absolute in a trivial way. Because 'other things' turned out to be 'equal', there is no justification for neglecting it.

1.4. *Conflict of duties; the Jephta-dilemma*

Finally, I want to bring up in this section the issue of the so-called conflict of duties. We came across it already with Hintikka, who used as an example the case in which a prima facie duty to fulfil a promise was overruled by a stronger one. This was a conflict of duties, for the obligations were conjointly incompatible, because fulfilment of both was impossible. He inferred, as a simple conclusion, 'the actual duty not to give the kind of promise that will be overruled by other obligations...' (see (18), p. 93).

Von Wright says something like this in 'A new system of deontic logic' (39), p. 119: 'It may be shown that, if the act of an agent gives rise to conflicting duties, then this act is itself something from which the agent has a duty to abstain'. He calls such a circumstance, in which incompatible obligations arise, a predicament. As a case in point he mentions the story of Jephta in the Book of Judges. Jephta promised God to immolate what would meet him on his return home. But the one he met at his arrival was his daughter. Now, '... by virtue

(9) Some authors mix up the two notions. For instance von Wright in (39). Cf. also our quotation of Hilpinen.

of his promise, he ought to do the very thing which, by virtue of the prohibition([10]), he ought to abstain from doing' ((39), p. 119).

So we see that his promise gave rise to conflicting duties. But does this provide sufficient basis for the conclusion that he had a duty to abstain from the promise? Surely, we may agree that Jephta has made a promise that he ought not to fulfil, that is to say, it turned out to be an actual duty not to fulfil it. Yet from this you cannot infer that he did something (making a promise), from which he had a duty to abstain. Intuitively it is absurd to determine the deontic (i.e. moral) status of a promise on the basis of later forthcoming contingencies: if Jephta's daughter had been overtaken in time by a goat, there would not have been a conflict of duties! On the contrary, the moral status of the promise depends exclusively on the situation in which it is made.

Von Wright says that Jephta promised 'to do the forbidden'. If that had been the case, you could indeed 'infer' that he ought not to make that promise (in a logic of promises some theorem to the effect that promising the forbidden is itself forbidden, would be desirable). But, certainly, you cannot say that it was forbidden to 'immolate what would meet him'. Jephta did not promise that he would immolate a human being, let alone his daughter. Nevertheless, we may agree that he made a promise that he ought not to fulfil. But in this respect there is no difference from Hintikka's example, in which nothing forbidden was promised either.

Yet, we have a feeling that there is a difference between Jephta's case and Hintikka's. We feel that Jephta should not have made the promise he did made. We do not infer this from the fact that he has promised something forbidden, or that his promise gave rise to conflicting duties. No, Jephta took a risk that was not warranted, because it was perfectly possible that what he would meet would be a human being and that fulfilling the promise would mean killing (say) his daughter. That is the difference in Hintikka's case; it is true, there the promiser took a risk as well, viz. that other things would not be equal, but this is a risk we normally accept in the game of promising, whereas we feel that Jephta took a risk that was too great. And this is an ethical judgement, not *inferred* from the fact that later a predicament arose, but based upon the situation in which Jephta did his promise.

([10]) Scil. to kill a human being.

Perhaps Von Wright arrived at his conception of the Jephta dilemma by this train of thought: Jephta promised to immolate the creature which was to meet him. Now, this turns out to be his daughter. So in fact he promised to immolate his daughter. Therefore he promised to do the forbidden.

The embarrassment is, I think, that you cannot, within the semantics of the current systems of deontic logic, distinguish between a situation in which a person's promise *gives rise* to conflicting duties and a situation in which someone *creates* a conflict of duties. In the last case someone promises to do what is already forbidden, for instance, you have an appointment with Suzy and you promise to Martha to have tea with her at the same time. Then you promise to do what, given the already existing situation, you ought not to do. In the first case, you do not promise something which, seen from the existing situation, you ought not to do. Only later the conflict arises, i.e. when you have difficulties in answering yourself what choice you should make, in other words, whether your prima facie duty has really passed over to an actual duty.

2. *Other questions*

2.1. *Commitment and detachment: a dilemma*

In the preceding section we saw how Hintikka distinguished beween two kinds of commitment, rendered by the formulas $O(p \supset q)$ and $(p \supset O\,q)$. Allegedly, these exhibited the structure of prima facie- and absolute commitment respectively. Our examination of his example showed that this analysis is wrong, for in the very example he gave, each of the notions of commitment $O(p \supset q)$. $(p \supset Oq)$ and pOq intuitively led, given p, to the same result: that q ought to be realized. The consistency of the sets $\{O(p \supset q), p, P\neg q\}$ and $\{pOq, p, P\neg q\}$ was all the worse for the current systems of deontic logic. For suppose I am asking myself whether I shall perform an action (p) that commits me to realizing q, in any of the above senses. I love to do p but hate realizing q. Now, the consistency of the above sets of formulas is misleading. I may be tempted to decide to do p on the consideration that it does not enhance the obligation to realize q after all, because

$P\neg q$ is perfectly consistent with the fact that p commits me to q, even *given* p.

This is a striking example of how the traditional systems fall short of doing their job, viz. providing a means for formulating cues for moral action: we saw already that, given pOq or $O(p \supset q)$, as soon as p is the case, a world in which $\neg q$ is true, has ceased to be an accessible deontically perfect world. And therefore $P\neg q$ does not represent a cue in this situation. So we may be tempted to conclude that we should be able to detach an obligation from a commitment and a fact.

On the other hand, systems of dyadic logic have been constructed precisely in order to give a formalization of a commitment that does not permit such a detachment. And rightly so, situations may occur that, in the language of dyadic deontic logic, must be described by the set $\{p, pOq, r, rO\neg q\}$. If we allowed modus ponens from a conditional obligation pOq plus a fact p to an unconditional obligation Oq, the set would be inconsistent.

These two considerations form what I would like to call the dilemma of commitment and detachment: 1. Detachment should be possible. How can we take seriously a conditional obligation if it cannot, by way of detachment, lead to an unconditional obligation. 2. Detachment should not be possible. If we allow detachment, the sets like the above are inconsistent, but they represent perfectly possible and deontically interesting situations. And the very consistency of these sets is the virtue of the dyadic formulas.

Van Fraassen is a defender of opinion 2. According to him, the following principle does not hold.

(5) 'If p, then it is obligatory that q' implies 'If p and r, then it is obligatory that q'.

He illustrates the non-validity of (5) by means of the following formulation of the Suzy Mae example, borrowed from Powers (see (29)), '... John Doe and Suzy Mae... violated a primary obligation. Due to the violation of this primary obligation a secondary obligation takes over, that of marrying Suzy Mae. This is not all because John has violated another primary obligation by shooting Suzy Mae... so John cannot marry Suzy. Hence he does not have a secondary obligation to marry Suzy.' (See van Fraassen (12), p. 152). Now, clearly[11], accepting detachment for such conditional obligations

[11] Because we accept detachment for 'if p and r then p'.

would validate (5). So we can consider this as a refutation of detachment for conditional obligation as well.

Against this view Castañeda ((6), p. 123) points out that the proposition 'If John impregnated Suzy, he ought to marry her' is governed by contraposition: it is equivalent to 'Only if John didn't impregnate Suzy, it is not the case that he ought to marry her' and it implies '(Either) John didn't impregnate Suzy Mae, or he ought to marry her.'

Following this line of reasoning we should accept detachment and we find ourselves in the same dilemma.

It is difficult to make a decision on the slippery basis of our natural language intuition, but I think we should say that Castañeda makes a good point here. Consider a situation in which you wonder what John ought to do now, given that he has impregnated Suzy Mae and you accept the truth of (6) 'If (given that) John has impregnated Suzy, he ought to marry her'. You cannot escape the conclusion that now, with this being so, John ought (prima facie) to marry her (12). In this sense (6) is equivalent to (7). 'Only if John did not impregnate Suzy, it is not the case that he ought to marry her'. But this is not the whole story. Let us carry ourselves back to a moment before John impregnated Suzy. Again we ask ourselves what John should do. We say that it is not the case that he ought to marry her, but (8) 'If John will impregnate Suzy, he ought to marry her'. However, would we mean that 'Only if John will not impregnate Suzy, it is not the case that he ought to marry her'? An objection would be: no, it is perfectly possible that he will impregnate Suzy and nevertheless ought (prima facie) not to marry her. For suppose he impregnates a more pitiful girl before impregnating Suzy. Then he ought to marry *her* and not Suzy. But this is not a refutation of (8), because (8) is a *prima facie* commitment with a 'ceteris paribus' proviso to be paraphrased as: other things being equal, impregnating Suzy Mae will commit John to marrying her. So we cannot even detach a prima facie unconditional Ought from (8). On the other hand (6), in its most natural interpretation, expresses an *absolute* commitment. Now, John having impregnated Suzy, the obligation to marry her has come into force, so (6)

(12) Cf. also the first paragraph of this section.

does not leave room for the commitment to be 'ceteris paribus', the committing act already lying in the past.

It must be granted that there is perhaps another interpretation of (6). When you are more careful, appreciating the possibility of John's having in the meantime impregnated the more pitiful girl as well, you may use (6), while you leave room for the other things being equal, and thus express a prima facie commitment. I think that, if we omit the words (given that) in (6), natural language intuition does not enable us to make a definite decision between the two versions of (6). Nor are we completely sure of the 'ceteris paribus' reading of (8). It might be used to say that, *as soon* as John has impregnated Suzy, he ought to marry her. This looks like an absolute commitment after all: it is as if the point of view of the speaker lies after the possible committing act, thus leaving no room for the commitment to be 'ceteris paribus'.

Now, it will be clear why (6) admits detachment, whereas (8) does not: (6)'s most plausible interpretation renders an absolute commitment, while (8) on first sight expresses a 'ceteris paribus' commitment.

So the solution of our dilemma should be looked for in the difference between these two notions of commitment. But, as we have seen, this presupposes notions of time, and these are not accounted for in the current systems. Therefore they cannot offer a solution to the dilemma.

2.2. *Ought implies Can*

Some authors on deontic logic discuss the Kantian question whether Ought implies Can. You might combine a system of deontic logic with a system of (alethic) modal logic in order to stipulate simply the validity of $(O\,p \supset \Diamond p)$ (13). The result would – in view of a Kripke-semantics – be trivial and you might expect that nobody would object to such a principle, but Stenius and Hintikka, for instance, do.

Stenius (see (35)) rejects the validity of (9) $\neg(O\,p \in S \wedge O \neg p \in S)$, where S is a system of norms. He argues that a system of norms for

(13) $\Diamond$ is the operator for logical possibility here.

which (9) is not true, is of course impossible to comply with and therefore 'unreasonable'. 'But to say that such a system exists is not a logical contradiction... There has been, and still is, a great temptation to try to find logical proofs for these ethical attitudes that one considers reasonable. My stress on the rejection of (9) is a warning against such arguments. The Kantian principle 'what I ought, I can'... is an ethical or metaphysical principle, and so I believe Kant himself conceived of it. It should not be made a logical principle'. (See (35), p. 254).

Hintikka's attitude to the logical status of $(Op \supset \Diamond p)$ is congenial. According to him, whereas $\Diamond p$ is not a logical consequence of Op on the assumptions he makes, it is a deontic consequence: $O(Op \supset \Diamond p)$ is valid. Indeed, he says that the validity of $(Op \supset \Diamond p)$ cannot be restored by any 'obvious and uncontroversial principle forthcoming on the level at which we are here moving' (see (18), p. 84).

In Hintikka's semantics the notion of deontic alternative (our deontically perfect world) plays a crucial role; he needs this notion in order to interpret formulas of the forms Op and Pp. But he presents this deontic alternative as a possible world, also called alternative. His interpretation of Pp, to be paraphrased as: 'in at least one deontic alternative, p is the case', 'suffices to make sure that p *can* be the case' (see (18), p. 70). So we need no controversial principle to establish the validity of even $(Pp \supset \Diamond p)$ (and a fortiori $(Op \supset \Diamond p)$) in Hintikka's system. But what kind of possibility did he have in mind? At page 84 he talks about *the* concept of possibility and at page 70, commenting on his definition of Pp, he states that p being the case in a possible world 'suffices to make sure that *can* be the case, i.e. that there is no inconsistency in assuming that p'. Clearly Hintikka uses a concept of logical possibility.

Of course sometimes we cannot fulfil our obligations. But those cases are not counterexamples against $\models(Op \supset \Diamond p)$. The truth of $(Op \wedge \neg\Diamond p)$ would mean that there are no possible deontically perfect worlds, and this surely does not characterize these examples.

Sometimes it may happen that the fulfilment of an obligation becomes impossible. *As soon as* this is the case we can no longer satisfy our obligation. Now, just as statement (3) of section 1.2. 'John ought to have a cup of coffee with Suzy' cannot be interpreted in terms of deontically perfect worlds simpliciter, we cannot interpret the notion of possibility, used in the last sentence, in terms of possible worlds simpliciter. If I use the sentence (10) 'John can have a cup of coffee then and there with Suzy' to render the situation before John's car accident I express a different proposition, from the one expressed by my use of (10) after John's crash. It may be that the first mentioned proposition is true, whereas the second may be false. So, if we want to assign a truth-value to (10) we should consider the time to which 'can' pertains. The possibility to fulfil the obligation disappears with John's accident. As soon as this accident is a fact, a world in which the obligation is fulfilled is no longer accessible, and John can no longer realize such a world in this situation. We see that the truth-value of (10) depends on the moment of time which 'can' pertains. That is why (10) cannot be interpreted in terms of possible worlds simpliciter.

But what then happens with John's obligation in the sketched situation? Is (3) 'still' true?

The answer to these questions is obvious if we realize that the distinction between possible worlds that are accessible at a certain moment and possible worlds that are not, is crucial in judging whether an ought-sentence expresses a cue for action. An ought-proposition is only a cue if it indicates really possible directions. If such a direction is cut off, it ceases to be a cue, for the essential point of a cue is to indicate what choice we must make from still possible alternatives. Thus the obligation in sentence (3) ceases to exist by an accident; (3) does no longer express a true proposition. Whereas we may blame John for not having fulfilled his obligation because he drove too fast, we cannot reasonably blame him for not trying to realize a world that in the meantime has become inaccessible. Ought-sentences that formulate cues for action pertain to possible worlds that are (still) accessible. In this sense Ought implies Can.

Interpreting the principle in terms of obligation and logical possibility is rather pointless. It is an utterly trivial truth that you are only obliged to do what is not contradictory. And the intuitive validity of $(Op \supset \Diamond p)$ is, from the point of view of the current systems, already implied by the theoremhood of $(Op \supset Pp)$: if something is the case in all possible deontically perfect worlds, then there is such a possible world in which it is the case. Therefore it is justified to make $(Op \supset \Diamond p)$ (not merely an ethical, but) a logical principle: norms should not require contradictions, otherwise they are not norms at all; not: otherwise they are bad norms.

Why then, does $(Op \supset \Diamond p)$ look suspect, as a logical principle, to Hintikka? I think, because norms may sometimes require a practical impossibility. Thus, in our example, the norm that all promises should be kept, was violated by force majeure. Therefore Hintikka doubts that Ought implies Can even in its innocent form $(Op \supset \Diamond p)$. It suggests more than it can live up to. Hence his need of the weaker form of an ethical principle $O(Op \supset \Diamond p)$. It would have been more appropriate to point out the trivial character of 'Can' in the formula $(Op \supset \Diamond p)$: it is not practical in the sense that it does not say anything about real possibilities. It is not backed by a strict-accessibility relation. Cues, on the other hand, should not demand what is practically impossible on pain of not being cues at all. In my opinion, this is the most substantial meaning of 'Ought implies Can' as a logical principle, from an ethical point of view.

Of course one cannot formalize this principle in a language of traditional deontic logic enriched by current modal symbols. We have noted that sentences of the form $\Diamond p$ do not render the structure of 'can'-statements like (10) for the same reason as Op cannot render (3): the point of time to which they pertain is not revealed. The modality at issue cannot be characterized as a logical one or a physical one tout court; it is tied to a situation, i.e. time-dependent. This modality we have in mind, when we respond to a reproach that we did not fulfil an obligation by pointing out that it was impossible to do it.

3. *Paradoxes*

3.1. *The easy paradoxes*

The theoremhood of $(Op \supset O(p \vee q))$ in systems of deontic logic has been the occasion of criticism. At first sight it looks paradoxical. Taking an example of Ross (see (32)) we get: If I ought to mail a letter, I ought to mail or burn it. This sounds pretty paradoxical and is known as the Ross-paradox. For suppose that somebody tells me that I ought to mail the letter and I say: 'So I ought to mail or burn it'. Then she would say something like: 'No, you ought to *mail* it, not to burn it!' So it seems wrong to infer $O(p \vee q)$ from Op.

But, of course, the oddity of this is of a pragmatic, not of a semantic character. Given Op, it is odd to assert that $O(p \vee q)$. As Hansson (see (15)) points out: it is a generally assumed convention to make as strong a statement as one is in a position to make. Thus my reaction in the above example is not sensible unless I did not understand the order and this explains the reaction of the other person. In the context of Op, $O(p \vee q)$ is redundant. In thise sense it is 'wrong' to infer $O(p \vee q)$ from Op, just as it is wrong to infer $(p \vee q)$ from p. But this is not an objection against the theoremhood of $(Op \supset O(p \vee q))$. The formula only says that, if it ought to be the case that p, then it ought to be the case that at least one of p and q (viz. p) is the case.

The same holds for $(Pp \supset P(p \vee q))$. Here the feeling of paradox is even stronger because of the fact that the consequent seems to express a free choice permission, i.e. a permission that implies a free choice between alternatives. When someone says: 'It is permitted to drink or to smoke', he usually means that it is both permitted to drink and permitted to smoke. Thus, another point of criticism of the standard-systems is that the distribution-principle $P(p \vee q) \supset (Pp \wedge Pq)$ is *not* theorem.

That is why some authors stress the need for introducing an operator for strong permission, inspired by a formal analogy with the tautology $((p \vee q) \supset s) \equiv ((p \supset s) \wedge (q \supset s))$: $\mathscr{D} \models_{w} P\phi$ iff for every $v \in W$, such that $\mathscr{D} \models_{v} \phi$: wRv. 'It is permitted that ϕ in w if and only if all worlds in which ϕ is the case are perfect alternatives to w'.

In (40) von Wright gives a similar definition $Pp =_{df} N(p \supset I)$, where N is an unspecified necessity-operator and I a constant. According to him '...if something which, in the strong sense, *may* be the case actually *is* the case, then everything which *ought* to be the case *is* the case, too'. (See (40), p. 165). But this is very odd. That it is permitted (in the strong sense) that p would mean that realizing p would guarantee that our world is perfect! Surely, this 'permission' is the strongest one you can think of, but it does not explicate any sense of permission in ordinary-language usage and indeed cannot be used to express propositions that function as cues for the moral agent (unless he is a Messiah).

To deal with the notion of free choice permission, we do not need another definition of a permission-operator at all, it can be expressed in the standard systems in a perfectly adequate way. As Hilpinen remarks in (16), p. 22, the word 'or' has in some cases the same force as 'and', in ordinary language. Thus 'in many cases the sentence' a may do p or q' is used to express the same statement as 'a may do p and a may do q''. Here 'or' is not used disjunctively(14). The proposition that it is permitted to drink or to smoke is, therefore, simply of the form $(Pp \wedge Pq)$.

So, neither the theoremhood of $(Op \supset O(p \vee q))$ nor the non-validity of the distribution principle $(P(p \vee q) \supset (Pp \wedge Pq))$ is a deficiency of a system of deontic logic.

3.2. *The more serious paradoxes*

The above paradoxes were called easy because a little consideration of the semantics of the monadic systems enabled us to see that there is no paradox after all. The paradoxes of this section, on the other hand, are called more serious, because they show the deficiency of the monadic systems in dealing with what is called contrary-to-duty imperatives or secondary duties. To cope with the difficulties, systems of dyadic logic have been constructed. Let us examine whether they have been succesful.

In (8) R. Chrisholm presented a set of sentences having the following structure:

I it ought to be the case that $\neg p$
II it ought to be the case that if $\neg p$, then $\neg q$
III if p, then it ought to be the case that q
IV p

Here we shall use a Suzy Mae version of it:
1. it ought to be the case that John does not impregnate Suzy Mae
2. it ought to be the case that if John does not impregnate Suzy Mae, then he does not marry her

(14) Hansson ((15), p. 171) mentions another example. He points out that 'I do not know if I will be there or not' does not mean that somebody is at a loss whether he will be in the disjunctive state of affairs of being or not being there.

3. if John impregnates Suzy, then it ought to be the case that he marries her
4. John impregnates Suzy.

The point is, that, if we try to formalize it in the language of monadic deontic logic we get

$$1^{\circ}\ O\neg p,\ 2^{\circ}\ O(\neg p \supset \neg q),\ 3^{\circ}\ (p \supset O\,q),\ 4^{\circ}\ p,$$

an inconsistent set of formulas whereas {1, 2, 3, 4} is felt to be consistent.

Another monadic formalization of 3: $O(p \supset q)$ (3′) or of 2: $(\neg p \supset O\neg q)$ (2′) saves consistency but makes the resulting set redundant: 3′ is a logical consequence of 1° and the same may be said of 2′ and 4° [15].

The generally accepted solution nowadays, representing 3 by the dyadic formula pOq, meets both requirements of consistency and non-redundancy. In fact, 3, being a contrary-to-duty imperative cannot be rendered in the language of the monadic systems, whose deontic operator O pertains to perfect worlds. p is not the case in any deontically perfect world, therefore 3 is interpreted as saying something about worlds that are almost perfect, viz. as perfect as worlds satisfying p may be so called p-ideal worlds (see Hilpinen (16), p. 26 and 30).

There is, however, still another requirement, proposed by L. Åqvist in (41), that should be taken very seriously. It demands that a formalization of the situation should countenance the fact that 1, 3 and 4 jointly entail that John ought to marry Suzy Mae in some sense of 'ought' [16].

Surely the dyadic solution does not meet this demand. We noted already in the preceding sections that situations in which a conditional secondary duty passes over to an unconditional duty cannot be accounted for in the current systems of dyadic deontic logic.

But it is a question whether this requirement of Åqvist should be adopted in this form. The sets of sentences that are used as examples of the Chisholm paradox always fail to reveal any temporal relations

[15] See Åqvist (41).

[16] In fact, Åqvist uses another version of the Chisholm paradox.

between the propositions involved. And it depends on this very temporal relation between 3 and 4, whether 3 and 4 allow the required detachment (see section 2.1.). So, actually the requirement is premature. It should be replaced by the more cautious but also stronger one that a solution should reveal whether, or rather, on what interpretation 4 and the conditional duty of 3 jointly entail an unconditional obligation.

Of course, the current monadic and dyadic logics are too poor to manage this, and this is not their only defect: interpreting 1 in terms of deontically perfect worlds is another one. You do not need to believe in *the* original sin in order to recognize the fact that a perfect world is no longer accessible, for some 'original sin' did occur, say John's being the off-spring of a rape or having told Suzy that he never would marry her, annihilating an earlier promise. So these semantics cannot even interpret 1 as a moral cue for action.

Formula 3 was intended to express a secondary duty, conveying what John ought to do after failing to fulfil his primary duty. But the Suzy Mae story goes further: John kills Suzy and now he ought to refrain from marrying her. So there arises another duty, incompatible with the one suggested by 3. The only way to describe the new situation in a dyadic language is to add $(r \wedge r\,O \neg q)$ to the original set. (A different course of the Suzy Mae story is perhaps more appropriate. We read for r: John impregnates (the more pitiful) Anna). And immediately we see the dilemma of commitment and detachment at work for the one who uses the language of the current deontic logic. On the one hand he should be happy that modus ponens is not permitted, because a contradiction would be the result. On the other hand the formulas of the set do not convey propositions unambiguously telling John what to do now. And this is precisely the point of Chisholm's criticism of the monadic systems that was the starting point of dyadic logic: we need a way of deciding what we ought to do after we fail to do some of the things we ought to do primarily. The set {1, 2, 3, 4, 'John impregnates Anna and now het ought not to marry Suzy'} on the contrary may very well suggest unambiguous cues: outrageous John again and again creates situations that are different from a moral point of view in the sense that in each new situation a different cue is in force. What cue is in force depends on the development of the story, i.e. depends on what phase is going on. Before he impregnates Suzy he ought not to marry her, afterwards he ought to, but only until he has impregnated Anna: then he ought not to marry Suzy after all, but Anna.

These ought-sentences tell unambiguously at each time what John has to do then, they all pertain to moments of time. And again, an analysis of them will only be satisfactory if it reveals this temporal aspect.

Within the Suzy Mae story we get the so called Good Samaritan paradox if we realize that, because at a certain moment Suzy is the girl that John has impregnated, John ought to marry a girl he has impregnated. But marrying an impregnated girl implies that there is an impregnated girl. Having in mind the rule that, if $\models(p \supset q)$, then $\models(Op \supset Oq)$, we must conclude that there ought to be an impregnated girl! ([17])

At first sight a solution is found, when we consider that John's duty to marry Suzy is a reparational one and is therefore not represented by formulas of the form Op but by qOp. Now the principle to be applied does no langer yield a paradoxical result: if $\models(p \supset q)$ then $\models((qOp) \supset (qOq))$ gives us the trivial qOq ([18]).

Our previous criticism indicates already why this solution is not satisfactory. It depends on a conditional formula (q O p) representing a duty of John's that has become a (prima facie) duty tout court, because the condition (q) has already been satisfied.

Another suggestion is that simple scope-distinctions on the basis of further analysis of the monolithical p,q we used up to now avoid the paradox, see Castañeda (5). 'John ought to marry an impregnated girl' should be analyzed as (11) $\exists x(Ix \wedge OMjx)$, not as $O\exists x(Ix \wedge Mjx)$, so that we cannot infer that there ought to be an impregnated girl. But this will not do either, for who is this x in (11)? Surely not Suzy: remember $O\neg Mjs$.

Thus neither does the paradox of the Good Samaritan receive a satisfactory solution within the frame of the current systems. We will

([17]) This is called the Good Samaritan paradox, because the usual example of it involves the Good Samaritan who ought to help a man who has been robbed: (so there ought to be a robbed man). See e.g. Åqvist (41).

([18]) See also van Fraassen (12).

see in chapter IV that temporal references are necessary and sufficient for that aim as well.

4. *Conclusion*

In this chapter we have scrutinized the traditional monadic and dyadic systems of deontic logic with respect to their role of providing languages of cues for the moral agent.

First we reviewed some notions of vital importance in this connection, in order to see to what extent the systems could manage them. The result was negative. Questions like: 'What is the difference between a prima facie- and an actual duty?', 'What happens when a prima facie duty passes into an actual one?', 'When does a commitment give rise to an actual duty and when not?', 'When is an obligation overruled by a stronger one?' could not be answered from the point of view of the semantics of the systems. A situation in which a conditional secundary obligation passes into an unconditional one could not be conveyed in their language. Neither could the structure of the so-called Jephta dilemma be revealed, the distinction between giving rise to – versus creating a conflict of duties being crucial. Then we saw that the dilemma of commitment and detachment could not be resolved: for that aim one must be able to distinguish between an absolute and a 'ceteris paribus' commitment. Furthermore, a non-trivial principle of Ought implies Can in terms of a notion of practical possibility could not be formulated. Finally we saw how these shortcomings came home to roost in the standard paradoxes of Chisholm, Suzy Mae and the Good Samaritan: they could not be resolved satisfactorily by the systems of dyadic logic because these could not convey propositions unambiguously telling what ought to be done in the situations at issue. Our conclusion must be that the current systems of deontic logic do not succeed in their task of providing a language, suited for the purpose of conveying cues that are sufficiently specific for the moral agent who asks himself: 'What should I do now?' In fact it turned out that they are highly inadequate: not even the simplest situations could be described. Yet, this is not to say that they are totally useless, only that their use is very restricted.

Monadic deontic logic is a logic of norms, telling what a deontically perfect world looks like. Indeed, its language conveys cues, only very general ones, expressing what one ought prima facie to do, ceteris paribus in a very strict sense. It is a cue only in that it implies that the real world does not meet the standards of an ideal world if you do not obey. But the world is already far from ideal. The other things are not equal. That is why looking at a perfect world is not enough to get cues for moral behaviour: one must decide whether following the alleged cue is justified in view of the imperfection of the world. The situation may demand quite a different line of conduct([19]). The perfect-world cues are, because of their strongly 'ceteris paribus' character, of an almost non-committal nature. But not entirely. We feel that, if we do not follow such a cue, the burden of justification rests upon us. We must be able to justify our course of action, by pointing out that satisfying the norm would be morally disadvantageous, or at least would not yield moral benefit in the situation.

The same considerations hold for dyadic deontic logic. It is a logic of primary and reparational norms, describing a (nearly) deontically perfect world. But the cues are still too general: its only advantage over the monadic logic is that it can express prima facie reparational commitments, although of a similar strongly 'ceteris paribus' character as well([20]), and thus subject to the above difficulties. No wonder then, that our examination revealed so many serious defects in these systems. And by this time it will be clear what the most substantial root of the shortcomings is: there is no practical-accessibility relation between the real world and the (nearly) deontically perfect worlds. We pointed out in section 2.2. that an ought-sentence is only a real cue for action if it indicates really possible directions. It should pertain to worlds that are still possible at the moment the moral agent asks himself what to do. Thus, as we already saw in the first section too, these ought-sentences are time-dependent. We will interpret them in terms of world-courses that are possible from a certain

([19]) Cf. the story of the man who had hidden Jews and who, being asked by a Nazi at the door, whether there were Jews in his house, answered in the affirmative. 'You ought not to lie'.

([20]) As van Fraassen remarks too, referring to the Suzy Mae story, "the 'everything else being equal' clause that tacitly accompanies statements of conditional obligation cannot be removed." (12), p. 153).

moment on and (nearly) as perfect as possible. ([21]) We will see that all the difficulties we encountered in this chapter are overcome by this simple device. But first we have to establish a practical-accessibility relation; this will be done in the next chapter in which a notion of temporal necessity will be defined.

([21]) See also note (1) of chapter IV.

([22]) pOq should be read as: q is the case in all worlds in which p is the case, but which are otherwise as perfect as worlds satisfying p may be.

II. A SYSTEM OF QUANTIFICATIONAL MODAL TEMPORAL LOGIC: QMTL

We noticed in I:2.2. that a sentence like 'John can have a cup of coffee then and there with Suzy' cannot be interpreted in terms of possible worlds simplicter, its truthvalue depending on the moment of time to which 'can' pertains. In order to interpret this kind of sentence involving a temporally relative modal notion we will present now a semantcs of the notion of temporal necessity. The intuition behind it is this:

A world is a temporal sequence of situations. At each moment there is a total situation, the complex of all 'facts' at that moment. We have a set of such possible worlds, all being ordered by a sequence of time, i.e. regarded as world-courses. Some of these worlds are accessible at time t for our world, viz. those worlds whose courses-until-t are identical with the course of our world-until-t. These are the worlds that have at time t the same past as our world. From time t on they may have different courses. ([1])

It is in terms of this accessibility-relation that we will define the time-related notions of necessity and possibility.

([1]) Cognate semantics, based upon similar intuitions, are to be found in Chellas (7) and Åqvist and Hoepelman (42).

1. *QMTL: a system of quantificational modal temporal logic*

1.1. *QMTL: language and semantics* (2)

A. *Language*

Alphabet: x,y,a,t,P,′,<,=,$\neg$,$\supset$,$\forall$,$\Box$,),(.

Terms:
- Ontological individual variables OIV = {x,x′,x″,x‴,...}
- Temporal individual variables TIV = {y,y′,y″,y‴,...}
- Ontological individual constants OIC = {a,a′,a″,a‴,...}
- Temporal individual constants TIC = {t,t′,t″,t‴,...} (3)

Predicate-letters I: PL = {″P,″P′,″P″,... } ∪
{‴P,‴P′,‴P″,... } ∪
{⁗P,⁗P′,... } ∪(4), etc.

Predicate-letters II: {=,<}

Atomic formulas: $P_z v_1 \ldots v_n$ (P n+1-predicate-letter,
z temporal term
$v_1 \ldots v_n$ ontological terms)
$v_1 = v_2$ (v_1, v_2 ontological terms)
$z_1 < z_2$ (z_1, z_2 temporal terms)

Formulas:
1 every atomic formula
2 $\neg\phi$ if ϕ is a formula
3 $(\phi \supset \psi)$ if ϕ and ψ are formulas
4 $\forall u \phi$ if ϕ is a formula and u is an individual variable
5 $\forall \overset{z}{x} \phi$ if ϕ is a formula, z is a temporal term and x is an ontological variable
6 $\Box_z \phi$ if ϕ is a formula and z is a temporal term
7 nothing else is a formula

(2) The reader is advised to read § 1.2. simultaneously with this section.

(3) We shall also use ′t, ″t, t + 1, t + 2, etc.

(4) ″P: 2-place predicate-letter, ‴P: 3-place predicate-letter, etc.

Definitions:

$$(\phi \vee \psi) = (\neg\phi \supset \psi)$$
$$(\phi \wedge \psi) = \neg(\neg\phi \vee \neg\psi)$$
$$(\phi \equiv \psi) = ((\phi \supset \psi) \wedge (\psi \supset \phi))$$
$$\exists u\, \phi = \neg \forall u \neg\phi$$
$$\overset{z}{\exists x}\, \phi = \neg \overset{z}{\forall x} \neg\phi$$
$$\Diamond_z \phi = \neg\Box_z \neg\phi$$

B. *Semantics*

A QMTL structure D is a quadruple $<T, \ll, D, W>$ such that

1 T is a non-empty set (of points of time)

2 $\ll \subseteq TxT$, such that $\ll$ is transitive, asymmetrical, connected (earlier than)

3 D is a non-empty set (of objects)

4 W is a set of quadruples $<w^1, w^2, w^3, w^4>$ (w), such that

a. w^1: TIC$\rightarrow$T, such that for each $u \in W$, each $t \in TIC$: $w^1(t) = u^1(t)$

b. w^2: OIC$\rightarrow$D, such that for each $u \in W$, each $a \in OIC$: $w^2(a) = u^2(a)$

c. w^3: $T \rightarrow Pow(D)\text{-}\{\emptyset\}$, such that for each $\tau, \tau' \in T$, such that $\tau' \ll \tau$: $w^3(\tau') \subseteq w^3(\tau)$

d. w^4: $TxPL \rightarrow \bigcup_{n \in \mathbb{N}} Pow(D^n)$ such that $w^4(\tau, P^{n+1}) \in Pow(D^n)$

Definition

$$wR_\tau u = w^4 \upharpoonright \{\tau' \in T \mid \tau' \ll \tau\}\, xPL = u^4 \upharpoonright \{\tau' \in T \mid \tau' < \tau\}\, xPL \text{ and for each } \tau' \ll \tau:\ w^3(\tau') = u^3(\tau')$$

Furthermore there is an *assignment b*: OIV$\rightarrow$D
TIV$\rightarrow$T

Definition

val(e,b) = b(e)	if e is an individual variable
val(e,b) = w^1(e)	(for arbitrary w) if e is a temporal individual constant
val(e,b) = w^2(e)	(for arbitrary w) if e is an ontological individual constant

Truth-definition:

$D \models_{w} \phi\,[b]$ is to be read as 'the formula ϕ is true at the QMTL-structure D in the world w under the assignment b'.

1 a. $D \models_{w} P_z\, v_1, \ldots v_n\, [b] \;\Leftrightarrow\; <val\,(v_1,b),\ldots, val(v_n,b)> \in w^4\,(val\,(z,b), P^{n+1}$
b. $D \models_{w} v_1 = v_2\, [b] \;\Leftrightarrow\; val\,(v_1,b) = val\,(v_2,b)$
c. $D \models_{w} z_1 < z_2\, [b] \;\Leftrightarrow\; <val\,(z_1,b),\ val\,(z_2,b)> \in\ll$

2 $D \models_{w} \neg\phi\,[b] \;\Leftrightarrow\;$ not $D \models_{w} \phi\,[b]$

3 $D \models_{w} (\phi \supset \psi)\,[b] \;\Leftrightarrow\;$ if $D \models_{w} \phi\,[b]$ then $D \models_{w} \psi\,[b]$

4 $D \models_{w} \forall x\, \phi\,[b] \;\Leftrightarrow\; D \models_{w} \phi\,[b^x_d]$ for each $d \in \bigcup_{\tau \in T} w^3(\tau)$
(where $[b^x_d]$ is exactly like [b] except for assigning d to x)
$D \models_{w} \forall y\, \phi\,[b] \;\Leftrightarrow\; D \models_{w} \phi\,[b^y_\tau]$ for each $\tau \in T$

5 $D \models_{w} \forall^{z}_{x}\, \phi\,[b] \;\Leftrightarrow\; D \models_{w} \phi\,[b^x_d]$ for each $d \in w^3\,(val\,(z,b))$

6 $D \models_{w} \Box_z\, \phi\,[b] \;\Leftrightarrow\; D \models_{u} \phi\,[b]$ for each $u \in W$ such that $wR_{val\,(z,t}$

A formula ϕ is valid ($\models \phi$) if and only if for each D,b,w: $D \models_{w} \varphi\,[b]$

Definition of the temporality of a formula ϕ under an assignment b (Temp (ϕ, b)

This is not given for all formulas

1 ϕ atomic
a. Temp $(P_z v_1 \ldots v_n,\ b) =$ val (z,b)
b. Temp $(v_1 = v_2, b)$ = arbitrary
c. Temp $(z_1 < z_2, b)$ = arbitrary

2 ϕ negative
Temp $(\neg\phi^1, b)$ = Temp (ϕ^1, b)

3 ϕ implication
Temp $(\phi^1 \supset \phi^2)$ = not defined if either Temp $(\phi^1$, b) or Temp $(\phi^2$, b) is not defined, otherwise
= Temp $(\phi^1$, b) I if only Temp $(\phi^2$, b) is arbitrary,
otherwise II if not Temp $(\phi^1, b) \ll$ Temp $(\phi^2$, b)

$= \text{Temp}(\phi^2, b)$ I if only $\text{Temp}(\phi^1, b)$ is arbitrary
otherwise II if not $\text{Temp}(\phi^2, b) < \text{Temp}(\phi^1, b)$

4 ϕ universal
$\text{Temp}(\forall u \phi^1, b)$ not defined

5 ϕ relatively universal
$\text{Temp}(\forall \overset{z}{x} \phi^1, b) = \text{Temp}(\phi^1, b)$ if not $\text{Temp}(\phi^1, b) < \text{val}(z, b)$
$= \text{val}(z, b)$ if $\text{Temp}(\phi^1, b) < \text{val}(z, b)$

6 ϕ modal
$\text{Temp}(\Box_z \phi^1, b) = \text{val}(z, b)$

Be ϕ_z a formula with val (z, b) as temporality under the assignment b.
Some *valid formulas* that are characteristic for the notion of temporal necessity are (5)

Th 1 $\models \forall y \forall y' (y < y' \supset (\Box_y \phi \supset \Box_{y'} \phi))$

Th 2 $\models \forall y \forall y' (y < y' \supset (\phi_y \equiv \Box_{y'} \phi_y)$

Th 3 $\models \forall y \forall y' (y < y' \supset (\Box_{y'} (\phi_y \supset \psi) \equiv (\phi_y \supset \Box_{y'} \psi)))$

Th 4 $\models \forall y \forall y' (y < y' \supset (\Box_{y'} \forall \overset{y}{x} \phi \equiv \forall \overset{y}{x} \Box_{y'} \phi))$

Th 5 $\models \forall y \forall y' (y < y' \supset (\Box_{y'} \forall \overset{y}{x} (\phi_y \supset \psi) \equiv \forall \overset{y}{x} (\phi_y \supset \Box_{y'} \psi)))$

Th 6 $\models \forall y \forall y' (y < y' \supset (\Box_{y'} \exists \overset{y}{x} \phi_y \equiv \exists \overset{y}{x} \Box_{y'} \phi_y))$

Th 7 – Th 13 will be presented in section 2.3. They involve definite descriptions. Furthermore, note

$$\models \forall y (\forall x \phi \supset \forall \overset{y}{x} \phi) \text{ and}$$

$$\models \forall y \forall y' (y < y' \supset (\forall \overset{y'}{x} \phi \supset \forall \overset{y}{x} \phi))$$

(5) Other valid formulas are the theorems of S_5, R_τ (for any $\tau \in T$) being an equivalence-relation.

1.2. *QMTL: comments on the system*

In this section I want to draw attention to some elements of the system and give some explanations.

a. *Language*

A few remarks will suffice here.

In the alphabet of the language of QMTL we distinguish two kinds of terms (constants, variables), viz. *ontological* terms relating to objects supposed to be contained in a universe D, and *temporal* terms pertaining to moments or stretches of time.

We do not have one-place predicate-letters ([6]). The first term of any atomic formula $P_z v_1 \ldots v_n$ is always a temporal term followed by at least one ontological term.

Other types of formula characteristic of the system are $\forall \overset{z}{x}\, \phi$ and $\Box_z \phi$ because of the occurrence of the temporal term in them.

b. *Semantics*

The elements of a QMTL structure

1. T is a set of moments or stretches of time that must make it possible to regard each world as a succession of situations, here called a worldcourse.
2. $\ll$ is the relation 'earlier than' that is defined over the set of moments mentioned under 1.
3. D is the universe of discourse, a set that contains all objects that occur in one or more worlds.
4. W is the set of possible worlds w each regarded as a sequence of 4 funcions viz.
   a. Each w^1 assigns a moment to each temporal individual constant in such a way that each w^1 assigns the same moment to the same temporal individual constant.
   b. Each w^2 assigns to each ontological individual constant an object from D in such a way that each w^2 assigns the same

([6]) See, however, note 17).

object to the same ontological individual constant. Thus proper names become rigid designators.

c. w^3 is a funtion that assigns to each moment a subset of the universe of discourse, the domain of w at that moment of time. In the course of time new objects may be added to the domain of a world but no object can disappear from the domain. Example: In 1000 BC Socrates is not yet in the domain of our world, but in 400 BC he is, and so he is in 1979 (semi-formally: Socrates $\notin w_0^3$ (1000 BC), Socrates $\in w_0^3$ (400 BC), Socrates $\in w_0^3$ (1979)). Socrates is now in the domain of our world and in that sense 'exists'; he is an object to which we can rigidly refer by way of a name, this name being a rigid designator. (Sometimes a name is not used as a rigid designator, but as an abbreviation of a definite description. Thus before Socrates was begot his father talked about 'my (first) son', calling him already 'Socrates' after *his* father, and saying things like: 'Socrates will be a great sculptor'). But in 471 BC 'Socrates' is not yet a rigid designator, and in this sense cannot be used for naming an 'existing' object as *we* can do in 1979 A.D. That is why in QMTL objects may appear in – but do not disappear from the domain of a world: we discriminate between two kinds of things not now being in 'real' existence, viz. 1. the future things *not yet* being members of the domain of our world; 2. the things of the past, that have already a place in the domain and are in that abstract sense existent. Further $\bigcup_{\tau \in T} w^3(\tau)$ is the total domain of w, the set of objects from D that are in the domain of that world at one or more moments. It will be clear that not every world has the same domain. There is a possible world-course from 600 BC onwards in which the parents of Socrates did not meet. In such a world Socrates does not occur.

d. By each w^4 for each moment a set of n-tuples of objects from D is assigned to each n+1-place predicate letter. Thus $w^4(\tau, P^{n+1})$ can vary per moment. An informal example: let the relation 'neighbour of' be rendered by means of a 3-place predicate-letter $P_y x_1 x_2$ (in which y marks the place of a time index). Now both $w^4(\tau, P^{2+1})$ and $w^4(\tau', P^{2+1})$ are sets of pairs of objects that are neighbours (namely in w at τ, respectively

τ'), but not necessarily $w^4(\tau, P^{2+1}) = w^4(\tau', P^{2+1})$, as people may move between τ and τ' (7).

Ad *Definition of* $wR_\tau u$

$wR_\tau u$ is the accesibility-relation between w and u at time τ if w and u have the same past at τ, i.e.

a. have the same totality of states of affairs until τ
b. have the same domain until τ

Now you may wonder why this relation is defined in terms of the past, rather than in terms of the past and the present. Why not define $wR_\tau u$ in such a way that w and u have the same totality of states of affairs and the same domain up to *and including* τ, i.e. reading $\leqq$ instead of $\lessdot$ in the definition? The reason is that as a result of this we should have $\models \forall y(\phi_y \supset \Box_y \phi_y)$. This is unsatisfactory, since I might well do something at a moment without its being necessary at that same moment. If it were otherwise, I should always have an excuse for my actions, saying, when I did something, that I could not act otherwise, because it was necessary then. This is only a satisfactory excuse if it means that at that very moment the circumstances/initial situation had (already) made it necessary/compelled me. It is not satisfactory if it means that at the moment I do the action, it is thereby necessary. Thus this kind of neccesity including the present is not appropriate, especially in deontic contexts.

Ad *Truth-definition*

Some remarks.

1a. gives an interpretation of the atomic formulas $P_z v_1 \ldots v_n$. An informal example may help to clarify its meaning. Take the sentence 'John and James are neighbours at time t'. Its structure is $P_t a_1 a_2$. It is true if the set of pairs of neighbours in our world at time t contains the pair <John, James> as a member.

Note the difference between the interpretations of $\forall x \phi$ and $\overset{z}{\forall x} \phi$.

(7) For certain predicate letters we might assume an (existence-) postulate: For each $d_1 \ldots d_n \in D$, if $<d_1 \ldots, d_n> \in w^4(\tau, P^{n+1})$ then $d_1 \ldots d_n \in w^3(\tau)$. See also section 2.3.

The quantifier of the first formula pertains to the objects of the total domain of a world, the quantifier of the second to the domain of a world at a certain moment (denoted by z)(8). A sentence like $\Box_z\phi$ 'at time z it is necessary that ϕ' is interpreted as: in all worlds that are possible from the time denoted by z onwards, ϕ is the case. When ϕ lies in the past (seen from z) it is trivially true that $\Box_z\phi$. But even if ϕ lies in the future it may be necessary that ϕ, viz. in those cases in which there is a sufficient condition for ϕ in the past. In section 2.2.1. we will say more about the notions of sufficient and necessary condition.

Ad *Definition of Temp* (ϕ,b)

The notion of temporality has been introduced in order to formulate some theorems characteristic of the concept of temporal necessity. They state relations of equivalence between formulas that are about moments related to each other by $\ll$ (earlier than).

Roughly I mean by 'temporality' the time about which a proposition (interpreted formula) is. Not all propositions have a temporality, however, and some propositions only have an arbitrary temporality. The key in taking decisions here is the requirement that the resulting definition should yield the validity of $\forall y \forall y' (y < y' \supset (\phi_y \supset \Box_{y'} \phi_y))$ (cf. th 2).

How the definition works may be seen when one goes through the proof of th 2 in the Appendix of (10). Here I confine myself to a few remarks.

Formulas of the form $\forall x \phi^1$ do not have a temporality. If we should take as its temporality the temporality of ϕ^1, we could not prove th 2: it may be the case that all objects in the domain of a world w satisfy ϕ^1 at a time t, while in a world u, accessible to w at t' (later than t) a new object comes into being (not included in the domain of w) not satisfying ϕ^1 at t in u. Note that this counterexample cannot function as an objection against assigning a temporality to formulas of the form $\overset{z}{\forall x} \phi^1$. For them the latest of val(z,b) and Temp(ϕ^1,b) is choosen as a temporality because it is the 'safest' in regard to th 2.

(8) Note that the temporally unrestricted quantifier could have been introduced by definition: $\forall x\phi = \forall y \overset{y}{\forall x}\phi$ (where y does not occur free in ϕ).

The same policy has been adopted to implications: the temporality of 'If I am in Amsterdam at 1 p.m. on the 7^{th} of May, then I am in Amsterdam at 11 p.m. on the 8^{th} of May' is 11 p.m. on the 8^{th} of May (the latest time).

Two other examples: 1. 'It is now, at 10 p.m. on the 7^{th} of May, impossible that I shall be in Amsterdam today (7^{th} of May) at 11 p.m.'. 2. 'It was possible at 9 p.m. on the 6^{th} of May that I should be in Amsterdam today (7^{th} of May) at 11 p.m.'. The temporality of 1. is 10 p.m. on the 7^{th} of May, the temporality of 2. is 9 p.m. on the 6^{th} of May, whereas the temporality of the subsentence '... that I shall (should) be in Amsterdam today (7^{th} of May) at 11 p.m.' is 11 p.m. on the 7^{th} of May.

A final word about the listed theorems

Th1 says that if a state of affairs ϕ is a constituent of all possible courses the world can have from τ on, the it is a constituent of all possible courses the world can have from any time τ', later then τ. For instance, if it is now (today) temporally necessary that I was in Amsterdam yesterday, then at any time after today, it will be necessary that I was in Amsterdam on that day. Th 2 expresses the trivial truth that if (and only if) a state of affairs ϕ is a constituent of a world at a certain moment τ, then it is a constituent of all the possible courses that world can have from any time τ', later then τ, onwards. The reason for this is that all the possible courses a world can have from a time τ', later then τ, include the course of that world until τ. Therefore as soon as something has become a fact it is necessarily a fact.

Theorems 3-6, on the contrary, are far from trivial and have important philosophical consequences: they exhibit that sometimes certain syntactical distinctions do not have a semantical background. Thus th 3 reveals under what conditions there is no semantical difference between the two readings of a sentence of the form 'if ϕ then necessarily ψ' resp. as stating an implication implying the necessity of the consequent and as stating the necessity of the whole implication. Likewise a distinction between de re- and de dicto modalities is sometimes only syntactical, and not existing from a semantical point of view (Th 4-6).

A fuller treatment of these issues, and of issues concerning th 7-13 will be given in the next sections.

2. *Philosophical applications of QMTL*

We shall see that the construction of QMTL is not merely an ad hoc measure, justified only by the needs of a workable deontic logic to be constructed upon this foundation later on. The temporally relative modal notions defined in terms of a strict-accessibility relation appear to be of vital importance both in analysing and evaluating arguments in modal logic that find there origin in Aristotle and still arouse interest, and in the study of the behaviour of definite descriptions in certain contexts. In order to illustrate the fruitfulness of QMTL we shall give some analyses on the basis of which we shall reach some philosophically interesting insights.

2.1. *Unumquodque, quando est, oportet esse*

In this section we give a first example of the role the notion of temporal necessity sometimes plays in philosophical contexts and we shall show how a sound intuition embodied by Th 2 may lead to an illicit conclusion. It is to be found in 'Philosophische Bemerkungen zu mehrwertigen Systemen des Aussagenkalküls' of Jan Łukasiewicz (see (24))([9]). In § 2 of that paper he tries to establish the principle

1. If it is supposed that not-p, then it is (on this supposition) not possible that p.

This principle he considers representative of the theorem

2. Unumquodque, quando est, oportet esse

and its origin in Aristotle's De interpretatione IX 19a 23 (see (2)):

3. Τὸ μὲν οὖν εἶναι τὸ ὂν ὅταν ᾖ, καὶ τὸ μὴ ὂν μὴ εἶναι ὅταν μὴ ᾖ, ἀνάγκη·

that he paraphrases resp. as 'Whatever is, *when* it is, is necessary' and as '... when something which is is, then it is also necessary; and when something which is not is not, it is also impossible.'

([9]) I shall use the English translation that appeared in (26).

In order to explain the theorems he gives two examples: 'It is not necessary that I should be at home this evening. But *when* I am already([10]) at home this evening, then on this assumption it is *necessary* that I should be at home this evening. A second example: It rarely happens that I have no money in my pocket, but *if* I have now (at a certain moment t) no money in my pocket, it is *not possible* on this assumption, that I have money (at just the same moment t) in my pocket. Note has to be taken of two things about these examples. First the propositions 'I am at home this evening' and 'I have (at the moment t) no money in my pocket' are supposed to be *true*, and on this supposition the necessity or impossibility respectively is inferred. Secondly, the word *quando* in (2), and the corresponding 'ὅταν' of Aristotle, is not a conditional, but a temporal particle. Yet the temporal merges into the conditional, if the determination of time in the temporally connected propositions is included in the content of the propositions.'([11])

The examples given are thought to be evident enough to establish the principle (1).

Let us look at (2) and (3). Without claiming the one and only one correct interpretation, I suggest that we may very well interpret them in terms of temporal necessity and, translating them in the language of QMTL, get a valid formula $(z < z' \supset (\phi_z \supset \Box_{z'} \phi_z))$([12]): as soon as something is the case it necessarily is the case. Now Łukasiewicz apparently recognizes the temporal character of the modal sentences at hand, as is witnessed by his remark about 'quando' and 'ὅταν'. Accordingly his first example has the same structure as (2) and represents the plain truth that as soon as I am already at home at a certain time, it is irrevocable (from that time on([13])) that I was then at home (my presence then and there has become a part of the (irrevocable) past).

([10]) The word 'already' does not occur in the translation in (26). But the German original text has 'schon' here.

([11]) See p. 42 and 43 of (26).

([12]) Or $(z < z' \supset \forall x(\phi_z(x) \supset \Box_{z'} \phi_z(x)))$, where x has a free occurrence in $\phi_z(x)$. Or is the more specific $(z < z' \supset \forall x(\overset{z}{\exists} x' x = x' \supset \Box_{z'} \overset{z}{\exists} x' x = x'))$ meant: As soon as something exists, it necessarily exists?

([13]) 'from...on' in a non-inclusive sense. Cf. section 1.2.

But what about the second example?

The 'when' of the first example is thought to 'connect temporally' the propositions and QMTL can make sense of this thought. After all the implication $(\phi_z \supset \Box_{z'} \phi_z)$ (where $z < z'$) has as a temporality the time 'when' pertains to (z'). But the second example has 'if' instead of 'when', and this must not be considered as accidental, in view of the remark that 'the temporal merges into the conditional'. This suggests a *non*-temporal reading of the second example: $(\neg\phi_z \supset \Box \neg\phi_z)$.

However this is of course not enough to establish principle (1)!

The trivial truth of temporal necessity of the 'when'-sentence in the first example smooths the way – because an explicit temporal term after 'necessary' has been omitted – for the 'if' of the ensuing example where the modality is allegedly no longer temporal([14]). In this way 'the temporal merges into the conditional'! Not a single reason is given to justify the transition.

Here we have an occasion on which the notion of temporal necessity leads to acceptance of an incorrect principle. But there is still another tempting element, viz. the plausibility of (1) from a pragmatic point of view. It seems to be incorrect to claim in a conversation the truth of a proposition p and at the same time leave open the possibility that p is not the case. You 'cannot' say: 'It is true that p, but possibly not p', just as you cannot say: 'p is the case, but I do not believe that'. But this is no reason to claim the validity of 'if p then it is believed that p'. Nor must the pragmatic incorrectness of 'It is true that p, but possibly not p' seduce you into accepting $(p \supset \Box p)$ as a theorem.

Łukasiewicz took principle (1) as valid and formalized it as $(\neg p \supset \neg\Diamond p)$ (by substitution one gets $(p \supset \neg\Diamond\neg p)$). Acceptance of the principle induced him to construct a three-valued logic for future-contingency propositions. It is easy to see indeed why he needed a third value for them: if they are true or false they express a necessity respectively impossibility, not a contingency. So he introduced a value I ('indefinite') for these propositions and interpreted

([14]) In the German original the suggestion is still stronger: it has the equivocal 'wenn' both in the first and the second example.

negation, implication and necessity in such a way that in his three-valued system ($\neg p \supset \neg \Diamond p$) is not valid for such propositions: if and only if the value of p is I, the value of the whole implication is I. Thus he saved the principle (1) in which the falsity of p (truth of not-p) is supposed ([15]).

But, as we saw, the examples Łukasiewicz employed in order to establish the principle did not offer a justification for the transition from a temporally relative necessity to a necessity simpliciter.

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([15]) For a fuller discussion of Łukasiewicz's argumentation in favour of a three-valued logic, see chapter II and VII of (9).

(To be continued in the next issue).

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